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EFFECTS OF PURSED LIP BREATHING AND BILATERAL CHEST WALL AUGMENTATION ON SLOWING RESPIRATORY RATES

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EFFECTS OF PURSED LIP BREATHING AND
BILATERAL CHEST WALL AUGMENTATION
ON SLOWING RESPIRATORY RATES

by

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STATEMENT BY AUTHOR

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ABSTRACT

The theoretical question of this study was derived from the recommended clinical practice of slowing respiratory rates of patients with chronic obstructive lung disease during times of stress. The specific intent was to determine if pursed lip breathing or the combination of pursed lip breathing and bilateral chest wall augmentation would be effective in slowing respiratory rates. If these techniques were helpful, then was one intervention more effective than the other?

A convenience sample of 20 patients with chronic obstructive lung disease participated in one control and two treatment sessions. Respiratory rates were monitored and compared to determine how long it took the patient to return to his resting rate after ambulation, using either pursed lip breathing alone or in combination with bilateral chest wall augmentation.

Results demonstrated that pursed lip breathing alone and in conjunction with bilateral chest wall augmentation were equally effective in slowing respiratory rates. Using these techniques to slow respiratory rates may mean an increased tolerance to activity, without the detrimental effects of a rapid respiratory rate, for patients with chronic obstructive lung disease.

CHAPTER 1

INTRODUCTION

Chronic obstructive lung disease (COLD) is defined as persistent airways obstruction of uncertain etiology (Burrows, 1983). The two major diagnoses associated with COLD are emphysema and chronic bronchitis. Emphysema is characterized by permanent, abnormal enlargement of any part of the acinus, accompanied by destructive changes (Thurlbeck, 1974). Chronic bronchitis is characterized by chronic excessive secretion of mucus in the tracheobronchial tree (Thurlbeck, 1974). Most patients with COLD have both symptomatic bronchitis and anatomic emphysema; the severity of each varies considerably in individual cases (Burrows, 1983).

The emphysema component of COLD causes excessive collapse of airways during expiration whereas the bronchial changes result in mechanical obstruction to airflow. Patients have expiratory flow rates which are lower than normal and if the disease is severe enough these patients may be breathing at maximum flows even with normal tidal breathing. Because of these physiological changes, the most efficient respiratory pattern for the patient with COLD is slow, deep breaths with a prolonged expiratory phase.

Exercise is often the factor that provokes patients to breathe less efficiently, notably with an increased respiratory rate. Patients may experience increased respiratory rates even after walking only a short distance. If patients continue to exercise their respiratory rate may become so rapid that their functional residual capacity (FRC) will increase to such a point that their inspiratory capacity will be greatly reduced. The limiting of volume excursion can eventually result in ineffective alveolar ventilation, increased proportion of minute volume wasted in physiological dead space, increased work of breathing and accentuation of pre-existing unequal distribution of ventilation.

Pursed lip breathing (PLB) and bilateral chest wall augmentation (BCWA) are two modes of treatment that have been used to decrease the respiratory rate of a patient with COLD experiencing an abnormally rapid rate. By slowing the respiratory rate and placing emphasis on the exhalation phase, a deeper inhalation occurs. Increasing the expiration time could prevent a patient's volume excursion from becoming progressively less and therefore prevent the detrimental effects of limited volume excursion.

There are few studies that compare the effectiveness of pursed lip breathing and bilateral chest wall augmentation in slowing respiratory rates in patients with COLD under stress. The data from this study can be useful in instituting these techniques as part of a regular treatment regimen for the patient with COLD.

Purpose of the Study

The purpose of the present study was to determine if pursed lip breathing (PLB) and the combination of PLB and bilateral chest wall augmentation (BCWA) were effective in slowing respiratory rates. Also determined was which technique was most effective for the individual subject in slowing his respiratory rate. The study also included the patient's perception of which technique was most effective in relieving his sensation of dyspnea.

Significance of the Problem

Treatment of patients with COLD that are experiencing the potentially detrimental effects of a rapid respiratory rate demands immediate attention. Nurses are frequently in a situation where a physician is not immediately available to initiate medical treatment. Therefore, it would benefit the nurse and patient to have techniques available that do not require a physician's supervision or order. Two techniques which fit into this category are pursed lip breathing and bilateral chest wall augmentation.

Pursed lip breathing and BCWA are assumed to decrease respiratory rates and maintain or increase volume excursion. The clinical assumption that these two techniques do slow respiratory rates needs empirical support. Therefore, data must be collected and each method substantiated in order to verify that the technique will decrease respiratory rates and secondly to determine which technique is most effective.

Assuming the PLB and BCWA are effective means of slowing respiratory rates, there is great potential for the patient with COLD to increase his activity tolerance and not experience the detrimental effects of an increased respiratory rate during and after exercise. If these interventions are helpful after exercise, PLB and BCWA also have potential use during exercise. The patient may attempt more activities and eventually be able to complete more tasks. Any technique which can make the activities of daily living easier or even possible is significant to investigate.

Hypotheses

1. Pursed lip breathing will decrease respiratory rates post-exercise in significantly less time than not intervening with the subject post-exercise.
2. The combination of bilateral chest wall augmentation and pursed lip breathing will decrease respiratory rates, post-exercise, in significantly less time than pursed lip breathing alone.
3. The combination of bilateral chest wall augmentation and pursed lip breathing will be perceived as relieving dyspnea post-exercise more effectively than pursed lip breathing alone.

Theoretical Framework

The theoretical framework encompasses the pathophysiological alterations in COLD that make breathing at rapid respiratory rates detrimental to the patient's well-being. The major factors that make increased respiratory rates detrimental are an increase in FRC, increased work of breathing and decreased gas exchange. Since the present study attempts to decrease respiratory rates, the advantages of the slower rate are included.

Pathophysiology

The elastic forces exerted by the lung and chest wall determine the FRC, which is the volume of air in the lung when all respiratory muscles are relaxed and there is no movement of air (Burrows, 1983). The pathological alterations occurring in emphysema cause loss of the lung elastic force. This loss can result in an increased volume of air in the lungs at FRC. An increased FRC can also occur in chronic bronchitis if the disease process is severe enough to promote premature closure of obstructed airways. If airway obstruction becomes so severe and causes prolonged expiration, a further increase in FRC may occur because the signal for inspiration arrives before expiration is complete (Thurlbeck, 1974).

In addition to the change in FRC, the patient with COLD will also experience alterations in residual volume (RV) and vital capacity (VC). These lung volume changes will occur as a result of changes in the compliance of lungs and chest wall, respiratory muscle weakness and abnormal airway closure (Burrows, 1983).

Emphysema can be characterized by a decrease in VC which results from an increased RV. Pathological destruction of alveolar walls obliterates the radial traction that normally creates a tethering effect and creates a tendency for airways to collapse prematurely on expiration. Premature collapse causes marked trapping of air or an increased RV. When a larger percentage of the total lung capacity is utilized for residual volume, the vital capacity is consequently reduced.

Chronic bronchitis can also be characterized by an increase in RV but the mechanism creating this increase is different from that in emphysema. In chronic bronchitis, there is mechanical obstruction or airways narrowing caused by an inflamed and edematous bronchial mucosa which predisposes airways to closure at high lung volumes (Thurlbeck, 1974). As in emphysema, the VC decreases as the RV increases, limiting volume excursion (Macklem, 1973).

Increased Functional Residual Capacity with Increased Respiratory Rates

The reduction of airway diameter in patients with COLD increases airway resistance which means a greater amount of pressure must be generated to maintain adequate flow. Resistance can be decreased by breathing at higher lung volumes. High lung volumes increases the traction applied to the intrathoracic airways which stretches them both in diameter and length. Therefore, patients with high airways resistance will breathe from a larger FRC in order to decrease resistance (West, 1977).

Besides decreasing resistance, breathing at a higher FRC allows the patient with COLD to increase his expiratory flow rate. In order for the patient to breathe faster he must increase his expiratory flow rates and to achieve these faster rates he must increase lung recoil which means breathing at a higher lung volume. If the patient is forced to breathe at a higher and higher FRC in order to attain fast enough expiratory flows, the result can be a limited volume excursion which may affect adequate gas exchange.

In addition to lung volume, another factor influencing airways resistance and consequently flow rates is the equal pressure point concept. This phenomenon is theorized to occur in the normal individual when he performs a forced expiratory maneuver. The equal pressure point is assumed to be responsible for the inability to exceed a maximum expiratory flow rate, even if an individual exerts additional muscle force (Cherniak, 1977).

Expiratory flow rates are determined by the difference between the driving pressure and the atmospheric pressure, assuming the pleural pressure is no greater than the pressure in the airway. If the pressure in the airway equals the pleural pressure, this point is called the equal pressure point. From this point toward the mouth, the airway undergoes dynamic compression. The amount of dynamic compression will depend on the pleural pressure and compliance of the airway (Burrows, 1983). Therefore, if there is loss of recoil, flow will be influenced by two mechanisms. These are: decreased driving pressure and dynamic compression of a longer segment of airway, which accounts for increased resistance and lower expiratory maximal flows.

The work generated by muscular forces must be sufficient to overcome both elastic forces and air flow resistance inherent in the respiratory structures (Burrows, 1983). The pattern of breathing adapted by the respiratory apparatus will be that which requires the minimum of work. If the flow resistant or elastic properties of the respiratory apparatus are altered by disease, the amount of either flow resistant or mechanical work will need to be adjusted to obtain a respiratory pattern at which the total work of breathing is minimal (Cherniak, 1977).

The most efficient pattern of breathing for the patient with COLD is slow, deep respirations. Those patients with emphysema have increased compliance which lessens the work needed to overcome elastic resistance but the increased airway obstruction increases the work needed to overcome flow resistance (Traver, 1982). The slow, deep respiratory pattern allows the pleural pressure to become more sub-atmospheric so that larger lung volumes can be attained. As the volumes increase so will the radial traction applied to the airways, lessening the resistance to flow, which reduces the work of breathing (Cherniak, 1977).

Normally, the potential energy stored in the elastic structures during the inspiration is sufficient to overcome resistance to flow on expiration (Cherniak, 1977). When flow resistance work increases, the energy stored is insufficient to produce adequate airflow during expiration (Fishman, 1980). Additional work must be done by the expiratory muscles, producing an active, forced expiratory pattern. Airway obstruction, as in emphysema or chronic bronchitis, increases the work of breathing since it is necessary to produce more muscle force to overcome flow resistance. Therefore, even at low respiratory rates, the work of breathing for the patient with COLD can be four to 10 times that of a healthy individual (Cherniak, 1977). There will be further increases in the work of breathing if the patient with COLD must maintain a rapid respiratory rate. Flow resistance work increases approximately in proportion to increases in respiratory rates (Cherniak, 1977).

Another factor to consider when there is an increase in respiratory rate and subsequent rise in FRC is the loss of tidal volume which creates increased physiologic dead space ventilation. The loss of tidal volume means that rate of ventilation must increase to maintain equivalent alveolar ventilation that a slow, deep pattern will attain (Traver, 1982). Also to be considered are the oxygen requirements of the respiratory muscles. An alteration in lung mechanics can increase the oxygen required by the respiratory apparatus as will any activity that necessitates increase in ventilation rates (Traver, 1982). It is thought that the high oxygen costs may be a factor in limiting exercise in patients with altered airway mechanics (West, 1977).

The forced expiratory volume in one second (FEV_1), is also a factor in the limitation of exercise and is often used as a guideline to determine shortness of breath for different FEV_1 values. For example; when the FEV_1 is above 1500 cc's, most adults are not aware of shortness of breath. When the FEV_1 falls below 1000 cc's, shortness of breath occurs with mild exertion, and when the FEV_1 is below 500 cc's, there is shortness of breath at rest (Traver, 1982).

Effects of Increasing Respiratory Rates

Dyspnea experienced by the patient with COLD often limits the person from participating in basic activities of daily living. Rapid respiratory rates accompanied by a high FRC are often used to explain the phenomenon of dyspnea (Dudley, 1973). Although this state of hyperinflation has not been proven to correlate with dyspnea, hyperinflation does reduce the efficiency of air exchange which can result in hypoxemia and hypercapnia (Shapiro, 1975).

Shallow rapid breathing accentuates any pre-existing inequality of air distribution during ventilation (Cotes, 1979). Gas distribution to an individual lung unit is dependent on the compliance of the airspace and the resistance of the airway leading to it. Since air goes to the area of least resistance, lung units with obstruction will experience a slower volume change than those unobstructed areas. With rapid respiratory rates, the obstructed area cannot undergo a fast enough air volume exchange, therefore most of the inspired volume will go to the unobstructed areas. This creates an overdistention of lung units, thus total lung compliance decreases (Geoffrey, 1966). If perfusion to the lung units remains equal whether the units are obstructed or not, gas exchange will be impaired (Macklem, 1973).

The pathological alterations occurring in emphysema and chronic bronchitis create obstructed lung units, so slow inflation and prolonged expiration for adequate emptying is required for adequate ventilation. If low breathing frequencies can be maintained, airflow is slow and ventilation is fairly evenly distributed which maintains an adequate ventilation/perfusion ratio (Fishman, 1980).

Advantages of Decreasing Respiratory Rates

The patient with COLD must make a conscientious effort to slow his respiratory rate once it has become rapid enough to cause adverse effects such as limited volume excursion. In order for the slower respiratory rate to be attained, a prolonged expiratory phase is necessary.

Sufficient time for exhalation allows for a deeper inhalation to follow. Slowing exhalation prevents the pleural pressure from rising dramatically which lessens the amount of dynamic compression on the downstream segment, decreasing resistance to airflow. Reducing resistance to the slow spaces can improve ventilation to those poorly ventilated units and correct some of the nonuniform distribution of flow (Menkes, 1980).

If slower respiratory rate is maintained with prolonged exhalation, the patient will not need to breathe at maximum flow rates or create high recoil pressures. The slower rate will keep the work of breathing minimal and should increase volume excursion (Cherniak, 1977).

CHAPTER 2

REVIEW OF THE LITERATURE

Literature pertaining to (1) effects of slowing respiratory rates, (2) effects of pursed lip breathing, and (3) effects of augmented breathing maneuvers are presented in this chapter.

Effects of Slowing Respiratory Rates

Sergysels and colleagues (1979) studied 12 patients with chronic obstructive airways disease of comparable severity; all had airway resistance that was approximately six times normal. The effect of low frequency breathing was compared with spontaneous breathing at rest and during exercise. Arterial blood samples were obtained from a catheter placed in the brachial artery. Respiratory rates and tidal volumes were measured with a Fleisch pneumotachograph. At rest, mean respiratory rates were lowered from 21.0 to 10.2. This decrease resulted in a small but significant increase in arterial oxygen tension (pO_2) and a decrease in arterial carbon dioxide tension (pCO_2). There was no significant change in minute ventilation. When the subjects exercised, slowing the respiratory rate produced a slight reduction in pCO_2, an increase in minute ventilation but no change in pO_2 values. It should be noted, however that only two of the 12 subjects were able to maintain low frequency breathing during exercise. The investigators summarize their results by stating that at rest, low frequency breathing increases alveolar ventilation and thus improves gas exchange of patients with chronic lung disease.

Ten hospitalized men with severe emphysema and/or chronic bronchitis were studied by Geoffrey and associates (1966). They used a respirator simulator to slow respiratory rates gradually, to the slowest rate the patient was able to tolerate and follow. Samples of arterial blood gases and expired air were obtained three times while the patient was breathing at his accustomed respiratory rate and again after his rate had been slowed. The average decrease in rate was 7.5 respirations per minute and there was a significant drop in minute volume ventilation of 1.9 liters per minute. A slight increase in alveolar ventilation was reflected in a small change in pCO^2 levels. The data collected demonstrated that maintenance of alveolar ventilation during decreased total minute ventialtion is due to the rate of effective ventilation being increased during slowed respiratory rates.

Motley (1963) measured arterial blood gas values and made spirogram recordings of tidal volumes on 35 patients with severe emphysema. These tests were performed while the subject was using his usual breathing pattern and after 10 minutes of controlled slower respiratory rates using an electronic respiratory simulator. He was able to slow breathing by 40 to 50 percent within a three minute period. With the slower respiratory rate, tidal volumes increased from 494 to 814 mls. per breath. Although not significant, minute ventilation increased from 4.01 to 4.27 liters per minute per square meter of body surface. Oxygen saturation levels improved in all but two cases, the average resting saturation was 89.5 percent during controlled breathing. Significant decreases in pCO_2 were obtained, the average drop being 3.3 mmHG. Motley concluded that a slow, deep respiratory pattern improves arterial blood gas values, probably due to the 50 to 100 percent increase in tidal volume.

Effects of Augmented Breathing Maneuvers

Petty and Guthrie (1971) compared four methods of augmented breathing in 10 male patients with severe chronic airways obstruction. Arterial blood gases on all 10 subjects demonstrated carbon dioxide retention, defined as a pCO_2 above 45 mmHG. The four methods used in order were: 1) lower chest and abdominal compression with a mechanical device applied by a physiotherapist; 2) a hand held Intermittent Positive Pressure Breathing (IPPB) device set at 20 cm. H_2O pressure with the patient breathing at his own respiratory rate; 3) instructing the patient to breathe as deeply as possible at a slow but comfortable rate; and 4) a physiotherapist manually assisting the patient in abdominal-diaphragmatic breathing and instructing the patient to exhale against pursed lips. Each of the four augmented breathing periods was followed by a 10 minute control period.

A Wright's Respirometer was used to measure tidal volumes three times during each study period. In the last two minutes of each phase arterial blood samples were obtained. The results showed statistically significant reductions in pCO_2 in all methods except voluntary deep breathing. The pCO_2 dropped the most after IPPB. Tidal volumes were significantly increased by all four methods, with IPPB producing the greatest increase. Respiratory rates and minute ventilation/pCO_2 ratios were reduced significantly, the lowest occurring with manual compression and pursed lip breathing. The authors conclude that the increased tidal volumes and decreased respiratory rates although transient, improve alveolar ventilation.

Effects of Pursed Lip Breathing

Mueller et al., (1970) studied the effects of PLB on ventilation and gas exchange during rest and exercise in 12 subjects with chronic airway obstruction. A standardized questionnaire was used first to determine whether or not the individual subjects did or did not get symptom benefit from PLB. Seven subjects claimed relief and five denied relief. The following sequence was used for each subject with steps three and five being randomly reversed and each step requiring six minutes: 1) normal breathing at rest; 2) PLB at rest; 3) normal breathing during exercise; 4) rest period of 10 minutes or more; and 5) PLB during exercise. For each step, except number four, an arterial blood sample and respiratory count were done during the last minute. Minute ventilation was calculated from expired gas volume which in turn was used to determine tidal volumes.

The data from the study indicated that PLB, during both rest and exercise, resulted in a marked drop in respiratory rate. Pursed lip breathing during exercise and rest did significantly increase tidal volumes in those subjects that felt PLB was beneficial. Pursed lip breathing at rest showed immediate and significant improvement in arterial pO_2; pCO_2 and O_2 saturation measurements compared to normal breathing. During exercise there were no changes in arterial blood gases as a result of pursed lip breathing. The authors concluded that PLB prevents airway collapse and as a result there is less air trapping, an increase in tidal volume and secondary decrease in respiratory rate.

Thoman, Stoker and Ross (1966) compared three different breathing patterns on 21 male ambulatory subjects with chronic obstructive pulmonary disease. Measurements of lung volumes were made initially using a Stead-Wells spirometer. Functional residual capacity and airway resistance measurements were made by total body plethysmograph and arterial blood samples were obtained from an indwelling needle placed in the brachial artery. Each subject participated in three 10 minute sessions in the following order: 1) normal pattern of breathing used by the individual; 2) pursed lip breathing; and 3) controlled breathing rate using a light to signal the patient to inspire.

The data collected showed that the controlled rate was very similar to pursed lip breathing in all parameters. Both techniques were able to significantly slow respiratory rates from a mean of 19.4 to 13.1 and increase tidal volumes an average of 224 mls. Arterial pCO_2 levels also dropped significantly in 16 subjects. The authors measured the pressure drop across pursed lips using a water manometer and a small polyethylene tube positioned in the mouth prior to placing a face mask. The pressure drop measured was in the range of two to four cm. of water. The investigators suggested that pursed lip breathing does forestall or diminish early airway collapse by increasing intraluminal pressure; thus airway resistance is decreased and ventilation enhanced. There was still uncertainty whether the slowed respiratory rate which occurs spontaneously during pursed lip breathing was responsible for some of the changes apparent in the data collected.

A study published in 1964 (Schmidt, Wasserman, & Illington) attempted to differentiate between airway functional mechanics during expiration in emphysema and bronchial asthma. The investigators tested 10 normal subjects, seven subjects diagnosed with bronchial asthma and 10 with emphysema. Expiratory airflow and induced positive oral pressures were measured on each subject. Oral pressures were created by the addition of weights to the spirometer to simulate pursed lip breathing.

The data collected reflected that increased oral pressures are not accompanied by increased vital capacities in the normal subjects or in patients with asthma or emphysema. In order to distinguish between the effects of changes in expiratory flow rates and oral pressure, the subjects' expiratory flow rate was displayed on the oscilloscope for observation by the subject. Observing his expiratory flow rates allowed the subject to control his rate of exhalation to a minimal flow rate prescribed by the experimenter. While the subject was performing these exhalation maneuvers, the investigator was changing oral pressures by adding weights to the spirometer to vary resistance. The same procedure was followed when all the subjects were asked to perform a maximum effort vital capacity maneuver.

The normal and bronchial asthmatic subjects demonstrated no change in vital capacity, while the subjects with emphysema increased their vital capacity by 42.1 percent using minimal effort technique. The researchers concluded that increasing oral pressures alone does not account for improved vital capacities in the subject with emphysema but the benefit obtained is due to the reduction of expiratory flow rates. Pursed lip breathing reduces the initial expiratory flow rate which allows for improved patency of the airway in the highly compliant lung. Decreasing expiratory flow decreases airway resistance at any given lung volume. The normal subject has lower compliance of the lung, therefore upper airway resistance and slower expiratory flow rates are of no advantage.

In a study conducted by Ingram and Schilder (1967) 15 male subjects with COPD were divided into two groups: those that obtained relief from dyspnea by pursed lip breathing and those that did not. Eight subjects claimed pursed lip breathing helped and the remaining seven denied it was useful. The investigators collected data using an intraesophageal balloon and pressure transducer to estimate intrapleural pressures. A pneumotachograph measured inspiratory and expiratory flow rates during non-obstructed breathing and while an obstructing rubber stopper was in place. Each subject performed ten obstructed and obstructed breaths. The equipment was designed with a large dead space volume to cause the subject to breathe large tidal volumes and at increased respiratory rates to simulate a pattern similar to a dyspneic episode. The group that claimed benefit from pursed lip breathing had a 51 percent drop in transpulmonary pressures when the obstruction was in place versus a 24 percent decrease in the non-pursed lip breathers. Peak expiratory flows decreased similarly in all subjects when obstructed, but lung volume improved proportionately more in those subjects with more large airway callapsibility. During non-obstructed breathing the pursed lip group demonstrated expiratory resistance values averaging 12.4 cm. of water per liter per second which were significantly higher than the non-pursed lip group which averaged 7.9 cm. of water per liter per second. The effectiveness of the obstruction in decreasing resistance across the lungs and airways was directly related to the amount that the non-obstructed expiratory resistance exceeded inspiratory resistance.

Barach and Seaman used motion picture films to contrast the effectiveness of contraction of the abdominal wall in inducing the diaphragm to ascend in normal individuals to patients with emphysema. They found that patients with emphysema had far less diaphragm movement than the control group. The patients with emphysema were given an emphysema belt worn over the lower abdomen and taught to ambulate leaning forward at a 15 degree angle; motion pictures were repeated. The diaphragm moved from the eleventh to the ninth rib and increased excursion of the diaphragm was noted on inspiration. On expiration the diaphragm ascended rapidly in a snap like action as a result of abdominal pressure from the emphysemic belt. It was also observed that when diaphragmatic breathing was restored, there was much less use of the neck and shoulder girdle accessory muscles. The authors conclude that diaphragmatic respiration takes place with less energy expenditure than ventilation by accessory muscle, therefore use of the belt and leaning forward during ambulation is beneficial to the emphysemic patient.

CHAPTER 3

METHODOLOGY

Research Design

An experimental design was used to study the effectiveness of two methods in slowing respiratory rates in subjects with COLD. The effectiveness of each method was evaluated by measuring the amount of time it took to bring post-exercise respiratory rates back to pre-exercise measured respiratory rates. Each subject filled out a questionnaire to determine which method he perceived as being most efficient in relieving dyspnea.

A convenience sample of 20 subjects participated in the study. Due to interindividual variability, each subject served as his own control. The control session was always conducted during the first visit. The order of the last two treatment sessions was randomly chosen. Either pused lip breathing or pused lip breathing and bilateral chest wall augmentation were instituted in the second or third session.

Population

The purpose and nature of the study was explained to a physician in private practice and specializing in pulmonary medicine. The physician was given a copy of the Subject and Physician Consent plus the criteria the subjects must meet (see Appendix A and B). The physician was then asked to give the investigator a list of potential subjects.

The investigator then chose 20 names out of 30 from a hat. If the subject was not available or refused to participate in the study, another name was drawn.

When a name was picked, initial contact was made with the potential subject by telephone. The subject was informed that his physician had submitted his name as a potential subject to participate in the study. The purpose and nature of the study was explained and the subject was asked if the sessions could be done at his place of residence. If the subject agreed to participate, a date and time for the initial session was made.

A written consent was given to the subject and any requested additional verbal explanation was given. Written consent was then obtained by subjects willing to participate in the study (see Appendix A).

Criteria for Subjects

Twenty subjects with a diagnosis of COLD were selected in a Southwestern metropolitan area. Subjects who agreed to participate in this study met the following criteria:

1. Physician confirmed diagnosis of chronic obstructive lung disease.
2. FEV_1 documented to be below 1500 cc's.
3. Stable, without hospitalization, for at least two weeks prior to participation in the study.
4. Able to understand, speak and read English.

5. Verified by the physician to tolerate ambulation that would increase their respiratory rate by 25 percent.
6. Willing to allow the investigator to conduct each treatment session at their place of residence.

Protection of Human Rights

The United States Department of Health, Education and Welfare has determined the guidelines for protection of subjects' human rights including the right to informed consent, confidentiality and protection against risk to subjects. These guidelines were followed in this study. The nature and purpose of the study was given to each subject. The subject was then asked if they were willing to participate, and if so, signed the subject consent form (see Appendix A). Each subject was assured confidentiality by assigning each subject a number for coding of the data. The research proposal, subject consent form and physician consent form were submitted and approved by the University of Arizona Human Subjects Committee (see Appendix C).

Treatments

Either pursed lip breathing or the combination of pursed lip breathing and bilateral chest wall augmentation was initiated after ambulation during Experimental Session I or II. No effort was made by the investigator to modify respiratory patterns while the subject was ambulating.

Pursed Lip Breathing (PLB)

Pursed lip breathing consists of the subject forming his lip's into a whistling position while performing a slow, prolonged exhalation. Inhaling can be done either through the mouth or nose.

Bilateral Chest Wall Augmentation and
Pursed Lip Breathing (BCWA and PLB)

Bilateral chest wall augmentation is accomplished by the investigator placing her hands just above the subjects rib margins. As the subject inhales, the investigator maintains hand contact but does not apply pressure. During exhalation, the investigator applies more and more pressure in coordination with expiratory movement (see Figure 1). Pursed lip breathing is used in conjunction with bilateral chest wall augmentation.

Methodology

Three treatment sessions were scheduled. Each session was held within ten days of the previous session. Each session consisted of asking the subject to ambulate on level ground. The subject was told to ambulate at a pace that would not cause undue shortness of breath or more dyspnea than the subject normally experienced with ambulation. The subject was informed he could use any aide (oxygen, walker, cane) for ambulating, if he routinely did so. The subject was also told that he could sit in the position he usually did and in which he felt most comfortable after ambulating.

At the beginning of each session, before ambulation was initiated, 25 percent increased respiratory rates and maximum radial pulse

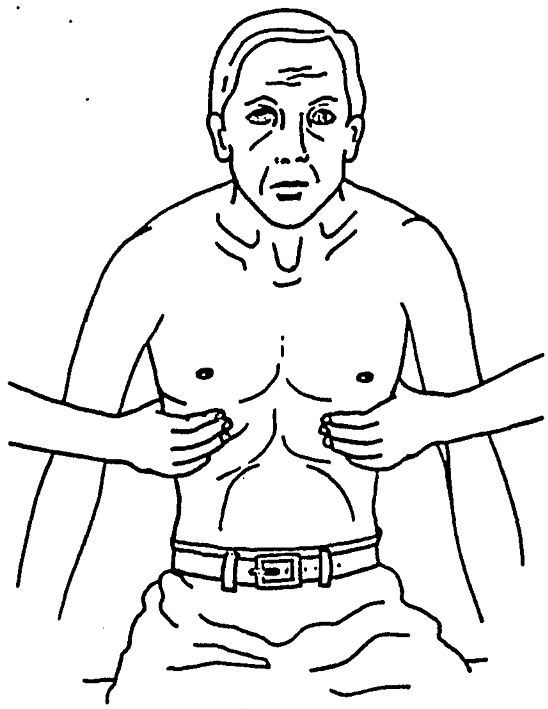

Figure 1 Bilateral Chest Wall Augmentation

From Traver, G. Respiratory Nursing; The Science and the Art. New York: John Wiley and Sons, 1982. With permission.

rates were calculated. Maximum pulse rates were determined by using the established Maximum Heart Rate table in the 75 percentile (see Appendix F). An increase in pulse rates to 75 percent of maximum was chosen since the sessions were conducted in the home and cardiac monitoring equipment was not available.

It was predetermined that the subject would be asked to terminate ambulating when one or the other of these maximum rates were reached. The subject was also informed that if he could no longer ambulate due to physical discomfort, he could stop walking. If one of these three criteria had not been met after 15 minutes of ambulation, the subject stopped walking and interventions were instituted.

Measurements

Respiratory Rates

The respiratory rate was measured at the beginning of each treatment session for 30 seconds, while the subject was at rest, using a Gillette Ticket Counter and digital stop watch. During the recovery period, respiratory rate was again measured 15 seconds every minute. Measurements were recorded on a data sheet (see Appendix D).

Radial Pulse

The subject's radial pulse was counted for 15 seconds and recorded while the subject was at rest. Radial pulse measurements were taken every five minutes for 15 seconds while the subject ambulated. Pulse rates were also measured for 15 seconds immediately after ambulation and when the subject's respiratory rate returned to his resting respiratory rate. These measurements were recorded on a data sheet (see Appendix D).

Recovery Time

A timer was used to indicate the time duration from when the subject stopped ambulating and when his respiratory rate returned to the documented pre-exercise rate. These were recorded on a data sheet (see Appendix D).

Other Data

Pertinent subject information, such as age and home oxygen use was obtained from the subjects' medical records and entered on the data collection sheet. It was also documented whether or not the subject spontaneously initiated pursed lip breathing on ambulation during each session. The three forced expiratory volume in one second values, that were measured at the beginning of the first session were averaged and recorded on the data collection sheet.

Subjective Response

The investigator designed a questionnaire to determine which of the three treatments provided the most subjective relief from dyspnea post-exercise. Three patients participating in a pulmonary rehabilitation program were asked to answer the questionnaire to validate that the terminology and questions were understood, before the study was initiated. The questionnaire was completed by each subject at the end of the third session (see Appendix E).

Research Sessions

Control Session

The subject was asked to perform three forced expiratory volume maneuvers using a Breon spirometer. These values were then averaged and documented. Resting respiratory rates and radial pulse rates were measured and recorded. The subject was then asked to walk until the predetermined respiratory and/or pulse rate was reached. The investigator had no verbal communication or physical contact with the subject during the recovery time. The amount of time it took the subject to return to his pre-exercise respiratory rate was measured. At the end of the session, PLB and BCWA was demonstrated as described in the Treatment section. The subject did not do a return demonstration at this time.

Experimental Sessions I and II

At the beginning of Experimental Session I and II, both PLB and BCWA were described and demonstrated. The treatment intervention that would be used for that session had been randomly chosen prior to Experimental Session I. Respiratory and pulse rates were measured as described in the measurement section.

The subject was asked to walk at his own pace. Pursed lip breathing was not encouraged during ambulation but spontaneous use was not discouraged. After the subject had stopped ambulation, either PLB or the combination of PLB and BCWA was initiated. Experimental Session II followed the same protocol as I, the treatment depended on which intervention had been performed in Session I.

Analysis of Data

A correlation was used to determine whether there was a relationship between FEV_1 values and ambulation time, and FEV_1 values and recovery time.

A one-way analysis of variance and the Tukey procedure were used to analyze the difference in recovery times between the three sessions.

A one-way analysis of variance for repeated measures was used to compare pulse rates before the subject exercised, immediately after exercise and when the subject had returned to his resting respiratory rate.

CHAPTER 4

STATISTICAL ANALYSIS AND DESCRIPTION OF RESULTS

This chapter presents the characteristics of the sample in the study. The results from measuring respiratory and pulse rates, FEV_1 values, ambulation and recovery times are presented and their analysis is included. The results of the subjective questionnaire are also discussed.

Characteristics of the Sample

The sample consisted of 20 subjects, eleven male and nine female, all with airway obstructive lung disease. Seven of the 20 subjects had a diagnosis of emphysema, seven had a diagnosis of asthma and the remaining six subjects had a diagnosis of chronic bronchitis. All 20 subjects were being treated by the same pulmonary physician.

The mean age of the subjects was 70.25 years with a range of 58 years to 85 years of age. All 20 subjects were ambulatory and without hospitalization for at least two weeks prior to participation in the study. Three subjects were on oxygen therapy at home; two of the three used oxygen continuously. Six subjects spontaneously began pursed lip breathing during ambulation for all three treatment sessions. All 20 subjects stopped ambulating because they increased their respiratory rate by 25 percent, therefore reaching the maximum respiratory rate allowed (see Table 1).

TABLE 1 Characteristics of the Subjects: Age, sex, if oxygen used, spontaneous pursed lip breathing used, FEV_1, and diagnosis.

Subject	Age	Sex	Oxygen Used While Ambulating	PLB Spontaneously	FEV_1 in cc's	Diagnosis
1	59	M	yes	yes	350	Emphysema
2	67	M	yes	yes	550	Emphysema
3	72	F	no	yes	725	Asthma
4	63	F	no	no	960	Asthma
5	81	F	no	no	800	Chronic bronchitis
6	58	M	no	no	600	Chronic bronchitis
7	75	M	no	no	800	Chronic bronchitis
8	66	F	no	no	500	Emphysema
9	69	M	no	no	1000	Emphysema
10	72	M	no	no	930	Emphysema
11	85	F	no	no	780	Chronic bronchitis
12	80	F	no	no	700	Asthma
13	73	M	no	yes	650	Emphysema
14	76	M	no	yes	1200	Emphysema
15	67	F	no	no	810	Chronic bronchitis
16	67	M	no	no	900	Chronic bronchitis
17	68	M	no	no	890	Asthma
18	66	F	no	no	1200	Asthma
19	64	F	yes	yes	820	Emphysema
20	77	M	no	no	800	Asthma

Forced Expiratory Volume in One Second

Forced expiratory volume in one second was measured three times on all 20 subjects at the beginning of the first session. The three FEV_1 values were then averaged for use in the research data. A Breon Spirometer, Model 2400, was used to measure FEV_1's. The results ranged from 350 to 1200 cc's. with a mean of 798 cc's.

A positive correlation of 0.42 demonstrated that FEV_1 values were significantly ($P \geq .05$) related to ambulation time (see Appendix G). A correlation coefficient of .036 demonstrated no significance in the realtionship between a subject's FEV_1 and recovery time (see Table 2).

Time Ambulated and Recovery Time

Analysis of all 60 ambulation times demonstrated a range of one to seven minutes, with a mean time of 3.72 minutes. There was no significant difference in ambulation time between the three sessions.

Recovery time varied between the three sessions. During the control session, recovery time ranged from one to seven minutes with a mean time of four minutes. For the pursed lip breathing session the mean recovery time was 2.49 minutes with a range of one to five minutes. The session which consisted of both pursed lip breathing and bilateral chest wall augmentation, demonstrated a mean of 2.22 minutes with a range of one to four minutes.

A one-way analysis of variance demonstrated a significant ($P \geq .001$) change between recovery times between the three sessions. The Tukey Procedure was used to determine where the difference in recovery times occurred between the three groups (Ferguson, 1976).

TABLE 2 Forced Expiratory Volume in One Second (FEV_1) and Recovery Time for Each Subject During the Control Session, Use of Pursed Lip Breathing (PLB), and Use of Pursed Lip Breathing and Bilateral Chest Wall Augmentation (PLB and BCWA) After Ambulation.

		Recovery Time in Minutes		
	FEV_1 in cc's	Control Session	PLB	PLB and BCWA
1	350	3.1	5.4	3.3
2	550	1.3	1.2	1.8
3	725	4.6	3.8	2.1
4	960	3.2	3.4	1.9
5	800	4.2	1.2	1.0
6	600	5.0	1.0	1.5
7	800	4.6	2.8	1.2
8	500	2.4	1.9	2.5
9	1000	4.1	2.7	1.6
10	930	7.0	3.0	2.1
11	780	3.5	2.1	3.9
12	700	3.3	2.5	1.1
13	650	3.7	2.2	2.4
14	1200	2.1	2.1	1.3
15	810	3.8	2.5	3.5
16	900	2.3	1.9	1.8
17	890	6.3	3.3	1.1
18	1200	4.5	3.2	3.7
19	820	4.1	2.0	2.3
20	800	3.2	1.6	4.2

Sessions I and II were categorized as one subset using this methods, since the highest and lowest means did not differ by more than the shortest significant range for a subset of that size. There was a highly significant difference between the two subsets. Sessions I and II were equally effective and distinctly different from the Control Session (see Appendix H).

Correlation of ambulation time to recovery time demonstrated a correlation coefficient of .346 with significance at the .004 level. Therefore, the longer the subject ambulated, the longer it took for the subject to recover to his resting respiratory rate (see Table 3).

Resting, Post-Exercise and Post-Treatment Pulse Rates

Pulse rates were counted on all 20 subjects at the beginning of each session, before ambulation began. Pulse rates ranged from 64 to 132 per minute with a mean of 93 per minute. Pulse rates were also counted immediately after the subject ambulated, at each treatment session. Pulse rates per minute demonstrated a mean of 101 with a range of 68 to 144. Measurement of pulse rates were also taken when the subject had returned to his resting respiratory rate. The rate per minute ranged from 64 to 134 with a mean of 92 (see Appendix I).

A one-way analysis of variance for repeated measures compared pulse rates before the subjects exercised, immediately after exercise and when the subject had returned to his resting respiratory rate after exercise. The only significant change noted was between the pulse

TABLE 3 Mean Ambulation and Recovery Times for the Control Session, Pursed Lip Breathing Session (PLB) and the Pursed Lip Breathing and Bilateral Chest Wall Augmentation Session (PLB and BCWA).

Measured in Minutes	Control	Sessions PLB	PLB and BCWA
Ambulation Time	3.7	3.8	3.6
Recovery Time	4.8	2.6	2.22

rates before exercise and immediately after. There was no significant difference in pulse rates between the Control Session, Session I or II.

Analysis of resting or pre-exercise pulse rates demonstrated no significant difference between the three treatment groups. Pulse rates taken immediately after ambulation did increase significantly from the resting rate but there was no significant difference between the session groups. Post-treatment pulse rates were analyzed according to the session group and then the groups were compared to each other. After the Control Session, the pulse rates ranged from 60 to 116 per minute with a mean of 91. Pulse rates per minute, after Experimental Session I (pursed lip breathing) ranged from 68 to 134 with a mean of 94. A range for pulse rates of 68 to 120 per minute were counted after Experimental Session II, with a mean of 88. Using a one-way analysis of variance for repeated measures, there was no significant difference in pulse rates after treatment among the three groups (see Table 4).

Subjective Questionnaire

At the end of the last treatment session each subject completed a subjective response questionnaire. For question one, the subject was asked which method seemed easiest for you to tolerate?, 12 subjects marked the combination of pursed lip breathing and bilateral chest wall augmentation, while eight chose pursed lip breathing alone. When asked which method seemed to relieve your shortness of breath the quickest, 14 answered both interventions and six answered pursed lip breathing. The next question, which method they might use in the future, 11 subjects marked pursed lip breathing and bilateral chest wall augmentation,

TABLE 4 Mean Pulse Rates per Minute Measured Before Ambulation, Immediately After Ambulation, After Recovery for the Control Session, Pursed Lip Breathing Session (PLB), and the Pursed Lip Breathing and Bilateral Chest Wall Augmentation Session (PLB and BCWA).

Rate Per Minute	Sessions		
	Control	PLB	PLB and BCWA
Before Ambulation	91.4	93.8	93.2
Immediately After Ambulation	98.9	105.1	100.0
After Recovery	91.0	94.0	88.0

while nine marked pursed lip breathing alone. Question four asked the subject which you think you can walk further using?, 11 subjects marked the combination of pursed lip breathing and bilateral chest wall augmentation and nine checked pursed lip breathing.

Findings Related to the Hypotheses

It was hypothesized that respiratory rates would decrease in significantly less time when pursed lip breathing and bilateral chest wall augmentation were used post-exercise compared to not intervening with the subject. The next hypothesis stated that the combination of bilateral chest wall augmentation and pursed lip breathing would be more effective in decreasing the time it took for the subject to return to his resting respiratory rate than pursed lip breathing alone. The findings demonstrated that it took significantly less time to decrease respiratory rates using either pursed lip breathing alone or in combination with bilateral chest wall augmentation versus not verbally or physically intervening with the subject's respiratory pattern. Therefore, the first hypothesis was accepted. The combination of bilateral chest wall augmentation and pursed lip breathing was found equally effective as pursed lip breathing alone, therefore, the second hypothesis was rejected. Finally, it was hypothesized that the combination of bilateral chest wall augmentation and pursed lip breathing would be perceived to relieve dyspnea more effectively than pursed lip breathing alone. There was a tendancy for subjects to chose the combination treatment over pursed lip breathing alone but not an adequate difference, therefore, the hypothesis was rejected. There was no significant difference between the two interventions.

It was noted that there was a significant correlation between FEV_1 measurements and how long the subject ambulated. The lower the subject's FEV_1, the shorter was his ambulation time. The more time the subject ambulated, the more time it took for the subject to recover to his resting respiratory rate.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

Interpretation of the results of this study and the relationship to the review of the literature and the theoretical framework are found in this chapter. The implications for health professionals directly responsible for the care of patients with chronic obstructive lung disease are discussed. Lastly, recommendations are made for further study on the effects of pursed lip breathing and bilateral chest wall augmentation as a nursing intervention for patients with chronic obstructive lung disease.

Slowing Respiratory Rates

Pathophysiological changes in the lung that occur in COLD result in an abnormal increase in the volume of air that remains in the lung at FRC. The altered compliance of the lungs or chest wall and changes in closing volume will cause a change in RV and VC (Burrows, 1983). By increasing the FRC there is increased traction applied to the intrathoracic airways which increases their diameter and length and decreases airways resistance (West, 1977). To achieve faster respiratory rates, the patient with COLD will increase his FRC. The faster respiratory rate allows him to increase his expiratory flow rate since breathing at a higher lung volume increases lung recoil and allows him to achieve faster flow rates. Breathing at higher lung volumes, however, can result in decreased volume excursion which leads to inadequate gas exchange. Also subsequent to decreased volume excursion, there is increased physiological dead space ventilation. This increase in dead space ventilation means that to maintain the same alveolar ventilation per minute that a slow deep respiratory pattern will attain, the total volume of ventilation must increase when there is decreased volume excursion (Cherniak, 1977).

Dynamic compression of the intrathoracic airways occurs when the pleural pressure exceeds airway pressure. This phenomenon is dependent on the pleural pressure and airway compliance which together account for an increase in resistance, lower expiratory maximal flows and hyperinflation (Burrows, 1983). Hyperinflation reduces the efficiency of air exchange which results in hypoxemia and hypercapnia (Shapiro, 1975).

To attain slower respiratory rates, a patient with COLD must prolong his expiratory phase. The prolonged phase prevents the pleural pressure from increasing dramatically and decreases the amount of dynamic compression of the airways which reduces the resistance to air flow. The slower rate will increase ventilation to poorly ventilated airways and improve alveolar ventilation (Menkes, 1980).

In the current study, PLB and BCWA, with emphasis on prolonging expiration, did slow respiratory rates. These interventions allowed the subject to return to his resting respiratory rate in significantly less time than when no intervention was performed.

It should be noted that the order of the sessions (with the control session always being first) could have affected the subjects' performance. On the first visit the subject may have been anxious about meeting the investigator and uncertain about how well they could tolerate the activities involved. However, this possible factor is not reflected in the ambulation times between treatment sessions.

The advantage of slowing respiratory rates was studied by Sergysels and associates (1979). Twelve subjects with COLD and an airway resistance six times normal were studied while performing low frequency respiratory rates. They demonstrated a significant increase in paO_2 and decrease in $paCO_2$. During exercise, still maintaining the slower respiratory rate there was a slight decrease in $paCO_2$ and no change in paO_2.

Improved alveolar ventilation with slowed respiratory rates was also demonstrated by Geoffry and associates (1966). The investigators were able to decrease respiratory rates in 10 subjects with COLD by an average of 7.5 per minute. Concurrently, there was a significant decrease in minute volume ventilation and a decrease in $paCO_2$ level. The increase in alveolar ventilation demonstrated improved effective ventilation during slowed respiratory rates.

Motley (1963) increased tidal volumes significantly in 35 subjects with emphysema by decreasing their respiratory rates by 40 to 50 percent. Due to the increased tidal volumes the paO_2 levels improved and there were significant decreases in $paCO_2$ values.

Petty and Guthrie (1971) compared four methods: 1) lower chest and abdominal compression with a mechanical device; 2) IPPB; 3) instructing the patient to breathe as deeply as possible at a slow but comfortable rate; and 4) manual assistance in abdominal-diaphragmatic breathing and PLB. The results demonstrated significant reductions in $paCO_2$, except with deep breathing. Tidal volumes increased significantly and there was a significant reduction in respiratory rates for each method. Improvement in alveolar ventilation was credited to the increased tidal volumes and decreased respiratory rates. In the present study BCWA and PLB did prove effective in slowing respiratory rates.

Pursed Lip Breathing

Pursed lip breathing is a common finding in patients with COLD. Many patients use the technique spontaneously and others may have been taught this technique and find it helpful. The mechanism of why it is beneficial is still unclear. One possible explanation is that breathing out in this manner slows exhalation, therefore respiratory rates are slower improving alveolar ventilation. Pursed lip breathing could also decrease the amount of compression by limiting the pressure drop between the equal pressure point and the mouth (Traver, 1982).

Mueller et al., (1970) concluded from their study on 12 subjects, that PLB prevents airway collapse, creates less air trapping, increases tidal volume and decreases respiratory rates. Pused lip breathing during rest did significantly increase tidal volume and arterial pO_2, pCO_2, and O_2 saturation when compared to normal breathing.

Another group of investigators (Thoman, 1966) also agreed that PLB forestalls airway collapse and improves ventilation. A slower respiratory rate produced by PLB was also included as a possible cause of significantly improved tidal volumes and lower arterial pCO_2 levels in the 21 subjects they studied.

Schmidt, Wasserman, and Illington (1964) concluded that increasing oral pressures by PLB alone does not account for improved vital capacities in the patient with emphysema. They explained that the benefits are due to a reduction in the initial expiratory flow rate which allows for improved patency of the highly compliant airway which decreases airway resistance at any given lung volume. These conclusions were made after measuring expiratory air flow and induced positive oral pressures in 10 subjects with emphysema.

The current study did show a significant decrease in respiratory rate with the subject utilizing PLB versus his normal respiratory pattern after exercise. Pursed lip breathing, which emphasizes prolonged expiration, allows the subject adequate time to exhale which will be followed by a deeper inhalation and subsequently a slower respiratory rate.

Work of Breathing

The work of breathing is determined by the muscle force needed to overcome elastic forces and air flow resistance inherent in the respiratory structures (Burrows, 1983). The pattern adapted will be one that requires minimal work (Cherniak, 1977). Patients with emphysema demonstrated slow, deep respirations because of increased lung compliance which means less work is necessary to overcome elastic resistance. Concurrently, they have increased airway obstruction, which increases the work needed to overcome resistance to flow (Traver, 1982).

A rapid respiratory rate creates increased flow resistance work and increases the work load on the inspiratory and expiratory muscles. Energy stored in the elastic structures is insufficient to overcome resistance to flow on expiration so accessory muscle use becomes necessary (Cherniak, 1977). Activity that necessitates increased respiratory rates in patients with COLD will increase oxygen demands by the respiratory apparatus (Traver, 1982). These high oxygen costs may be a factor in limiting exercise tolerance for patients with COLD (West, 1977).

In the current study, it was noted that the mean ambulation time for all sessions was 3.35 minutes. Eight subjects were only able to ambulate one minute before reaching the maximum respiratory rate parameter. The longer the subject ambulated the longer it took for him to return to his resting respiratory rate. This relationship may be due to an increasing oxygen deficit the longer the person walks. If there is accessory muscle use, the deficit can become greater. Recovery times may be longer to allow that person to replace his oxygen deficit.

The FEV_1 also appears to have a relationship to ambulation time since in this study the FEV_1 correlated with the amount of time the patient was able to ambulate. Having an increased FRC causes the subject to breathe faster with an increased expiratory flow rate which results in them reaching their maximum respiratory rate parameter sooner than those subjects with a higher FEV_1. This finding concurs with the guideline that the FEV_1 can be used to determine shortness of breath for different FEV_1 values.

Limitations of the Study

This study was limited by the factor that FEV_1 measurement was obtained only at the beginning of the first session. Patients with COLD have large variations in their respiratory status even over short periods of time. There were differences noted in breathing patterns for the same subject on each of the three visits. Measurement of the FEV_1 at each treatment session would have allowed the investigator to analyze recovery times using comparative FEV_1 values.

It was apparent to the investigator that there was a large variation in the motivation of the individual subjects to ambulate. Several of the subjects maintained a routine exercise program and were better able to tolerate ambulating for this study.

Each subject was ambulated in his home environment which became a variable when the subjects were compared to each other. The type of cooling system, type of walking surface and size of area seemed to either encourage or discourage ambulating. All of the subjects with evaporative cooling complained of being hot which may have prevented them from ambulating longer.

Clinical Implications

The purpose of this study was to evaluate the effectiveness of PLB and BCWA in slowing respiratory rates. It was demonstrated that either PLB or the combination of PLB and BCWA do decrease respiratory rates significantly faster than not intervening with the subjects breathing pattern. There was no significant difference between the two interventions. The Subjective Response Questionnaire was to evaluate which treatment the subject perceived as relieving his dyspnea most effectively. The results demonstrated that both treatments were equally beneficial.

Based on the significant data and the results of the subjective questionnaire, the nurse, who is caring for the patient with COLD should instruct the patient with an increased respiratory rate to purse lip breathe. Whether or not the nurse should initiate BCWA needs to be determined by assessing the individual patient. It was apparent to the investigator that many of the subjects did not like the tactile stimulation when the investigator was controlling his respiratory rate. If the patient in distress will feel constrained or panicked by the physical contact used with BCWA, further distress and anxiety could occur.

The results of this study demonstrate that PLB alone is effective in slowing respiratory rates. Therefore, the nurse should include this technique in patient teaching. Pursed lip breathing can be effectively used by the patient at home, without supervision, and may prevent the detrimental effects of rapid respiratory rates. Teaching the spouse or significant other to use BCWA when indicated is going to be a decision made by the individual.

Ambulation time was not statistically compared with other patients with COLD, but the FEV_1 values obtained for the group as a whole, led the investigator to anticipate that ambulation times should have been longer. The short ambulation times measured, illustrates the need to encourage these patients to routinely ambulate. Informing patients of pulmonary rehabilitation programs available and educating them on the advantages of exercise may facilitate a better quality of life for patients with COLD.

Suggestions for Further Study

Further studies that compare PLB and BCWA are important for continued improvement in care of the patient with COLD. Similar research to the present study could provide additional and useful information about the parameters addressed in the present study. The measurement of arterial CO_2 levels would be helpful in determining the effectiveness of PLB and BCWA in improving alveolar ventilation. The advancement of technology will make transcutaneous monitoring of arterial CO_2 levels accessible to investigators without using an invasive procedure.

In future studies, subjects should be tested in a controlled environment which would decrease the variables that occurred by collecting data at the subject's home.

The measurement of oxygen saturation using an ear oximeter before, during and after PLB and BCWA would be helpful in assessing the effectiveness of each intervention in relieving hypoxia. Lastly, it would most certainly be helpful to have a more physiologically impaired homogeneous group.

Further investigation should allow for a longer prestudy training period which would allow the investigator more time to teach PLB and BCWA, plus allow the subject to practice these techniques over a longer time span. If the subjects were more familiar with these techniques, they may be more willing to use them. Also feasible, is measuring respiratory rates while the subject ambulates instead of simply taking measurements pre and post exercise.

Further research should recognize that none of the subjects involved in this study reached their maximum predicted pulse rate. Therefore, respiratory rates may be more pertinent in limiting ambulation.

CHAPTER 6

SUMMARY

Pursed lip breathing and bilateral chest wall augmentation are two modes of treatment that can decrease the respiratory rate of the patient with COLD experiencing an abnormally rapid rate. By slowing the respiratory rate and placing emphasis on the exhalation phase, the depth of breathing can increase. Increasing the depth of breathing could prevent a patient's volume excursion from becoming progressively less and therefore prevent the detrimental effects of limited volume excursion. The purpose of this study was to examine PLB and the combination of PLB and BCWA as effective means to decrease respiratory rates, and compare their effectiveness to not intervening with the patient's respiratory pattern.

Twenty subjects with documented COLD participated in the study. The subjects were contacted by telephone and arrangements were made by the investigator to conduct the three sessions (Control, Experimental I and II) at his place of residence.

All treatment sessions included having the subject walk until a predetermined respiratory and/or pulse rate was reached. Resting and post-exercise respiratory rates and radial pulse rates were measured and recorded.

During the Control Session the investigator had no verbal communication or physical contact with the subject while the subject recovered from ambulating. Experimental Sessions I and II were randomly assigned. One consisted of the investigator verbally encouraging the subject to PLB until his respiratory rate returned to his pre-exercise rate. The other Session followed the same protocol except that both PLB and BCWA were initiated after ambulation stopped. A subjective response questionnaire was completed by each subject at the end of the last experimental session.

Forced expiratory volumes in one second were measured on each subject. Statistical analysis demonstrated a correlation between FEV_1 values and the time ambulated. Recovery times between Experimental Sessions I and II were significantly less than the Control Session, but there was no significant difference between Session I and II.

Resting, post-exercise and post-treatment radial pulse rates were compared for all three treatment sessions. Between the session groups there was no significant difference noted for the three measurements of pulse rate. During each of the sessions, there was a significant increase in pulse rates from pre-exercise to post-exercise.

The subjective response questionnaire did not show a significant preference by the subjects for PLB or the combination of PLB and BCWA. Pursed lip breathing and BCWA did prove effective in slowing respiratory rates and therefore would be useful in the clinical setting. Individual patients need to be assessed before initiating BCWA to determine if they can tolerate the physical contact used to alter their breathing pattern. Slowing respiratory rates using either of these techniques will allow the patient with COLD to keep his work of breathing at a minimum.

This study of the effects of PLB and BCWA on slowing respiratory rates in subjects with COLD should be repeated. Further studies should include measuring arterial CO_2 levels and blood oxygen saturation before, during and after PLB and BCWA.

APPENDIX A

SUBJECT'S CONSENT FORM

Subject's Consent Form

Project Title: Effect of Pursed Lip Breathing and Bilateral Chest Wall Augmentation on Slowing Respiratory Rates.

I, Ann C. Fassett, R.N., am conducting a study to determine the best way to slow breathing rates in patients with chronic obstructive lung disease. I will compare pursed lip breathing and pursed lip breathing with bilateral chest wall augmentation. Slowing your respiratory rate may be helpful in allowing you to participate in more activities of daily living.

Your physician is familiar with the study and has given his approval for me to contact you to participate in this study. He feels that you will be able to tolerate the activities involved.

During the sessions I will be counting your respiratory rate and pulse. You will be asked to walk until your respiratory rate has increased by 25 percent or your pulse rate reaches a certain number. The most you will be asked to walk is 15 minutes. If you experience any physical discomforts or distress, you may inform me and walking will be stopped immediately.

After you have stopped walking either pursed lip breathing or pursed lip breathing and bilateral chest wall augmentation will be used except for the first session in which I will observe the way you normally relax and recover.

You are to use any aides you normally use while you are walking, for example: cane, walker and/or oxygen.

Pursed lip breathing means you will form your lips into a whistling position while breathing out. You can breathe in, either through the mouth or nose. Bilateral chest wall augmentation is accomplished by my hands resting on each side of your chest over the ribs. As you breathe in, I will keep my hands on your sides but will not apply pressure. As you breathe out, I will apply more and more pressure until you are ready to breathe in again. While I am doing bilateral chest wall augmentation I will also ask you to purse lip breathe.

At the end of the third session, I will ask you to answer questions in writing about the method you felt worked best to slow down your respiratory rate.

There are no known social or psychological risks involved in participating in this study. There is no cost to you for your participation. Walking may cause temporary shortness of breath or an increase in heart rate. Your physician will be available by phone to help if you need it.

The benefits of this study are to determine how good these techniques are in slowing respiratory rates. If these techniques are proven to slow your breathing, they may let you tolerate activity better. The results of this study may also help other patient's with chronic obstructive lung disease who have problems breathing during and after exercise.

Your participation in this study also includes permitting the investigator to record pertinent information from your chart, including age, sex, height, weight, arterial blood gases and previous pulmonary function tests.

You will be assured of confidential handling of the information obtained in this study. Your name will not be used as all information will be coded. The results may be published in group form, but your identity will not be revealed. You give your permission for the results to be used for purposes other than this specific study.

If you decide not to participate in this study, it will in no way affect your relationship with your doctor or affect the quality of your care. I will answer any questions you may have about the study at any time.

The nature, risks, demands and benefits of the study have been explained to me and I understand what my participation involves. Furthermore, I understand that I am free to ask questions and withdraw from the project at any time without affecting my relationship with any institution or person.

I understand that in the event of physical injury resulting from the research procedures, financial compensation for wages and time lost and the costs of medical care and hospitalization is not available and must be borne by the subject. I understand that the investigator will provide information upon my request.

I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principal investigator or authorized representatives of the College of Nursing. A copy of this consent form is available to me upon request.

Subject's Signature ______________________________ Date ______________

Witness Signature _______________________________ Date ______________

APPENDIX B

PHYSICIAN'S CONSENT FORM

Physician's Consent

I, Ann C. Fassett, R.N., am conducting a study to determine if pursed lip breathing or the combination of pursed lip breathing and bilateral chest wall augmentation are effective in slowing respiratory rates in patients with chronic obstructive lung disease, and if so, which method is most effective.

In order to participate in this study, the subjects must meet the following criteria:

1. Physician comfirmed diagnosis of chronic obstructive lung disease.
2. FEV_1 documented to be below 1500 cc.'s.
3. Stable, without hospitalization for at least two weeks prior to participation in the study.
4. Able to understand, speak and read English.
5. Verified by a physician to tolerate ambulation that will increase their respiratory rate by 25 percent.
6. Willing to allow the investigator to conduct each treatment session at their place of residence.

The following treatment protocol will be performed on each subject, Sessions A and B will be randomized.

1. The control session consists of measuring respiratory rates and radial pulse rates while the subject is at rest. The subject will then be asked to walk until his respiratory rate has increased by 25 percent or his pulse rate has increased to a rate 75 percent of the established Maximum Heart Rate (Cardiac Laboratory, Pacific Medical Center, San Francisco). The maximum length of time for ambulation is 15 minutes. The subject will also be informed that he may terminate ambulation if he experiences any physical discomfort. The investigator will have no verbal or physical contact with the subject during the recovery time. The amount of time it takes the subject to return to his pre-exercise rate will be measured.

2. Session A will consist of the investigator measuring the resting respiratory and radial pulse rates at the beginning of the session. The subject will then be asked to walk until there is a 25 percent increase in respiratory rate, the radial pulse has reached 75 percent of the established Maximum Heart Rate, the subject experiences physical discomfort, or has walked a total of 15 minutes. Upon terminating ambulation the investigator will verbally encourage the subject to purse lip breathe until his respiratory rate has returned to his pre-exercise rate.

3. Session B will follow the same protocol as in session A except that both pursed lip breathing and bilateral chest wall augmentation will be instituted after ambulation is stopped. Also, at the end of this session the subject will be asked to complete a subjective questionnaire to determine which technique he felt was most effective in slowing his respiratory rate.

The subject will be allowed to use any aids he normally utilizes while ambulating, for example, oxygen, walker or cane.

Your schedule of availability by telephone will be taken into consideration when scheduling sessions in the subject's home so that any possible physical detrimental effects from ambulating the subject can be immediately communicated to you.

Permission has been granted to me, Ann C. Fassett, R.N., from the Human Subjects Committee of the University of Arizona, to conduct this study. If you feel the subject meets the above criteria for inclusion in the study and will tolerate the protocol outlined, please sign you name below. Consent will also be obtained from the individual subject after you have approved of his participation. I will answer any questions you have about the study at any time.

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

Physician's Signature ______________________ Date ____________

Witness Signature _________________________ Date ____________

Physician's Consent

I, ____________________________ have read the subject and physician consent forms and give the investigator, Ann C. Fassett, R.N., permission to contact ______________________________ as a potential subject for her study. This patient fits the criteria listed and is able to tolerate the physical demands of ambulation as described in the consent form.

Physician's Signature ___________________________ Date _________________

Witness Signature _______________________________ Date _________________

APPENDIX C

HUMAN SUBJECTS COMMITTEE APPROVAL

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85724
HUMAN SUBJECTS COMMITTEE
ARIZONA HEALTH SCIENCES CENTER 2305
TELEPHONE: 626-6721 OR 626-7575

15 April 1982

Ann C. Fassett, R.N.
College of Nursing
Arizona Health Sciences Center

Dear Ms. Fassett:

We are in receipt of your project, "Effect of Pursed Lip Breathing and Bilateral Chest Wall Augmentation on Slowing Respiratory Rates", which was submitted to the Human Subjects Committee for review. The procedures to be followed pose no more than minimal risk to the subjects involved. Regulations issued by the U.S. Department of Health and Human Services (45 CFR Part 46.110) authorize approval of this type project through the expedited review procedures, so that full Committee review is not required. A brief summary is submitted to the full Committee for their information and comment, if any, after administrative approval is granted. This project is approved effective 15 April 1982.

Approval is granted with the understanding that no changes will be made in either the procedures followed or in the consent form to be used (copies of which we retain on file) without the knowledge and approval of the Human Subjects Committee and the Departmental Review Committee. Any physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all singed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require this information and the principal investigator is unavailable for some reason.

Sincerely yours,

Milan Novak

Milan Novak, M.D., Ph.D.
Chairman

MN/jm

cc: Ada Sue Hinshaw, R.N., Ph.D.
College Review Committee

APPENDIX D

DATA COLLECTION SHEET

DATA COLLECTION SHEET

CONTROL SESSION

Name ______________________________ Date ________________________

Age ___________ Sex ______________ I.D.# ________________________

FEV_1 _______________ Diagnosis ____________________

_______________ Oxygen yes ____ no _____

____

Respiratory Rate at Rest for 30 Seconds _______ X 2 ________

Pulse Rate at Rest for 15 Seconds __________ X 4 __________

Start Ambulation

Respiratory Rate every Minute for 15 Seconds	Pulse Rate every 5 Minutes for 15 Seconds
1 ___	
2 ___	
3 ___	
4 ___	
5 ___	_____
6 ___	
7 ___	
8 ___	
9 ___	
10 ___	_____
11 ___	
12 ___	
13 ___	
14 ___	
15 ___	_____

Pulse Rate Immediately after Subject Stopped Ambulation __________

Did Subject Spontaneously start Purse Lip Breathing while Ambulating?

yes ______ no ______

Why did Subject Stop Ambulating? ____________________________________

Time Taken to Return to Resting Respiratory Rate __________________

Pulse at Resting Respiratory Rate after Ambulation __________________

DATA COLLECTION SHEET

EXPERIMENTAL SESSIONS

Name ______________________________ Date __________ I.D.# __________

Intervention Used: PLB Alone ________

PLB and BCWA _____

Respiratory Rate at Rest for 30 Seconds _____ X 2 _____

Pulse Rate at Rest for 15 Seconds _____ X 4 ______

Start Ambulation

Respiratory Rate Every Minute for 15 Seconds	Pulse Rate every 5 Minutes for 15 Seconds
1 ___	
2 ___	
3 ___	
4 ___	
5 ___	_____
6 ___	
7 ___	
8 ___	
9 ___	
10 ___	_____
11 ___	
12 ___	
13 ___	
14 ___	
15 ___	_____

Pulse Rate Immediately after Subject Stopped Ambulation __________

Did Subject Spontaneously start Purse Lip Breathing while Ambulating:

yes ______ no ______

Why did Subject Stop Abmulating? ________________________________

Time Taken to Return to Resting Respiratory Rate __________________

Pulse at Resting Respiratory Rate after Ambulation ________________

APPENDIX E

SUBJECTIVE RESPONSE QUESTIONNAIRE

SUBJECTIVE RESPONSE QUESTIONNAIRE

Subject's Number ____________________

Please check the square next to the answer which best describes your feelings.

1. Which method seemed easiest for you to tolerate?

   ☐ pursed lip breathing

   ☐ hands applying pressure as you breathe out and pursed lip breathing

2. Which method seemed to relieve your shortness of breath the quickest?

   ☐ pursed lip breathing

   ☐ hands applying pressure as you breathe out and pursed lip breathing

4. Do you think you can walk further using:

   ☐ pursed lip breathing

   ☐ hands applying pressure as you breathe out and pursed lip breathing

APPENDIX F

MAXIMUM HEART RATE (MHR) FOR UNTRAINED SUBJECTS PREDICTED BY AGE AT 75 PERCENT LEVEL

Maximum Heart Rate (MHR) for Untrained Subjects
Predicted by Age at 75 percent level

AGE	50	55	60	65	70	75	80	85	90
MHR	138	137	135	134	132	131	129	128	126

Adapted From: Hirschberg, G. <u>Rehabilitation: The Manual for the Care of the Elderly</u>. Philadelphia: J. B. Lippencott, 1976.

APPENDIX G

FORCED EXPIRATORY VOLUME IN ONE SECOND (FEV_1) AND AMBULATION TIME FOR EACH SUBJECT DURING THE CONROL SESSION, EXPERIMENTAL SESSION I AND EXPERIMENTAL SESSION II AND AN AVERAGE TIME IN MINUTES FOR ALL THREE SESSIONS.

Forced Expiratory Volume in One Second (FEV_1) and Ambulation Time for Each Subject During the Control Session, Experimental Session I and Experimental Session II and an Average Time in Minutes for All Three Sessions.

		Ambulation Time in Minutes			
	FEV_1 in cc's	Control Session	Experimental Session I	Experimental Session II	Average Time
1	350	1.7	3.0	3.2	2.6
2	550	1.5	1.5	2.1	1.7
3	725	5.0	4.2	3.8	4.3
4	960	3.5	4.0	3.7	3.7
5	800	2.8	2.5	3.1	2.8
6	600	1.8	3.0	2.7	2.5
7	800	3.5	4.1	3.6	3.7
8	500	1.5	2.0	1.7	1.7
9	1000	1.5	1.8	2.2	1.8
10	930	7.1	7.1	7.0	7.0
11	780	4.6	3.2	4.4	4.0
12	700	3.5	3.4	2.2	3.0
13	650	3.1	4.5	2.2	3.3
14	1200	4.0	4.3	3.1	3.2
15	810	5.0	5.5	6.1	5.5
16	900	3.9	3.5	2.6	3.3
17	890	6.2	6.6	6.0	6.3
18	1200	5.5	6.6	5.5	5.9
19	820	2.9	2.1	2.0	2.3
20	800	5.0	4.8	4.8	4.9

APPENDIX H

AMBULATION TIME AND RECOVERY TIME FOR EACH SUBJECT DURING THE CONTROL SESSION, USE OF PURSE LIP BREATHING (PLB), AND USE OF PURSED LIP BREATHING AND BILATERAL CHEST WALL AUGMENTATION (PLB and BCWA) AFTER AMBULATION

Ambulation Time and Recovery Time for Each Subject During the Control Session, Use of Purse Lip Breathing (PLB), and Use of Pursed Lip Breathing and Bilateral Chest Wall Augmentation (PLB and BCWA) After Ambulation.

	Ambulation and Recovery Time in Minutes					
	Control Session		PLB		PLB and BCWA	
	Ambulation Time	Recovery Time	Ambulation Time	Recovery Time	Ambulation Time	Recovery Time
1	1.7	3.1	3.0	5.4	3.2	3.3
2	1.5	1.3	1.5	.12	2.1	1.8
3	5.0	4.6	4.2	3.8	3.8	2.1
4	3.5	3.2	4.0	3.4	3.7	1.9
5	2.8	4.2	2.5	1.2	3.1	1.0
6	1.8	5.0	3.0	1.0	2.7	1.5
7	3.5	4.6	4.1	2.8	3.6	1.2
8	1.5	2.4	2.0	1.9	1.7	2.5
9	1.5	4.1	1.8	2.7	2.2	1.6
10	7.1	7.0	7.1	3.0	7.0	2.1
11	4.6	3.5	3.2	2.1	4.4	3.9
12	3.5	3.3	3.4	2.5	2.2	1.1
13	3.1	3.7	4.5	2.2	2.2	2.4
14	4.0	2.1	4.3	2.1	3.1	1.3
15	5.0	3.8	5.5	2.5	6.1	3.5
16	3.9	2.3	2.5	1.9	2.6	1.8
17	6.2	6.3	6.6	3.3	6.0	1.1
18	5.5	4.5	6.6	3.2	5.5	3.7
19	2.9	4.1	2.1	2.0	2.0	2.3
20	5.0	3.2	4.8	1.6	4.8	4.2

APPENDIX I

PULSE RATES PER MINUTE FOR EACH SUBJECT BEFORE AMBULATION, IMMEDIATELY AFTER AMBULATION, AND AFTER RECOVERY MEASURED DURING THE CONTROL SESSION, USE OF PURSED LIP BREATHING (PLB) AFTER AMBULATION, AND USE OF PURSED LIP BREATHING AND BILATERAL CHEST WALL AUGMENTATION (PLB and BCWA) AFTER AMBULATION

Pulse Rates per Minute for Each Subject Before Ambulation, Immediately After Ambulation, and After Recovery Measured During the Control Session, Use of Pursed Lip Breathing (PLB) After Ambulation, and Use of Pursed Lip Breathing and Bilateral Chest Wall Augmentation (PLB and BCWA) After Ambulation.

	Radial Pulse Rate per Minute								
	Control Session			PLB			PLB and BCWA		
	Before	After	After Recovery	Before	After	After Recovery	Before	After	After Recovery
1	120	128	112	128	144	100	120	120	120
2	132	136	116	128	132	124	124	124	116
3	96	104	100	88	100	88	92	104	96
4	72	76	76	76	84	80	80	92	80
5	68	68	68	84	84	68	76	80	68
6	108	120	116	120	140	134	120	116	112
7	64	92	68	68	80	68	72	80	76
8	96	100	88	104	112	100	100	104	104
9	76	88	88	80	84	80	68	80	64
10	92	120	96	88	126	104	88	92	92
11	80	76	76	76	80	76	80	88	84
12	80	86	80	88	88	92	92	96	96
13	88	104	96	88	104	96	92	108	90
14	96	104	96	96	100	96	104	104	96
15	96	100	92	84	104	96	88	104	92
16	88	68	68	100	104	88	88	104	80
17	92	96	96	100	112	96	84	82	88
18	80	96	88	88	108	96	84	100	96
19	108	116	112	104	116	100	108	112	104
20	96	100	92	88	100	104	104	100	96

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