

**Effectiveness of Active Cycle of Breathing Technique on Tetraplegic
SCI patient at CRP in Bangladesh**

Md. Imran Hossain

Bachelor of Science in Physiotherapy (B.Sc. PT)

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BHPI, CRP, Savar, Dhaka-1343



Bangladesh Health Professions Institute (BHPI)

Department of Physiotherapy

CRP, Savar, Dhaka-1343

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We the undersigned certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled

Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI patient at CRP in Bangladesh

Submitted by **Md. Imran Hossain**, for the partial fulfillment of the requirement for the degree of Bachelor of Science in Physiotherapy (B.Sc. PT).

.....
Mohammad Anwar Hossain
Associate Professor, BHPI
Senior consultant & Head of Physiotherapy Dept.
CRP, Savar, Dhaka-1343.
Supervisor

.....
Professor Md. Obaidul Haque
Vice Principal
BHPI, CRP, Savar, Dhaka-1343.

.....
Ehsanur Rahman
Associate Professor & MPT coordinator
Department of Physiotherapy
BHPI, CRP, Savar, Dhaka-1343.

.....
Asma Islam
Assistant Professor
Department of Physiotherapy
BHPI, CRP, Savar, Dhaka-1343.

.....
Md. Shofiqul Islam
Associate Professor & Head
Department of Physiotherapy
BHPI, CRP, Savar, Dhaka-1343.

DECLARATION

I declare that the work presented here is my own. All sources used have been cited appropriately. Any mistakes or inaccuracies are my own. I also decline that same any publication, presentation or dissemination of information of the study. I would bind to take consent from the department of Physiotherapy of Bangladesh Health Profession Institute (BHPI).

Signature:

Date:

Md. Imran Hossain

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Acronyms

ACBT	Active Cycle of Breathing Technique
BHPI	Bangladesh Health Professions Institute
BMRC	Bangladesh Medical Research Council
CRP	Centre for the Rehabilitation of the Paralysed
FVC	Forced Vital Capacity
IRB	Institutional Review Board
PT	Physiotherapy
PTs	Physiotherapist
RCT	Randomized Control Trial
SCI	Spinal Cord Injury
SD	Standard Deviation
SPSS	Statistical Package for the Social Science
WHO	World Health Organization

Abstract

Respiratory complication is the most common complication among the patients of SCI with cervical injury in Bangladesh. Chest physiotherapy is the essential intervention for the tetraplegic SCI patients in CRP. ACBT is commonly used for treating the patient who have respiratory complications.

To explore the effectiveness of ACBT for the patient with tetraplegic SCI, a study was conducted with a design of randomized control trial. Total 30 samples were selected from hospital patient for this study attending Centre for the rehabilitation of the paralysed (CRP) in between November 2020 to April 2021 from Spinal Cord Injury unit at Savar. A pre-test and post-test intervention protocol was designed where 15 samples were assigned in experimental group for the treatment approach of ACBT along with conventional physiotherapy and other 15 samples were assigned in control group for conventional physiotherapy treatment both for 3 times in a week total 4 weeks for total 12 sessions. Data was collected by using a structured questionnaire related to SCI and respiratory complications. Socio-demographic data were collected by a semi-structured questionnaire. Data was analyzed by using SPSS software version 28.0 which focused through tables, paired t-test and unrelated t-test of the parametric test, Wilcoxon t test and Mann Whitney U test of the non-parametric test.

A significant improvement of respiratory functions was demonstrated in both groups but the results show the better improvement among most of the variables in the experimental group (ACBT with conventional physiotherapy) ($p < 0.05$ or higher than $p < 0.05$) after the post-test which indicate that ACBT with conventional physiotherapy is more effective than the conventional physiotherapy treatment. So, ACBT may be considered as beneficial for tetraplegic SCI patients. Therefore, Physiotherapist may suggest applying this intervention for tetraplegic SCI patients to improve their respiratory condition.

Key words: ACBT, SCI, Conventional physiotherapy.

1.1. Background

A Spinal cord injury (SCI) defines as the damage of any part of the spinal cord that often causes permanent changes in strength, sensation, and other functions below the level of the injury. The injury may make it more difficult to breathe and cough if abdominal and chest muscles are affected. These include the diaphragm and the muscles in the chest wall and abdomen. The neurological level of injury will determine what kind of breathing problems may have. If persons have cervical and thoracic SCI, they may have an increased risk of pneumonia or other lung problems. Medications and therapy can treat these problems (Mayo Clinic Staff, 2014).

The World Health Organization (WHO) states that 10% of the total population are disabled in Bangladesh & most of those are physically disabled. These disabled people are very often deprived of social opportunities and their rights in our country. SCI is a condition that often occurs at a young age & healthy individual around the world. SCI can happen to anyone at any age. However, people between the age of 19 to 26 are more likely to have SCI due to an accident or some act of violence (Ackery et al., 2005).

Pulmonary complications are the leading cause of morbidity and death both in the shorter and longer-term after injury. Bellamy et al retrospectively reviewed 54 patients and cited 64 complications and a 31% death rate. However, these were cervical injuries only. In another study has determined the incidence of respiratory complications in the acute care stage following an SCI.

A study reported that 35.7% of SCI patients have pulmonary complications which were a retrospective study encompassing for one month after the injury. The death rate was 18% with 11% of the deaths attributable to respiratory problems. Recently, a prospective study revealed that 50% of acutely injured patients developed either atelectasis or pneumonia within 1-month post-SCI (Berney et al., 2011).

In the acute hospitalization phase, respiratory complications are highly common with 84% of patients with cervical (1–4) vertebral level and 60% of those with cervical (5–8) vertebral levels of injuries experiencing respiratory compromise. The number of respiratory complications during this acute phase contributes considerably to both hospital length of stay and costs (Gething et al., 2006).

The frequency of respiratory complications is co-related with injury level and severity, associated injuries, and the age and pre-existing co-morbidities of the patient (Kirshblum et al., 2007).

The pulmonary complication can also vary with the level of the injury; with higher-level injuries such as cervical (1–4) vertebral level being more likely to develop pneumonia and lower cervical injuries atelectasis (Gething et al., 2006).

SCI is a major public health problem in Bangladesh and respiratory complication is the most common cause of death. This complication occurs as a result of a reduction in inspiratory and expiratory ability and may also cause a reduction in lung volume and capacities. Lung function is considered by the quantification of gas flow or volume. The measurement is usually made by using a spirometer that measures lung volume. Spinal cord injury (SCI) resulting in tetraplegia has an insightful effect on respiratory function (Royster et al., 2006).

The respiratory complication is a leading cause of morbidity in patients with SCI. Because these patients need some routine respiratory care that is not always given at the early stage that they deserve in a rehabilitation program. If anybody has a chest infection, he/she may feel shortness of breathing, tightness in the chest, and has a raised temperature or cough. The mucus in the chest will become thicker and the lungs will produce more mucus to help to clear the infection of lungs. It may also notice that who has a respiratory problem, their normal function becomes restricted. Regular Changing position and Chest physiotherapy help to move the mucus out of the chest and also drink plenty of fluids as the mucus will be harder to clear if you are dehydrated (Sekaran et al., 2010).

Impaired respiratory muscle function and increased risk of respiratory complications

have been frequently mentioned as an indication for respiratory muscle training in persons with spinal cord injury (Wegrzyn et al., 2009).

Besides, it is well established that persons with quadriplegia have a reduced physical capacity. Due to the loss of motor function in lower and/or upper limbs and the relatively immobile lifestyle associated with the injury (Van Houtte et al., 2006). Also, respiratory muscles might participate in non-ventilatory function during exercise.

Therefore, it is proved that exercise performance might benefit from respiratory therapy in persons with spinal cord injury. Following SCI at the cervical and thoracic regions, there is paralysis or weakness of the respiratory muscles with a reduction of vital capacity and lung and chest wall compliance. This results in breathing difficulties as well as needs excessive effort during breathing. Patients will have an ineffective cough mechanism, which causes difficulty in the mobilization of bronchial secretions. Secretion retention and autonomic dysfunction are additional factors that result in a worsening of respiratory status leading to a delay for SCI rehabilitation. The cough mechanism is an essential part in the removal of secretions. It has three components: an inspiratory phase, a compressive phase when the closure of the glottis together with the contraction of the expiratory muscles generates an increased intrathoracic pressure, and an expulsive phase resulting from the sudden opening of the glottis (Fauzi et al., 2017).

Respiratory complications are the major cause of morbidity & mortality in patients with cervical and high thoracic spinal cord injury especially patients with high cervical cord injury. As the respiratory problem is life-threatening for tetraplegic SCI patients, all patients with an acute lesion need chest physiotherapy and special care (Zimmer et al., 2007).

Respiratory management contains a variety of strategies including airway management, weaning protocols, respiratory care protocols, and physiotherapy intervention (Ditunno et al., 2005). Guidelines for respiratory management after SCI were published in 2005 (Berlly & Shem, 2007).

Here, Active cycle of breathing technique (ACBT) can be adapted easily to a patient with different states that can be used independently with or without the inclusion of

manual techniques. It is an effective treatment in improving pulmonary function, airway clearance, and oxygenation (Savci et al., 2006).

ACBT is a breathing technique that helps to loosen and clear mucus from the lungs, improves ventilation in the lungs, and improves the efficiency of cough (Mckoy et al.,2016).

ACBT consists of three main phases include Breathing Control, Deep Breathing Exercises, or Thoracic Expansion Exercises, Huffing or Forced Expiratory Technique (Larner & Galey, 2013).

Breathing control is used to prevent bronchospasm and oxygen desaturation. On the other hand, the thoracic expansion exercises help to clear the secretions and assist to improve the collateral ventilation. The aim of the treatment is to clear the secretions that may decrease the frequency of infections and also prevent further airway damage and deterioration of lung function and potentially reduce the risk of lung disease. The Forced Expiratory Technique is performed by one or two forceful expirations which also called huffs and by breathing control. The Forced expiratory technique is an essential part of the ACBT in which thoracic expansion exercises and limited periods of breathing control are included (Lewis et al.,2011).

1.2 Rationale

Pulmonary complications are the most common cause of morbidity and mortality of SCI patients. They occur throughout the patient life and are the leading cause of hospitalization. Patients are particularly susceptible to respiratory complications in the first few weeks after SCI. In this period, respiratory complications are the second leading cause of death of the SCI patients. The most common pulmonary complications are hypoventilation, atelectasis, secretion retention, and pneumonia. Each lead to a mismatch between ventilation and perfusion, resulting in hypoxemia and, if untreated, may lead to respiratory failure. Patients with tetraplegia are particularly vulnerable. Persons with SCI experience changes in their different functions (Harvey, 2008).

The prevention of respiratory complications is very much essential for SCI patients. Lung volume and vital capacity indicate the ability to take a deep breath and also cough effectively for an injured person. The tetraplegic patient faces significant respiratory dysfunction as they don't find the proper lung function. Physiotherapists should provide special care to sustain the good respiratory function of the tetraplegic patient as a part of the rehabilitation program (Pellegrino et al., 2005).

Active cycle of breathing technique (ACBT) is a technique that can be easily adapted by patients in different circumstances. It can be used independently with or without the aid of manual techniques. It is an effective treatment in improving pulmonary function, airway clearance, and oxygenation (Savci et al., 2006).

Considering the outcome of ACBT, the short time goal is to improve airway clearance that may lead to improve long term health outcomes such as improve quality of life or reduce respiratory complications (Lewis et al., 2011).

1.3. Aims

The study aims to investigate the effectiveness of the Active Cycle of Breathing Technique on Tetraplegic SCI patients at CRP in Bangladesh.

1.4. Objectives

1.4.1. General objective

- To find out the Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI patient at CRP in Bangladesh.

1.4.2. Specific objective

- To find out the socio-demographic factors for tetraplegic SCI patients with respiratory complications.
- To assess the blood oxygen saturation level of the participants.
- To assess the respiratory rate of the participants.
- To assess the pulse rate of the individuals.
- To explore the effectiveness of the Active Cycle of Breathing Technique for the improvement of quality of life.
- To explore the effects of ACBT on the reduction of pulmonary complications.

1.5. Hypothesis

Alternative Hypothesis

H_a: $\mu_1 - \mu_2 \neq 0$ or $\mu_1 \neq \mu_2$, where the experimental group and control group initial and final mean difference is not same.

Null Hypothesis

H_o: $\mu_1 - \mu_2 = 0$ or $\mu_1 = \mu_2$, where the experimental group and control group initial and final mean difference is same.

1.6. Operational Definition

Spinal Cord Injury

A Spinal cord injury is defined as damage or trauma to the spinal cord that in turn results in a loss or impaired function resulting in reduced mobility or feeling (Quadriplegic and paraplegic spinal cord injury, 2005).

Effectiveness

Effectiveness is the capacity for producing a result that is desired. When something is deemed to be effective, it means it has an expected outcome or produces a valid impression.

Active Cycle of Breathing Technique

The Active Cycle of Breathing technique is a set of breathing techniques used to relax and open the airways. These exercises make cough work better and help to clear mucus out of the lungs.

Spinal cord is cylindrical in form and considerably flattened in anterior and posterior areas (Back, 2006).

It begins at the foramen magnum in the skull and it continues with the medulla oblongata in the brain. It terminates inferiorly at the lower border of the first lumbar vertebra. The location of the spinal cord is within the vertebral foramen which is called the vertebral canal (Snell, 2010).

The vertebral bodies protect the spinal cord anteriorly and vertebral arches protect it laterally and posteriorly. The spinal cord is a communicating link between the spinal nerves and the brain. The spinal cord is considered as the major path through which sensory and motor information travel between the brain and the body (Kirshblum et al., 2011).

The receptor of the body receives the sensory stimuli from the environment which sends the signal to the brain and then the brain sends its messages to the spinal nerves through the spinal cord which causes movements of the body (Snell, 2010).

The spinal cord becomes damaged or gets injured then it is called SCI. SCI may responsible for interrupting whole-body communication. SCI usually occurs after an unexpected, traumatic, and non- traumatic damage to the spinal cord. This injury or damage results in a fracture, dislocation of vertebrae, an intervertebral disc which in turn ruptures the spinal cord partially or completely. A Spinal cord injury is defined as damage to the spinal cord that results in a loss or impaired function which reduced mobility or feeling (Quadriplegic and paraplegic spinal cord injury, 2005).

SCI results from an accident that breaks or severely damages the spinal cord in the segments of the neck and back. In Bangladesh, it is a common practice to carry a heavy load on the head. Most of the SCI takes place due to an accidental fall while carrying a load (Hoque et al., 2012).

In Bangladesh, during harvesting, the farmers, and laborers carry their products on their heads and transport them from the field to local stores or from one vehicle to another. The most usual reasons of SCI in Bangladesh are falling while carrying a heavy load on the head, road traffic accidents, falling from a height, fall of a heavy object onto the head or neck, bull attack, and diving into shallow water (Hoque et al., 2012).

Razzak et al., (2011) mentioned that between 20-40 people per millions of the population acquire spinal injury each year. According to the report of the National SCI statistical centre (NSCISC) among the developed countries only in the U.S.A., approximately 12000 new cases of SCI are found every year. Approximately 60% of the cases were found in people of 16-40 years (Ottomaneli & Lind, 2009).

Currently, there is no accurate number of persons SCI in Bangladesh. Therefore, it is difficult to know or estimate the total number of patients with SCI in Bangladesh. The most common age group for SCI ranges from 25-29 years in Bangladesh and 83% of them are male (Islam et al., 2011).

The major complication of SCI is paralysis in body parts such as the upper and lower extremities. A lot of complications can also result from SCI. The person with SCI might have complications like lack of skin sensation, pressure sore, bowel and bladder complexities, respiratory complications, and autonomic dysreflexia, sexuality dysfunction, etc (Somers, 2006).

According to (Sinclair et al., 2006), there are some other complications like deep vein thrombosis, decreased vital capacity, osteoporosis, postural hypotension, spasticity, and heterotrophic ossification. From the practical observation of the researcher at CRP, it has been seen that the most common complication is pressure sore, urinary tract infection, bowel and bladder problem, burning sensation, autonomic dysreflexia, abdominal distension, psychosocial distress, etc. One of the common complications of tetraplegic patients is respiratory distress or chest complication. These complications can be developed at any time after the injury. These complications can also be developed during the rehabilitation phase and after discharge.

Respiratory impairment occurs from spinal cord injury (SCI) results in medical

consequences that are leading causes of morbidity, mortality, and economic burden. High risk of pulmonary infection, symptoms of respiratory dysfunction, and also death is included as the pulmonary complication. Inspiratory capacity is reduced in the individuals who experienced a higher-level lesion, resulting in micro atelectasis, dyspnoea with exertion, and also severe impairments, and respiratory insufficiency. Expiratory muscles are impaired in many cases of SCI with susceptibility to lower respiratory tract infections, and profound effects on the cough, on the clearance of secretions. A person with SCI, quality of life is diminished by respiratory symptoms that include cough, phlegm, and wheezing. In the cases of higher lesions, asthma-like disorders of airway function have been described, which are prevented by cholinergic antagonists (Christopher, 2007).

Respiratory Physiotherapy is something one can do to help their SCI patients for better breathing. Sometimes the amount of mucus is too much or too thick that can block the air from moving in and out of the SCI patient's lungs. Mucus makes it too hard for the patients to breathe. Mucus that sits too long in the lungs can also grow germs that can make the SCI patient sick. Respiratory Physiotherapy helps to loosen the patient's mucus, so the patient can cough it up. The aim of early treatment of respiratory dysfunction in SCI is intensive management of secretions and atelectasis, which has been shown impressive results on SCI patients (Singh et al., 2005).

The most important objective of the treatment is to do the expansion of the lungs and to clear the secretions. The techniques commonly used to help remove the secretion which includes assisted coughing, vibration, percussion, etc. (Hicks et al., 2011).

Airway clearance techniques became popular in the 1990s (McIlwaine, 2007).

These include the active cycle of breathing technique, positive expiratory pressure mask therapy, high-pressure PEP mask therapy, airway oscillating devices, autogenic drainage, high-frequency chest compression devices, and the resistive inspiratory manoeuvre. In the early 1990s, physicians concern about oxygen desaturation during chest physiotherapy which was addressed with the use of sufficient pauses for relaxation and breathing control during ACBT (Robinson et al., 2010).

The active cycle of breathing technique (ACBT) is commonly used to promote airway clearance for individuals with chronic lung disease which is characterized by copious secretions. Abnormal secretion production can potentially lead to airway obstruction and sputum retention, thereby infection of the airways and inflammation will be the predisposing factors. The aim of the method is to clear secretions that may decrease the frequency of infections, therefore preventing further airway damage and deterioration of lung function, and potentially reducing the rate of progression of lung disease (Elkins et al., 2006).

ACBT is considered as a cycle of techniques that is used to loosen the airway secretions. This technique includes breathing control, thoracic expansion exercises, and also the forced expiration technique. In the period of breathing control, the individual uses their lower chest to perform tidal breathing which is also known as gentle relaxed breathing and it is performed at their own depth. Patients are encouraged to relax their shoulders and upper chest. while performing the technique. on the other hand, breathing control is considered as the resting period between the active steps of the technique. In the Thoracic expansion exercises include deep breathing inspiration and passive relaxed expiration. The FET consist of huffing and breathing control, where one or two forced expirations are performed which interspersed with breathing control (International Physiotherapy Group for CF, 2009).

Huffing is a type of coughing technique that includes inhaling and active exhaling. The length of huffing can be alternated with the optimize clearance. Huffing helps to mobilize and to clear peripheral secretions. One of the most beneficial acts of the technique is that can be self-administered by the patient (Robinson et al., 2010).

CRP is a non-profitable organization in Bangladesh where patients from all over the country get physiotherapy treatment for SCI and other neurological conditions. CRP is the only rehabilitation center in Bangladesh for SCI patients. CRP provides some essential treatments including medical, surgical, and therapeutic. Physiotherapists are an autonomous practitioner who can diagnose and treat disorders of movement, function, and human performance caused by activity, injury, disease, disability, or aging which affect the muscles, bones, joints, nervous system, heart, circulation, and lungs. They identify the problem and maximize the movement and function throughout

health promotion, preventative healthcare, treatment, and rehabilitation using a variety of physical, electro-physical, cognitive, and pharmacological agents. Physiotherapy is an essential element of the rehabilitation process and performs a diverse range of approaches such as manual therapy, vertebral therapy, exercise therapy, and electrotherapy. This service is available for both out-patients and in-patients. Physiotherapists at CRP are primary health care professionals so patients do not need a physician referral to visit a Physiotherapist. Physiotherapists in CRP have the ability to perform differential diagnosis regarding each of the primary Physiotherapy areas including Musculoskeletal, Neurology, and Paediatrics. For many years, CRP has developed its physiotherapy services through the continuous professional development program.

As CRP has a good international connection, it offers a standard of Physiotherapy practice, and the educational services according to the modern world standard. Thousands of Patients have been benefited through receiving Physiotherapy treatment from the organization. The Physiotherapy department has also started a Sports Rehabilitation Unit and a Gymnasium. Specialist services are available for the cases of stroke in the Stroke Rehabilitation Unit. Critical and challenging patients care services are provided by the clinical specialist once a week. Every year many SCI patients come to CRP to take treatment. The majority number of patients is tetraplegic. Physiotherapists ensure comprehensive rehabilitation services since patients' admission to the discharge. The physical rehabilitation program starts by providing respiratory physiotherapy for the acute patients and it continues until their improvement in mobility, balance, coordination, gait re-education, lifting, and also transferring from one place to another has occurred. Community-Based Rehabilitation (CBR) services are also provided by the Physiotherapists for the patients to make sure about the proper social rehabilitation after discharged from CRP (CRP Bangladesh, 2014).

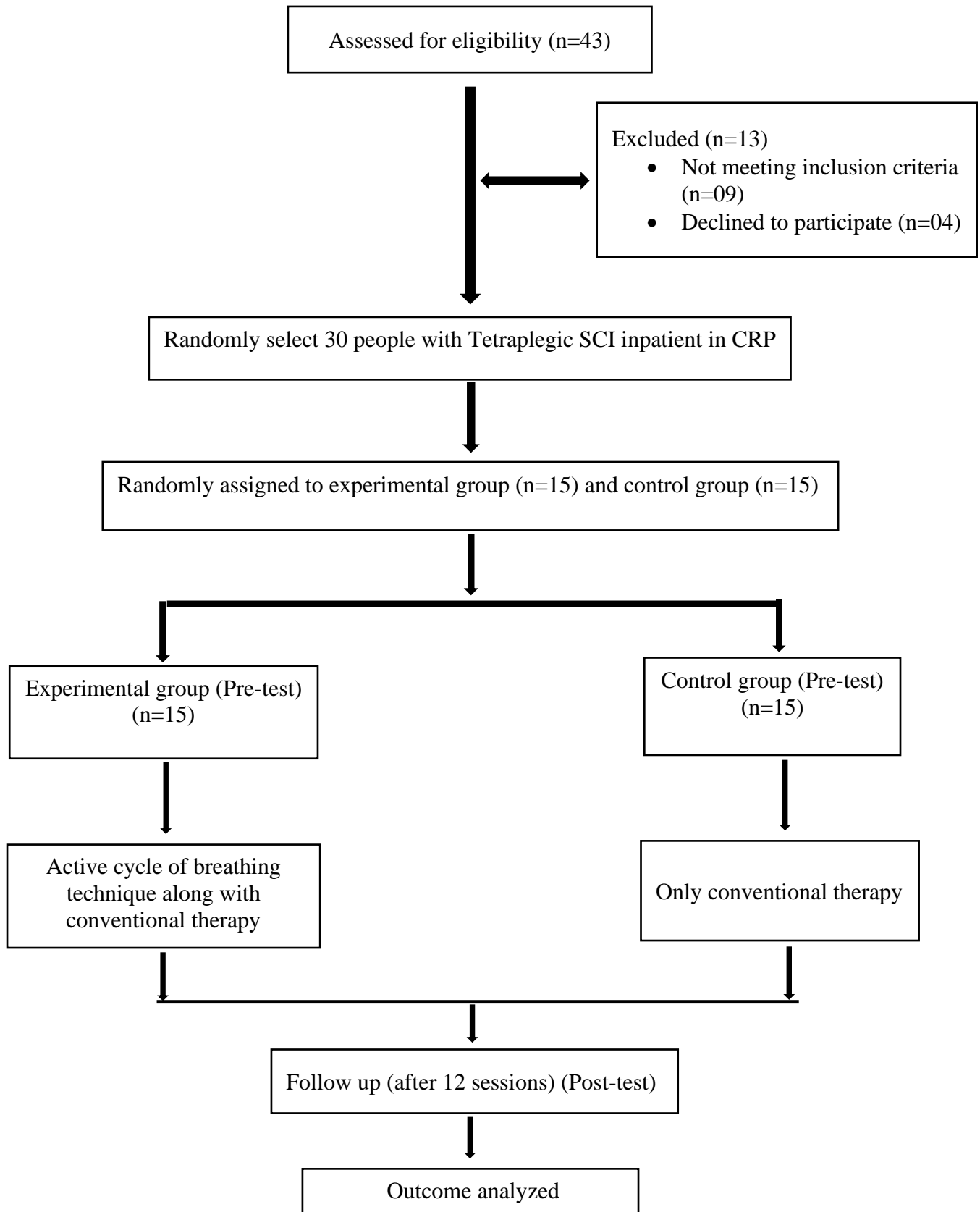
3.1. Study design

The study was conducted using a Randomized Control Trial (RCT) with two different groups. Only the experimental group was received the Active Cycle of Breathing Technique (ACBT) along with conventional physiotherapy while in the control group was received only conventional physiotherapy treatment. A pre-test (before intervention) and post-test (after intervention) was administered with each subject of both groups to compare functional ability before and after the treatment.

This was the study of a simple random sample technique and data collectors was being blind in this study.

3.2. Flowchart

Flowchart of the phases of Randomized Control Trial



3.3. Study area

The study area was the Spinal Cord Injury (SCI) Unit of Physiotherapy Department of Centre for the Rehabilitation of the Paralysed (CRP), Savar, Dhaka.

3.4. Study duration

The researcher has been started collecting data from November 2020 and ended in April 2021.

3.5. Study population

The study population was the patients diagnosed as Tetraplegic SCI in the Spinal Cord Injury (SCI) Unit of Physiotherapy Department at CRP, Savar, Dhaka.

3.6. Sampling technique

Simple Random Sample Techniques were used in this study. Subjects, who was meet the inclusion criteria, was taken as the sample in this study. 30 patients with Tetraplegic SCI were selected from inpatient SCI unit of physiotherapy department of CRP, Savar and then 15 patients were assigned to Experimental group for the treatment approaches of Active Cycle of Breathing Technique (ACBT) along with conventional physiotherapy and 15 patients to the Control group for conventional physiotherapy treatment by computer-generated random number using Microsoft Office Excel 2019 because it improved internal validity of experimental research. For the control group, the samples were given numerical numbers C1, C2, C3, etc. and E1, E2, E3, etc. for the experimental group.

3.7. Inclusion criteria

- Tetraplegic SCI patient were included because tetraplegic SCI patients has more respiratory complication than paraplegic SCI patients.
- Age between 20 to 50 years – This age group patients were usually not affected by severe pulmonary diseases.
- Both male and female were given same priority.
- The patient who had decreased lung volume and capacity were included in the study.
- Patient with intact cognition were included in this study as the patient could correctly follow the instruction of the physiotherapist for the interventions.
- Those who were motivated and given consent to include in the study (Tarin, 2015).

3.8. Exclusion criteria

- Rib fracture patient were excluded from the study to prevent further injury.
- Head injury patient were also excluded as they may experience dizziness or other complications during the interventions.
- Those who were not motivated and not wanted to give consent excluded from the study.
- Medically unstable patients were excluded for this study.
- Patient who had diagnosed bronchial asthma or restrictive lung disease were excluded as the intervention may penetrate their complications (Islam, 2017).

3.9. Sample size

In this study, 30 participants were selected according to the inclusion and exclusion criteria. 15 participants were in the experimental group and 15 participants in the control group.

3.10. Method of data collection

The researcher used the internationally accepted structured questionnaire for collecting data.

3.10.1. Data collection tools

- Record or Data collection form
- Informed Consent
- Structured questionnaire
- Spiro meter
- pulse oximeter
- Pen
- Notebooks
- Papers

3.10.2. Questionnaire

The researcher developed a self-made questionnaire under the advice and permission of the supervisor following certain guidelines. There were socio-demographic (name, age, address..... etc.), disease related question (year of lesion, skeletal level, neurological level, cause of injury..... etc.), medical information questions (respiratory rate, pulse rate, blood oxygen saturation level...etc) were formulated to determine the outcome of cardio-pulmonary functions.

3.10.3. Data collection procedure

The study procedure was conducted by assessing the patient, initial recording, treatment, and final recording. After screening the patient at the department, the patients were assessed by a qualified physiotherapist. 4 weeks of treatment were provided for every subject. 30 subjects were chosen for data collection according to the inclusion

criteria. Data were gathered through a pre-test and post-test intervention and the data was collected by using a written questionnaire form which had been formatted by the researcher. A pre-test was performed before beginning the treatment. The same procedure was performed to take a post-test at the end of 4 weeks of treatment. The researcher was provided the assessment form to each subject before starting treatment and after 4 weeks of treatment patient. The researcher was collected the data from the group in front of the qualified physiotherapist to reduce the biases. At the end of the study, a parametric related "t" test and non-parametric related Wilcoxon signed-rank test and Mann–Whitney U test to calculate the significance had been done for statistical analysis.

3.11. Intervention

Two physiotherapists who were expert in treatment of Active Cycle of Breathing Technique were involved in treatment of patients. All the physiotherapists have the experience have more than five years, in the aspect of chest physiotherapy. It was arranged in service training to share the information to practical demonstration regarding Active Cycle of Breathing Technique including types of exercise, dose, repetition and patient position. In addition, the types, dose, repetition, duration of conventional care including breathing exercise, purse lip breathing exercise, and exercise therapy was taken permission from head of Physiotherapy department, Centre for the Rehabilitation of the Paralysed (CRP). In control group treatment protocol that was provided which was followed through the documents that was written by expert physiotherapists in CRP.

3.12. Data analysis

Data was analyzed by using SPSS version 28.00 to compute the descriptive statistics using tables and also percentage and parametric tests were conducted using paired t-test and unrelated t-test. As well as, non-parametric tests were conducted by Wilcoxon signed-rank test and Mann–Whitney U test.

Estimated predictor

Hypothesis test of mean difference between the experimental group and the control group, within groups and also between groups, assuming normal distribution of the

parent population, two different and or independent variables, variables were quantitative by estimated predictor of paired t-test or unrelated t-test.

The researcher had calculated the variables mean, mean difference, standard deviations, standard error, degree of freedom and significant level to show that experimental group and control group mean difference in within group was significantly different than the standard table values. In the between group, the data shows that the mean difference was greater than the control group. The researcher had tested mean variables stating problem to test using t statistic, which is paired t-test and also unrelated t-test that was predicted as normally distributed if $df \geq 30$.

Hypothesis Test

Paired t test

Paired t-test was used to compare difference between means of paired variables. Selection of test of hypothesis is mean difference under t distribution.

Assumption

Paired variables

Variables were quantitative

Parent population of sample observation follows normal distribution.

Null and alternative hypothesis

Ho: $\mu_1 - \mu_2 = 0$ or $\mu_1 \geq \mu_2$; where the experimental group and control group initial and final mean difference was same.

Ha: $\mu_1 - \mu_2 \neq 0$, $\mu_1 < \mu_2$; where the experimental group and control group initial and final mean difference was not same.

Here,

Ho= Null hypothesis

Ha= Alternative hypothesis

μ_1 = Mean difference in initial assessment

μ_2 = Mean difference in final assessment

Formula: test statistic t is follows:

$$t = \frac{\bar{d}}{SE(\bar{d})} = \frac{\bar{d}}{\frac{SD}{\sqrt{n}}}$$

Here,

\bar{d} = mean of difference (d) between paired values,

SE (\bar{d}) = Standard Error of the mean difference,

SD= standard deviation of the differences d and

n= number of paired observations.

Calculation of paired t value of the respiratory rate as below-

$$t = \frac{\bar{d}}{SE(\bar{d})} = \frac{\bar{d}}{\frac{SD}{\sqrt{n}}} = \frac{1.4667}{\frac{3.9076}{\sqrt{15}}} = 1.454$$

Level of Significant

The researcher has used 5% level of significant to test the hypothesis. Calculated t value and compared with standard t value in with appropriate degrees of freedom; the null hypothesis was rejected when observed t-value is large than the standard t-value and alternative hypothesis was accepted. On the other hand, reversed decision has taken when the calculated value of t is smaller than the standard t-value. All these decisions were taken with a prefixed level of significance (for this case this is 5%).

In this way researcher had calculated paired t-value and significant level and have presented in the following tables-

Table– III.I.: Paired samples t-test

	Experimental Group			Control Group			
	t	df	Significance	t	df	Significance	
Respiratory rate Pre - Respiratory rate Post	1.454	14	.084	Respiratory rate Pre - Respiratory rate Post	.139	14	.446
Pulse rate Pre - Pulse rate Post	1.531	14	.074	Pulse rate Pre - Pulse rate Post	2.092	14	.028*
Volume of lung Pre - Volume of lung Post	-5.501	14	.001*	Volume of lung Pre - Volume of lung Post	-4.090	14	.001*
Blood oxygen saturation level Pre - Blood oxygen saturation level Post	-4.000	14	.001*	Blood oxygen saturation level Pre - Blood oxygen saturation level Post	-1.046	14	.157
Force vital capacity Pre - Force vital capacity Post	-5.000	14	.001*	Force vital capacity Pre - Force vital capacity Post	-2.582	14	.011*

Unrelated t test

Unrelated t test was used to compare difference between two means of independent variables. Selection of test of hypothesis was two independent mean differences under independent t distribution.

Assumption

Different and independent variables

Variables were quantitative

Normal distribution of the variables

Formula: test statistic t is follows:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$$

Here,

\bar{x}_1 = Mean of the Experimental Group,

\bar{x}_2 = Mean of the Control Group,

n_1 = Number of participants in the Experimental Group

n_2 = Number of participants in the Control Group

S_1 = Standard deviation of experimental group

S_2 = Standard deviation of control group

Calculation of unrelated t value of the respiratory rate as below-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}} = \frac{21.80 - 24.73}{\sqrt{\frac{(3.212)^2}{15} + \frac{(2.987)^2}{15}}} = -2.590$$

By using this formula, researcher has calculated all the t-value and have presented in the following tables –

Table– III.II: Unrelated samples t-test

	Group	Mean	SD	t	df	Significance
Respiratory rate (per minute)	Experimental	21.80	3.212	-2.590	28	.008*
	Control	24.73	2.987	-2.590	28	.008*
Pulse rate (per minute)	Experimental	71.00	5.757	-.795	28	.217
	Control	73.40	10.169	-.795	28	.217
Volume of lung (CC)	Experimental	1140.00	91.026	2.009	28	.027*
	Control	1046.67	155.226	2.009	28	.028*
Blood oxygen saturation level	Experimental	97.20	1.014	2.934	28	.003*
	Control	96.07	1.100	2.934	28	.003*
Forced vital capacity	Experimental	780.00	174.028	2.628	28	.007*
	Control	606.67	186.956	2.628	28	.007*

Wilcoxon signed-rank test

Formula:

$$Z = \frac{W_s - \frac{n(n+1)}{4}}{\sqrt{\frac{n(n-1)(2n+1)}{24}}}$$

Here,

W_s = Smallest of absolute values of the sum

n = Total number of samples

Calculation Wilcoxon sign rank Z test for difficulty in breathing as below:

$$Z = \frac{W_s - \frac{n(n+1)}{4}}{\sqrt{\frac{n(n-1)(2n+1)}{24}}} = \frac{10.31 - \frac{15(15+1)}{4}}{\sqrt{\frac{15(15-1)(2 \times 15+1)}{24}}} = -3.017$$

By using this formula, researcher has calculated the t-value and have presented in the following tables –

Table– III.III: Wilcoxon Signed Ranks Test

Experimental Group			Control Group		
	Z	Sig.		Z	Sig.
Difficulty in breathing post-Difficulty in breathing Pre	3.017	.003*	Difficulty in breathing post-Difficulty in breathing Pre	2.714	.007*
Chest tightness post-Chest tightness Pre	2.889	.004*	Chest tightness post-Chest tightness Pre	2.646	.008*
Dizziness during deep breathing post-Dizziness during deep breathing Pre	1.000	.317	Dizziness during deep breathing post-Dizziness during deep breathing Pre	1.414	.157
Pain during coughing post-Pain during coughing Pre	3.162	.002*	Pain during coughing post-Pain during coughing Pre	2.646	.008*
Secretion of sputum during coughing post-Secretion of sputum during coughing Pre	3.162	.002*	Secretion of sputum during coughing post-Secretion of sputum during coughing Pre	3.000	.003*
Sleep disordered breathing post-sleep disordered breathing Pre	2.449	.014*	Sleep disordered breathing post-sleep disordered breathing Pre	2.449	.014*
Fatigue Post - Fatigue Pre	3.162	.002*	Fatigue Post - Fatigue Pre	2.646	.008*

Mann Whitney U Test

Formula:

$$U = n_1 n_2 + \frac{n_x(n+1)}{2} - T_x$$

Here,

n_1 = number of subjects from experimental group

n_2 = number of subjects from control group

T_x = the larger rank total

n_x = the number of the subjects of the group with larger rank total

Calculation of Mann Whitney U of difficulty in breathing as below:

$$U = n_1 n_2 + \frac{n_x(n+1)}{2} - T_x = 15 \times 15 + \frac{15(15+1)}{2} - 251.50 = 93.50$$

By using this formula, researcher has calculated all the t-value and have presented in the following tables –

Table– III.IV: Mann-Whitney U Test

	Pre-test				Post-test		
	Mann-Whitney U	Z	Sig.		Mann-Whitney U	Z	Sig.
Difficulty in breathing	93.500	.840	.401	Difficulty in breathing	85.500	1.234	.217
Chest tightness	105.000	.328	.743	Chest tightness	79.500	1.654	.098
Dizziness during deep breathing	90.000	1.445	.148	Dizziness during deep breathing	97.500	1.439	.150
Pain during coughing	109.500	.138	.890	Pain during coughing	96.500	.954	.340
Secretion of sputum during coughing	111.000	.072	.943	Secretion of sputum during coughing	105.000	.482	.630
Sleep disordered breathing	112.500	.000	1.000	Sleep disordered breathing	112.500	.000	1.000
Fatigue	105.000	.482	.630	Fatigue	82.500	1.624	.104

3.13. Informed Consent

For this study, researcher was given consent form to every participant for the purpose of the research and consent forms was explained to the subject verbally. Researcher mentioned those participants were fully voluntary and they had the right to withdraw at any time. Researcher insured them confidentiality would be maintained. Information might be published in the way of presentation or writing format but they did not be identified. The study results may not have any direct effects on them but the members of Physiotherapy population may be benefited from the study in future. They will not be embarrassed by the study. At any time, the researcher would be available to answer any additional questions in regard to the study.

3.14. Ethical Consideration

The whole process of this research project was done by following the Bangladesh Medical Research Council (BMRC) guidelines and World Health Organization (WHO) Research guidelines. The proposal of the dissertation including methodology were presented to the Institutional Review Board (IRB). Then the proposal of the dissertation including methodology were approved and obtained permission from the concerned authority of ethical committee of Bangladesh Health Professions Institute (BHPI). Again, before the beginning of the data collection, researcher had obtained the permission from the concerned authorities ensuring the safety of the participants. The researcher strictly maintained the confidentiality regarding participant's condition and treatments. Here researcher was used an information sheet and consent form both in English and Bengali to take the participant's consent. The researcher had obtained consent to participate from every subject. A signed informed consent form was received from each participant. The participants were informed that they have the right to meet with outdoor doctor if they think that the treatment is not enough to control the condition or if the condition become worsen. So, all the participants were informed that they are completely free to decline answering any question during the study and were free to withdraw their consent and terminate participation at any time. Withdrawal of participation from the study did not affect their treatment in the physiotherapy department and they still had got the same facilities. Every subject had the opportunity to discuss their problem with the senior authority or administration of CRP and have any questioned answer to their satisfy.

30 patients were enrolled in the study. Among them, 15 in the ACBT with conventional treatment group (experimental group) and 15 in the only conventional treatment group (control group). The whole subject of both experimental and control group scored their respiratory rate, pulse rate, oxygen saturation rate, lung volume, force vital capacity, difficulty in breathing, chest tightness, dizziness during deep breathing, pain during coughing, secretion of sputum during coughing, sleep disordered breathing and fatigue before and after completing treatment.

Table– IV.I: Baseline Data

	Experimental Group		Control Group	
	Min. - Max.	Mean with SD	Min. - Max.	Mean with SD
Age	20.00 - 50.00	31.6667 (±10.01190)	20.00 - 50.00	39.0667 (±11.13852)
Gender	1.00 - 1.00	1.0000 (±.00000)	1.00 - 2.00	1.0667 (±.25820)
Marital status	1.00 - 2.00	1.4667 (±.51640)	1.00 - 2.00	1.1333 (±.35187)
Educational qualification	2.00 - 4.00	3.1333 (±.83381)	1.00 - 5.00	2.3333 (±1.34519)
Occupation	1.00 - 11.00	5.3333 (±4.43471)	1.00 - 11.00	7.5333 (±3.15926)
Residential area	1.00 - 3.00	2.00 (±1.00)	1.00 - 3.00	2.2667 (±.96115)
Family type	1.00 - 2.00	1.5333 (±.51640)	1.00 - 2.00	1.6000 (±.50709)
Family members	3.00 - 9.00	5.0667 (±1.53375)	3.00 - 7.00	5.0667 (±1.38701)
Earning members	1.00 - 3.00	1.1333 (±.51640)	1.00 - 2.00	1.2000 (±.41404)

Average monthly family income	5000 - 20000	12933.3333 (±3825.97638)	8000 - 20000	13400.0000 (±4136.94159)
Year of lesion	2.00 - 3.00	2.0667 (±.25820)	1.00 - 2.00	1.7333 (±.45774)
Skeletal level	3.00 - 16.00	7.0000 (±3.76070)	2.00 - 16.00	6.8000 (±3.32093)
Neurological level	3.00 - 16.00	5.2667 (±3.28344)	2.00 - 10.00	4.3333 (±1.95180)
Cause of lesion	1.00 - 2.00	1.0667 (±.25820)	1.00 - 2.00	1.0667 (±.25820)
Cause of traumatic lesion	1.00 - 7.00	3.4286 (±2.20887)	1.00 - 8.00	4.0000 (±2.66025)
Cause of non-traumatic lesion	1.00 - 1.00	1.0000 (±.0000)	2.00 - 2.00	2.0000 (±.0000)
ASIA impairment scale	1.00 - 2.00	1.4667 (±.51640)	1.00 - 2.00	1.3333 (±.48795)
General Health	2.00 - 5.00	3.5333 (±.74322)	2.00 - 5.00	3.6000 (±1.05560)
History of any systematic disease	1.00 - 2.00	1.1333 (±.35187)	1.00 - 3.00	1.3333 (±.61721)

Age:

From the above-mentioned table, it is obvious that mean age with standard deviation of participant in control group was 39.07 ± 11.14 years and whereas experimental group mean age with standard deviation was 31.67 ± 10.012 years on average. The maximum age population 23.3% that age was 50 years. The second highest age population were 25, 27 and 40 years where each of the population percentage was 10%. On the other hand, 20-, 22- and 38-years age group population were 6.7% each. The rest age group population were 3.3% each which was the lowest in this study.

Gender:

In this research, it is obvious that sex of participant in experimental and control group was male 96.7% (n=29) and female 3.3% (n=01). On the other hand, the mean with standard deviation of gender for experimental group was 1.00 ± 0.00 and for the control group was $1.067 \pm .026$.

Marital status:

Among the total number of participants, 21 of the participants were married which was 70% of the population and 9 of them were unmarried which was the rest 30%. Where the mean with standard deviation for experimental group was 1.467 ± 0.516 and for the control group was 1.133 ± 0.352 .

Educational Qualification:

In this study, among the participants, Primary education completed participants were highest rate that was about 36.7% (n=11), S.S.C. passed participant was second highest rate that was 20.0% (n=06), HSC passed; illiterate and graduation completed participants were according to 7%, 4% and 2%. This above (Table-III) showed that the mean with standard deviation of educational qualification for control group was 2.33 ± 1.35 and the mean with standard deviation of educational qualification for experimental group was 3.133 ± 0.834 .

Occupation:

Among the participants businessman were the highest rate that was about 26.7% (n=08). Students were second highest rate that was 23.3% (n=07). Farmers were 13.3% (n=04), Construction workers were 10.0% (n= 03), Garment's workers were 6.7% (n=02). On the other hand, Auto driver, Employee, house wife, Mobile servicing, Rickshaw puller and Shopkeeper participants were respectively 3% and (n=1) for each occupation. On the other hand, the mean with standard deviation for experimental group was 5.33 ± 4.435 and the mean with standard deviation for control group was 7.53 ± 3.159 .

Residential Area:

In this study, among the 30 participants the highest number of populations live in rural area that was 53.3% (n=16). 40.0% (n=12) live in urban area and the rest 6.7% (n=02) live in the semi-rural area. The above (Table-III) shows that the mean with standard deviation of residential area for control group was 2.267 ± 0.96 and for the experimental group was 2.00 ± 1.00 .

Family type:

This study showed that 56.7% (n=17) participants live in nuclear family and the rest 43.3% (n=13) live in the extended family whereas the mean with standard deviation was 1.53 ± 0.516 for the experimental group and $1.60 \pm .507$ for the control group.

Family members:

Among the 30 participants the minimum number of family members of the participants was 3 and the maximum number of family members of the participants was 9 whereas the mean with standard deviation was 5.067 ± 1.534 for the experimental group and 5.067 ± 1.387 for the control group. Most of the participants family members number was 4 (n=10) which was 33.3% of the study. The number of family members percentage respectively same for 5 and 6 which rate was 20.0% (n=6) each. 13.3% (n=7) participants family members were 7, 10% (n=3) participants family members were 3 and the least 3.3% (n=1) family members number was 9.

Earning members:

The minimum earning members of the participants for the experimental group was 1.00 and the maximum earning members was 3.00 whereas the mean with standard deviation of the group for earning members was 1.13 ± 0.516 . On the other hand, the minimum earning members of the participants for the control group was 1.00 and the maximum earning members was 2.00 as well as the mean with standard deviation was 1.20 ± 0.414 for the control group (Table-IV. I).

Average monthly family income:

The above Table-III shows that the minimum average monthly family income of the experimental group was 5000.00 and the maximum range was 20000.00 and the mean with standard deviation for the group was 12933.33 ± 3825.976 . On the other hand, the minimum average monthly family income of the control group was 8000.00 and the maximum range was 20000.00 whereas the mean with standard deviation was 13400.00 ± 4136.94 .

Year of lesion:

The Table-III reveals that the mean with standard deviation for year of lesion of the experimental group was 2.067 ± 0.26 and the value for the control group was 1.73 ± 0.458 . The highest 83.3% (n=25) participants were affected in 2020, 13.3% (n=4) were affected in 2021 and the rest 3.3% (n=1) were affected in 2019.

Skeletal level:

Among the 30 participants, the minimum skeletal level was C3 (3.00) and the maximum skeletal level was D7 (16.00) in the experimental group whereas the minimum range was C2 (2.00) and maximum range was D7 (16.00) in the control group. The Table-III reveals that the mean with standard deviation of the experimental group was 7.00 ± 3.76 and the mean with standard deviation of the control group was 6.80 ± 3.32 .

Neurological level:

In the experimental group, the minimum neurological level was C3 (3.00) and the maximum level was D7 (16.00) whereas the mean with standard deviation was 5.27 ± 3.28 . In control group, the minimum level was C2 (2.00) and the maximum neurological level was D1 (10.00) whereas the mean with standard deviation was 4.33 ± 1.95 .

Cause of lesion:

The Table-III shows that among the 15 participants of the experimental group, the mean with standard deviation for cause of lesion was 1.067 ± 0.258 . On the other hand, among the 15 participants of the control group, the mean with standard deviation was also 1.067 ± 0.258 . Where 93.3% (n=28) participants cause was traumatic and the rest 6.7% (n=2) participants cause was non-traumatic among the total 30 participants.

Cause of traumatic lesion:

In control group, the mean with standard deviation for cause of traumatic lesion was 3.43 ± 2.21 and for the experimental group the value was 4.00 ± 2.66 .

Cause of non-traumatic lesion:

Among 30 participants, only (n=2) participants cause was non-traumatic. Where (n=1) in the experimental group and (n=1) in the control group. In the experimental group, the participant cause was TB spine. In the control group, the participant cause of lesion was transverse myelitis.

ASIA impairment scale:

The highest percentage of the participants ASIA impairment scale was 60% (n=18) for complete-A and the rest 40% (n=12) for Incomplete-B. On the other hand, the mean value with standard deviation was 1.47 ± 0.516 for the experimental group and 1.33 ± 0.49 for the control group.

General health:

Among the 30 participants, 43.3% (n=13) participants general health was fair, 30.0% (n=9) participants general health was good. 13.3% (n=4) participants general health was very good and also 13.3% (n=4) participants general health was poor. In experimental group, the mean with standard deviation was 3.53 ± 0.74 . The value was 3.60 ± 1.056 for the control group.

History of any systematic disease:

In this study, 16.7% (n=5) participants had Diabetes mellitus and only 3.3% (n=1) participants had hypertension among the total 30 participants. The mean with standard deviation for the experimental group was 1.13 ± 0.35 and the value was 1.13 ± 0.62 for the control group (Table-III).

4.2. Respiratory rate:

The study found that within experimental group analysis in respiratory rate variable the degree of freedom was 14 and the calculated t value was 1.454 which represent the p value of 0.084. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically not significant ($p > .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was not effective for reduction of Respiratory rate among patients with tetraplegic SCI. In this study, control group subjects were 15 and control group participants received only conventional physiotherapy for tetraplegic SCI. In fact, within control group analysis followed the same subject design formula. As this one was the same subject design in within group analysis, this experiment was calculated using paired “t” test formula. After conducting the test statistics, it was found that within control group analysis in respiratory rate variable the degree of freedom was 14 and the calculated t value was .139 which represent the p value of .446. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically not significant ($p > .05$). This means that conventional physiotherapy was not effective for reduction of Respiratory rate among patients with tetraplegic SCI. In this study, pre-test mean score of respiratory rates was 23.27 in experimental group and 24.87 among control group. On post test score after treatment showed that respiratory rate had reduced in both groups. Above table shows us that in both experimental and control group p value was .111 in the pre-test which changed significantly after the post-test at .008. Thus, it was claimed that both intervention of experimental and control group shows statically significant ($p < .05$) after the post-test. This means that both interventions were effective for reduction of Respiratory rate among patients with tetraplegic SCI.

4.3. Pulse rate:

The study found that within experimental group analysis in pulse rate variable the degree of freedom was 14 and the calculated t value was 1.531 which represent the p value of .074. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically not significant ($p > .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was not effective to normalize pulse rate among patients with tetraplegic SCI. In this study, control group subjects were 15 and control group participants received only conventional physiotherapy for tetraplegic SCI. In fact, within control group analysis followed the same subject design formula. As this one was the same subject design in within group analysis, this experiment was calculated using paired "t" test formula. After conducting the test statistics, it was found that within control group analysis in pulse rate variable the degree of freedom was 14 and the calculated t value was 2.092 which represent the p value of .028. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that conventional physiotherapy was effective to normalize pulse rate among patients with tetraplegic SCI. In this study, pre-test mean score of pulse rates was 72.33 in experimental group and 75.40 among control group. On post test score after treatment showed that pulse rate had reduced in both groups. Above table shows us that in the pre-test experimental group p value was .155 and in control group p value was .156 which changed in both group after the post-test at .217. Thus, it was claimed that both intervention of experimental and control group showed statically not significant ($p > .05$) after the post-test. This means that both interventions were not effective to normalize pulse rate among patients with tetraplegic SCI.

4.4. Volume of lung:

The study found that within experimental group analysis in lung volume variable the degree of freedom was 14 and the calculated t value was -5.501 which represent the p value of .001. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective to improve lung volume among patients with tetraplegic SCI. In this study, control group subjects were 15 and control group participants received only conventional physiotherapy for tetraplegic SCI. In fact, within control group analysis followed the same subject design formula. As this one was the same subject design in within group analysis, this experiment was calculated using paired "t" test formula. After conducting the test statistics, it was found that within control group analysis in Volume of lung variable the degree of freedom was 14 and the calculated t value was -4.090 which represent the p value of .001. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that conventional physiotherapy was effective to improve lung volume among patients with tetraplegic SCI. In this study, pre-test mean score of lung volume was 1000.00 in experimental group and 953.33 among control group. On post test score after treatment showed that lung volume had increased in both groups. Above table shows us that in both experimental and control group p value was .120 in the pre-test which changed significantly after the post-test in experimental group at .027 and in control group at .028. Thus, it was claimed that both intervention of experimental and control group shows statically significant ($p < .05$) after the post-test. This means that both interventions were effective to improve lung volume among patients with tetraplegic SCI.

4.5. Blood oxygen saturation level:

The study found that within experimental group analysis in Blood oxygen saturation level variable the degree of freedom was 14 and the calculated t value was -4.000 which represent the p value of .001. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective to improve Blood oxygen saturation level among patients with tetraplegic SCI. In this study, control group subjects were 15 and control group participants received only conventional physiotherapy for tetraplegic SCI. In fact, within control group analysis followed the same subject design formula. As this one was the same subject design in within group analysis, this experiment was calculated using paired "t" test formula. After conducting the test statistics, it was found that within control group analysis in Blood oxygen saturation level variable the degree of freedom was 14 and the calculated t value was -1.046 which represent the p value of .157. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically not significant ($p > .05$). This means that conventional physiotherapy was not effective to improve Blood oxygen saturation level among patients with tetraplegic SCI. In this study, pre-test mean score of blood oxygen saturation level was 95.60 in experimental group and 95.73 among control group. On post test score after treatment showed that blood oxygen saturation level had increased in both groups. Above table shows us that in both experimental and control group p value was .350 in the pre-test which changed significantly after the post-test in both group at .003. Thus, it was claimed that both intervention of experimental and control group shows statically significant ($p < .05$) after the post-test. This means that both interventions were effective to improve blood oxygen saturation level among patients with tetraplegic SCI.

4.6. Force vital capacity:

The study found that within experimental group analysis in Force vital capacity variable the degree of freedom was 14 and the calculated t value was -5.000 which represent the p value of .001. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective to improve Force vital capacity among patients with tetraplegic SCI. In this study, control group subjects were 15 and control group participants received only conventional physiotherapy for tetraplegic SCI. In fact, within control group analysis followed the same subject design formula. As this one was the same subject design in within group analysis, this experiment was calculated using paired "t" test formula. After conducting the test statistics, it was found that within control group analysis in Force vital capacity variable the degree of freedom was 14 and the calculated t value was -2.582 which represent the p value of .011. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that conventional physiotherapy was effective to improve Force vital capacity among patients with tetraplegic SCI. In this study, pre-test mean score of forced vital capacity was 617.33 in experimental group and 533.33 among control group. On post test score after treatment showed that forced vital capacity had increased in both groups. Above table shows us that in both experimental and control group p value was .050 in the pre-test which changed significantly after the post-test in both group at .007. Thus, it was claimed that both intervention of experimental and control group shows statically significant ($p < .05$) after the post-test. This means that both interventions were effective to improve forced vital capacity among patients with tetraplegic SCI.

4.7. Difficulty in breathing:

The study found that within experimental group analysis in difficulty in breathing variable the value of Z was 3.017 which represent the p value of .003. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective for reduction of difficulty in breathing among patients with tetraplegic SCI. The study found that within control group analysis in difficulty in breathing variable the value of Z was 2.714 which represent the p value of .007. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that only conventional physiotherapy was also effective for reduction of difficulty in breathing among patients with tetraplegic SCI. In this study, pre-test Mann-Whitney U score of difficulty in breathing was 93.50 and 85.50 after the post-test. Above table shows us that in pre-test p value was .401 which changed after the post-test at .217. Thus, it was claimed that the intervention shows statically not significant ($p > .05$) after the post-test. This means that the intervention was not effective for reduction of difficulty in breathing among patients with tetraplegic SCI.

4.8. Chest tightness:

The study found that within experimental group analysis in chest tightness variable the value of Z was 2.889 which represent the p value of .004. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective for reduction of chest tightness among patients with tetraplegic SCI. The study found that within control group analysis in chest tightness variable the value of Z was 2.646 which represent the p value of .008. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that only conventional physiotherapy was also effective for reduction of chest tightness among patients with tetraplegic SCI. In this study, pre-test Mann-Whitney U score of chest tightness was 105.000 and 79.500 after the post-test. Above table shows us that in pre-test p value was .743 which changed after the post-test at .098. Thus, it was claimed that the intervention shows statically not significant ($p > .05$) after the post-test. This means that the intervention was not effective for reduction of chest tightness among patients with tetraplegic SCI.

4.9. Dizziness during deep breathing:

The study found that within experimental group analysis in Dizziness during deep breathing variable the value of Z was 1.000 which represent the p value of .317. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically not significant ($p > .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was not effective for reduction of dizziness during deep breathing among patients with tetraplegic SCI. The study found that within control group analysis in dizziness during deep breathing variable the value of Z was 1.414 which represent the p value of .157. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically not significant ($p > .05$). This means that only conventional physiotherapy was also not effective for reduction of dizziness during deep breathing among patients with tetraplegic SCI. In this study, pre-test Mann-Whitney U score of dizziness during deep breathing was 90.000 and 97.500 after the post-test. Above table shows us that in pre-test p value was .148 which changed after the post-test at .150. Thus, it was claimed that the intervention shows statically not significant ($p > .05$) after the post-test. This means that the intervention was not effective for reduction of dizziness during deep breathing among patients with tetraplegic SCI.

4.10. Pain during coughing:

The study found that within experimental group analysis in pain during coughing the value of Z was 3.162 which represent the p value of .002. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective for reduction of pain during coughing among patients with tetraplegic SCI. The study found that within control group analysis in pain during coughing variable the value of Z was 2.646 which represent the p value of .008. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that only conventional physiotherapy was also effective for reduction of pain during coughing among patients with tetraplegic SCI. In this study, pre-test Mann-Whitney U score of pain during coughing was 109.500 and 96.500 after the post-test. Above table shows us that in pre-test p value was .890 which changed after the post-test at .340. Thus, it was claimed that the intervention shows statically not significant ($p > .05$) after the post-test. This means that the intervention was not effective for reduction of pain during coughing among patients with tetraplegic SCI.

4.11. Secretion of sputum during coughing:

The study found that within experimental group analysis in Secretion of sputum during coughing the value of Z was 3.162 which represent the p value of .002. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective for reduction of Secretion of sputum during coughing among patients with tetraplegic SCI. The study found that within control group analysis in Secretion of sputum during coughing variable the value of Z was 3.000 which represent the p value of .003. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that only conventional physiotherapy was also effective for reduction of sputum during coughing among patients with tetraplegic SCI. In this study, pre-test Mann-Whitney U score of secretion of sputum during coughing was 111.000 and 105.000 after the post-test. Above table shows us that in pre-test p value was .943 which changed after the post-test at .630. Thus, it was claimed that the intervention shows statically not significant ($p > .05$) after the post-test. This means that the intervention was not effective for reduction of secretion of sputum during coughing among patients with tetraplegic SCI.

4.12. Sleep disordered breathing:

The study found that within experimental group analysis in sleep disordered breathing the value of Z was 2.449 which represent the p value of .014. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective for reduction of sleep disordered breathing among patients with tetraplegic SCI. The study found that within control group analysis in sleep disordered breathing variable the value of Z was 2.449 which represent the p value of .014. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that only conventional physiotherapy was also effective for reduction of sleep disordered breathing among patients with tetraplegic SCI. In this study, pre-test Mann-Whitney U score of sleep disordered breathing was 112.500 and also 112.500 after the post-test. Above table shows us that in pre-test and post-test p value respectively was .1.000. Thus, it was claimed that the intervention shows statically not significant ($p > .05$) after the post-test. This means that the intervention was not effective for reduction of sleep disordered breathing among patients with tetraplegic SCI.

4.13. Fatigue:

The study found that within experimental group analysis in fatigue the value of Z was 3.162 which represent the p value of .002. Thus, it was claimed that before and after application of Active Cycle of Breathing technique along with conventional physiotherapy for experimental group showed statistically significant ($p < .05$). This means that Active Cycle of Breathing technique along with conventional physiotherapy was effective for reduction of fatigue among patients with tetraplegic SCI. The study found that within control group analysis in fatigue variable the value of Z was 2.646 which represent the p value of .008. Thus, it was claimed that before and after application of conventional physiotherapy for control group showed statistically significant ($p < .05$). This means that only conventional physiotherapy was also effective for reduction of fatigue among patients with tetraplegic SCI. In this study, pre-test Mann-Whitney U score of fatigue was 105.000 and 82.500 after the post-test. Above table shows us that in pre-test p value was .630 which changed after the post-test at .104. Thus, it was claimed that the intervention shows statically not significant ($p > .05$) after the post-test. This means that the intervention was not effective for reduction of fatigue among patients with tetraplegic SCI.

The researcher aim was to find out the effectiveness of Active Cycle of Breathing Technique on Tetraplegic Spinal Cord Injury patients where a self-made questionnaire was designed according to the respiratory complications of tetraplegic SCI patients and the previous research questionnaires on this area. A Randomized Control Trial study was followed by the researcher where 15 participants were selected for the experimental group and 15 participants were selected for the control group according to the inclusion and exclusion criteria. Among the total thirty participants, experimental group participants were given treatment of ACBT along with the conventional physiotherapy for 4 weeks of 12 sessions. On the other hand, control group participants were given treatment of conventional physiotherapy also for 4 weeks of 12 sessions. A pre-test and post-test data were collected by double blinded random sample technique. The parametric data were analyzed by using paired and unrelated t test as well as the non-parametric data were analyzed by using Wilcoxon Signed Rank Test and Mann Whitney U Test.

After data analysis, it was evaluated that the maximum age population 23.3% that age was 50 years and 96.7% participants were male in this study. It was also observed in socio-demographic area that 70% participants were married and 36.7% of the participants were completed their primary education which was the highest in the study. Among the participants businessman were the highest rate that was about 26.7% and most of the population of the study live in rural area that was about 53.3%. This study showed that 56.7% participants live in nuclear family and 33.3% participants family members were 4 where both percentages were highest in the study for these queries.

The study also found that the highest 83.3% participants were affected in 2020 where 93.3% participants injury cause was traumatic which was also highest in the study for this query. 60% participants ASIA impairment scale was complete-A and 43.3% participants general health was fair where both were highest in the study.

The study demonstrated that among the total 30 participants within group analysis, both experimental and control group lung volume and forced vital capacity were significant. It indicates that ACBT with conventional physiotherapy whether as only conventional physiotherapy had a great impact on improving lung volume and improving forced vital capacity in patients with tetraplegic SCI. On the other hand, Among the total

participants within group analysis, blood oxygen saturation level was significant for experimental group and pulse rate was significant for the control group. It indicates that ACBT with conventional physiotherapy had a great impact on improving blood oxygen saturation level and only conventional physiotherapy had an impact on normalizing pulse rate in patient with tetraplegic SCI.

The researcher also evaluated that among the total participants between group analysis, in both experimental and control group respiratory rate, lung volume, blood oxygen saturation level and forced vital capacity were significant. It indicates that ACBT with conventional physiotherapy as well as only conventional physiotherapy had a great impact on reducing respiratory rate, improving lung volume, blood oxygen saturation rate and forced vital capacity in patient with tetraplegic SCI.

In non-parametric within group data analysis, in both experimental and control group difficulty in breathing, chest tightness, pain during coughing, secretion of sputum during coughing, sleep disordered breathing and fatigue were significant. It refers that ACBT along with conventional physiotherapy and also only conventional physiotherapy both were effective to improve these variables result in tetraplegic SCI patient.

Though Mann Whitney U score reduced and Z value increased in between group analysis of the non-parametric variables, the result was not statically significant. It indicates that the interventions were not effective to improve the result of the variables. As ACBT with conventional physiotherapy had more significant variables and values than the only conventional physiotherapy treatment. So, it can be declared that ACBT with conventional physiotherapy is more effective than only conventional physiotherapy treatment on tetraplegic SCI patients.

The other studies also declared that respiratory complications are the most common in upper thoracic spinal cord injuries when compared to Lower thoracic spinal cord injuries. Chest physiotherapy plays an important role in reducing the complications. In order to find the effect of inspiratory muscle training in upper thoracic spinal cord injuries, the study was conducted with an experimental group consisting of 25 patients where the combined effect of incentive spirometry, diaphragmatic breathing exercises, and Active Cycle of Breathing technique is more effective in improving the pulmonary functions in upper thoracic spinal cord injuries (Subbiah, 2017).

Airway clearance techniques are used to aid in mucus clearance in a variety of disease states. Autogenic drainage and active-cycle-of-breathing technique are 2 such

modalities that rely heavily on basic airway physiology to enhance clearance (Lapin, 2002).

There was no significant difference in lung function and the number of pulmonary exacerbations between ACBT and ACBT along with conventional chest physiotherapy. All other outcomes were either not measured or had insufficient data for analysis. There is insufficient evidence to support or reject the use of ACBT over any other airway clearance therapy. Four studies, with four different comparators, found that ACBT was comparable to other therapies in outcomes such as patient preference, lung function, sputum weight, oxygen saturation, and number of pulmonary exacerbations. Longer-term studies are needed to more adequately assess the effects of ACBT on outcomes important for patients such as quality of life and patient preference (Robinson et al.,2010).

The techniques of ACBT were shown to have a more beneficial short-term effect on sputum wet weight when compared to conventional physiotherapy treatment (Lewis et al.,2012).

Limitation of the study:

- The main limitation of this study was its short duration.
- The sample size is really very small, so the result is difficult to generalize among whole population.
- In this study, interventions were given by clinical physiotherapists. So, the inter-rater reliability was not maintained due to lack of time and patient's availability.
- Sometimes treatment sessions were interrupted due to public holiday and recruit physiotherapists taken leave in the data collection that may interrupt the result
- There was no available research done in this area in Bangladesh. So, relevant information about tetraplegic patient with specific intervention for Bangladesh was very limited in this study.
- The study is done in the covid pandemic situation which may have the impact on the result.
- Data collection of the study is done in summer. The other season like winter and rainy season may vary in the result and also in the patient's complications.
- The research project was done by an undergraduate student and it was his first research project. So, the researcher had limited experience with techniques and strategies in terms of the practical aspects of research. As it was the first survey of the researcher so might be there were some mistakes that overlooked by the supervisor and the honorable teacher.

6.1 Conclusion

It was a randomized control trial study where pre-test and post-test design with two group of experimental and control to examine the effectiveness between Active Cycle of Breathing Technique along with conventional physiotherapy and only conventional physiotherapy on Tetraplegic SCI, where the results of the study have demonstrated that the Active Cycle of Breathing Technique is significantly more capable of producing beneficial effects on the improvement of respiratory function in tetraplegic patient with Spinal Cord Injury. Respiratory physiotherapy has very important effect to minimize or reduce respiratory and pulmonary complication. From this research the researcher explores the effectiveness of Active Cycle of Breathing Technique on the tetraplegic patient with Spinal Cord Injury, which will be helpful to facilitate their rehabilitation, to enhance functional activities and to improve their respiratory function. From this research, researcher concluded the specific variables and comparison of their improvement. This will aid the professionals to decide the specific and effective treatment protocol for tetraplegic SCI patients.

6.2 Recommendation

Physiotherapist should implement a broader role and holistic treatment techniques for the persons with SCI. Physiotherapists need to update their knowledge in this area. Physiotherapists should involve the patients in treatment to reduce respiratory problem. Physiotherapists need to concentrate more on this issue during the treatment period. If the Physiotherapists do not involve the patients in their treatment, it would not be significant. For this reason, it is necessary to involve the patients in respiratory physiotherapy etc. Despite the limitations of the study particularly small sample size, the results of the study give further motivation to controlled clinical trials with sufficient time and sample size. Future study should include a multiple blinding procedure of data collection to maintain intra-rater reliability. It could be also suggested that for future studies can be carried out with comparable patient variables with emphasis on ergometric and functional levels.

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APPENDIXES

Permission Letter

Date: September 19,2020

Head

Department of Physiotherapy

Centre for the Rehabilitation of the Paralysed (CRP)

Chapain, Savar, Dhaka. -1343.

Through: Head, Department of Physiotherapy, BHPI.

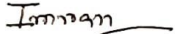
Subject: Prayer for seeking permission to collect data for conducting research project.

Sir,

With due respect and humble submission to state that I am Md. Imran Hossain, a student of 4th year B.Sc. in Physiotherapy at Bangladesh Health Professions Institute (BHPI). The Ethical committee has approved my research project entitled: **Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI patient at CRP in Bangladesh**” under the supervision of Mohammad Anwar Hossain, Associate Professor, Department of Physiotherapy, BHPI. I want to collect data for my research project from the Department of Physiotherapy at CRP. So, I need permission for data collection from the Spinal Cord Injury (SCI) unit of Physiotherapy Department at CRP (CRP, Savar, Dhaka. -1343). I would like to assure that anything of the study will not be harmful for the participants.

I, therefore pray and hope that your honor would be kind enough to grant my application and give me permission for data collection and oblige thereby.

Yours faithfully,


Md. Imran Hossain

4th year

B.Sc. in Physiotherapy

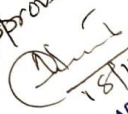
Class Roll: 11, Session: 2015-16

Bangladesh Health Professions Institute (BHPI)

(An academic Institution of CRP)

CRP-Chapain, Savar, Dhaka. -1343.

*Recommended
Shafiq
19.09.20*

Approved

18/11/2020
MOHAMMAD ANWAR HOSSAIN
Senior Consultant &
Head of Physiotherapy Dept
Associate Professor, BHPI
CRP Savar, Dhaka-1343



বাংলাদেশ হেল্থ প্রফেশন্স ইনস্টিটিউট (বিএইচপিআই)
Bangladesh Health Professions Institute (BHPI)
(The Academic Institute of CRP)

Ref.
CRP/BHPI/IRB/09/2020/403

Date
12th September 2020

To
Md. Imran Hossain
4th year B.Sc. in Physiotherapy
Session: 2015-2016, Student ID: 112150282
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Subject: Approval of the thesis proposal “Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI patient at CRP in Bangladesh” by ethics committee.

Dear Md. Imran Hossain
Congratulations.

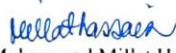
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above-mentioned dissertation, with yourself, as the principal investigator. The following documents have been reviewed and approved.

Sr. No.	Name of the Documents
1	Dissertation proposal
2	Questionnaire (Bengali & English version)
3	Information sheet and consent form

The purpose of the study is to find out the effectiveness of active cycle of breathing technique on tetraplegic spinal cord injury patient at CRP in Bangladesh. The study involves use of a questionnaire that may take 15 to 20 minutes to answer the questionnaire and there is no likelihood of any harm to the participants. Data collectors will receive informed consents from all participants. Any data collected will be kept confidential. The members of the Ethics committee have approved the study to be conducted in the presented form at the meeting held at **8.30AM on 1st March, 2020 at BHPI (23rd IRB Meeting)**.

The Institutional Ethics committee expects to be informed about the progress of the study, any changes occurring in the course of the study, any revision in the protocol and patient information or informed consent and ask to be provided a copy of the final report. This Ethics committee is working accordance to Nuremberg Code 1947, World Medical Association Declaration of Helsinki, 1964-2013 and other applicable regulation.

Best regards


Muhammad Millat Hossain
Assistant Professor, Dept. of Rehabilitation Science
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh.

Information Sheet

The name of the researcher is Md. Imran Hossain. He is the student of 4th year, Department of Physiotherapy, Bangladesh Health Professions Institute (BHPI). As a part of his academic issues, he must conduct a dissertation in this academic year. So, researcher would like to invite you to participate in this study. The title of the study is **“Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI patient at CRP in Bangladesh.”**

Your participation is voluntary in the study. You can withdraw your participation in anytime. There is not the facility to get any pay by this participation. The study will never be any harm to you, but it will help the service user to know your experience, which is very important for the service provider to plan for their future activities.

Confidentiality of all records will be highly maintained. The gathered information from you will not be disclosed anywhere except this study and supervisor. The study will certainly never reveal the name of participants.

If you have any query regarding the study, please feel free to ask to the contact information stated below:

Md. Imran Hossain

Student of 4th year

B.Sc. in Physiotherapy, Department of Physiotherapy

Bangladesh Health Professions Institute (BHPI),

Centre for the Rehabilitation of the Paralysed (CRP),

Chapain, Savar, Dhaka-1343.

Consent Form

This research is part of Physiotherapy course and the name of the researcher is *Md. Imran Hossain*. He is a student of Bangladesh Health Professions Institute (BHPI) in B.Sc. in Physiotherapy in 4th year. The study was entitled as **“Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI patient at CRP in Bangladesh.”** The aim of the study is to explore the Effectiveness of Active Cycle of Breathing Technique on Tetraplegic Spinal Cord Injury (SCI) patient.

In this study I am a participant and I have been clearly informed about the purpose and aim of the study. I will have the right to refuse in taking part any time at any stage of the study. I will not be bound to answer to anybody. This study has no connection with me and there will be no impact on me and my patient regarding treatment at present and in future.

I am also informed that, all the information collected from the interview that is used in the study would be kept safety and maintained confidentiality. My name and address will not be published anywhere. Only the researcher and supervisor will be eligible to access in the information for his publication of the research result. Your name and address will not be published anywhere of this study. I have been informed about the above-mentioned information and I am willing to participate in the study with giving consent.

Signature/Fingerprint of the Participant:	Date:
Signature of the Researcher:	Date:
Signature/Fingerprint of the witness:	Date:

ENGLISH QUESTIONNAIRE

Research Title: Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI patient at CRP in Bangladesh.

Part-A: Personal information

<p>Name: .....Date:</p> <p>ID No.:</p> <p>Contact No.:</p> <p>Email:</p> <p>Present Address:</p> <p>Permanent Address:</p>

Part- B: Socio-demographic information

Please give tick (✓) mark in the correct answer

Serial	Question	Response
1.	Age	.....Years
2.	Sex	<input type="radio"/> Male <input type="radio"/> Female
3.	Marital status	<input type="radio"/> Married <input type="radio"/> Unmarried <input type="radio"/> Widow <input type="radio"/> Divorced <input type="radio"/> Separated
4.	Educational qualification	<input type="radio"/> Illiterate <input type="radio"/> Primary education completed <input type="radio"/> S.S.C. passed <input type="radio"/> H.S.C. passed <input type="radio"/> Graduation completed <input type="radio"/> Post-Graduation completed <input type="radio"/> Others.....
5.	Occupation	.....
6.	Residential Area	<input type="radio"/> Urban area <input type="radio"/> Semi-urban area <input type="radio"/> Rural area
7.	Family type	<input type="radio"/> Nuclear family <input type="radio"/> Extended family
8.	Family members	.....
9.	Earning member	.....
10.	Average monthly family income	.....(<i>taka</i>)

Part C: Disease related information

Please give tick (✓) mark in the correct answer

Serial	Question	Response
1.	Year of lesion	.....
2.1.	Skeletal level	.....
2.2.	Neurological level	.....
3.	Cause of lesion	<input type="radio"/> Traumatic <input type="radio"/> Non-Traumatic
4.	Cause of traumatic lesion	<input type="radio"/> Fall from height <input type="radio"/> Fall while carrying heavy load on head <input type="radio"/> Fall of heavy object on neck <input type="radio"/> Fall of heavy object on back <input type="radio"/> Road traffic accident (RTA) <input type="radio"/> Others.....
5.	Cause of non-traumatic lesion	<input type="radio"/> TB spine <input type="radio"/> Transverse myelitis <input type="radio"/> Spinal tumour <input type="radio"/> Multiple sclerosis <input type="radio"/> Others.....
6.	ASIA impairment scale	<input type="radio"/> Complete-A <input type="radio"/> Incomplete-B <input type="radio"/> Incomplete-C <input type="radio"/> Incomplete-D <input type="radio"/> Normal-E
7.	General health	<input type="radio"/> Excellent <input type="radio"/> Very good <input type="radio"/> Good <input type="radio"/> Fair <input type="radio"/> Poor
8.	History of any systematic disease	<input type="radio"/> Diabetes mellitus <input type="radio"/> Hypertension <input type="radio"/> Stroke <input type="radio"/> Cardiac arrest <input type="radio"/> Others.....

Part-D: Medical information: (To be filed out by Physiotherapist)
(Pre-test data)

Please give tick (✓) mark in the correct answer

Serial	Question	Response
1.	Respiratory rate (per minute)	.....
2.	Pulse rate (per minute) (To be measure by pulse oximeter)	.....
3.	Volume of lung (CC) (To be measure by Spiro meter)	.....
4.	Blood oxygen saturation level (To be measure by pulse oximeter)	.....
5.	Forced vital capacity (FVC) (To be measure by Spiro meter)	.....
6.	Difficulty in breathing	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
7.	Chest tightness	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
8.	Dizziness during deep breathing	<input type="radio"/> Experienced <input type="radio"/> Not experienced
9.	Pain during coughing	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
10.	Secretion of sputum during coughing	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
11.	Sleep disordered breathing	<input type="radio"/> Experienced <input type="radio"/> Not experienced
12.	Fatigue	<input type="radio"/> Yes <input type="radio"/> No

Part-D: Medical information: (To be filed out by Physiotherapist)
(Post-test data)

Please give tick (✓) mark in the correct answer

Serial	Question	Response
1.	Respiratory rate (per minute)	.....
2.	Pulse rate (per minute) (To be measure by pulse oximeter)	.....
3.	Volume of lung (CC) (To be measure by Spiro meter)	.....
4.	Blood oxygen saturation level (To be measure by pulse oximeter)	.....
5.	Forced vital capacity (FVC) (To be measure by Spiro meter)	.....
6.	Difficulty in breathing	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
7.	Chest tightness	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
8.	Dizziness during deep breathing	<input type="radio"/> Experienced <input type="radio"/> Not experienced
9.	Pain during coughing	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
10.	Secretion of sputum during coughing	<input type="radio"/> Severe <input type="radio"/> Moderate <input type="radio"/> Mild <input type="radio"/> Not experienced
11.	Sleep disordered breathing	<input type="radio"/> Experienced <input type="radio"/> Not experienced
12.	Fatigue	<input type="radio"/> Yes <input type="radio"/> No

বাংলা প্রশ্নপত্র

গবেষণার শিরোনাম: বাংলাদেশের সি.আর.পি.তে টেট্রাপ্লেজিক এস.সি.আই. রোগীদের উপর একটিভ সাইকেল অফ ব্রিথিং টেকনিকের কার্যকারিতা।

অংশ- ক: ব্যক্তিগত তথ্য

নাম:..... তারিখ:.....

.....

আই.ডি. নং:.....

যোগাযোগ:.....

ইমেইল:.....

বর্তমান ঠিকানা:

.....

.....

.....

স্থায়ী ঠিকানা:

.....

.....

.....

অংশ- খঃ আর্থ-জনসংখ্যার তথ্য

দয়া করে সঠিক উত্তরে টিক (✓) চিহ্ন দিন

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
১.	বয়স	.....বছর
২.	লিঙ্গ	<input type="radio"/> পুরুষ <input type="radio"/> মহিলা
৩.	বৈবাহিক অবস্থা	<input type="radio"/> বিবাহিত <input type="radio"/> অবিবাহিত <input type="radio"/> বিধবা <input type="radio"/> তালাকপ্রাপ্ত <input type="radio"/> পৃথক
৪.	শিক্ষাগত যোগ্যতা	<input type="radio"/> নিরক্ষর <input type="radio"/> প্রাথমিক শিক্ষা সম্পন্ন <input type="radio"/> এস.এস.সি পাশ <input type="radio"/> এইচ.এস.সি পাশ <input type="radio"/> স্নাতক পাশ <input type="radio"/> স্নাতকোত্তর <input type="radio"/> অন্যান্য.....
৫.	পেশা	.....
৬.	বাসস্থান	<input type="radio"/> নগর অঞ্চল <input type="radio"/> মফঃস্বল শহর <input type="radio"/> গ্রাম্য অঞ্চল

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
৭.	পারিবারিক প্রকারভেদ	<ul style="list-style-type: none"> ○ অণু পরিবার ○ যৌথ পরিবার
৮.	পরিবারের সদস্যসংখ্যা	.....(জন)
৯.	উপার্জনকারী সদস্যসংখ্যা	.....(জন)
১০.	গড় মাসিক পারিবারিক আয়	.....(টাকা)

অংশ- গঃ রোগ সম্পর্কিত তথ্য

দয়া করে সঠিক উত্তরে টিক (✓) চিহ্ন দিন

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
১.	আঘাতের বছর	.....
২.১.	স্কেলেটাল লেভেল	.....
২.২.	নিউরোলোজিক্যাল লেভেল	.....
৩.	আঘাতের কারণ	<ul style="list-style-type: none"> ○ ট্রমাটিক ○ নন-ট্রমাটিক
৪.	ট্রমাটিক আঘাতের কারণ	<ul style="list-style-type: none"> ○ উচ্চতা থেকে পতন ○ মাথায় ভারী বোঝা বহন করার সময় পতন ○ ঘাড়ে ভারী বস্তুর পতন ○ কোমরে ভারী বস্তুর পতন ○ সড়ক দুর্ঘটনা ○ অন্যান্য.....
৫.	নন-ট্রমাটিক আঘাতের কারণ	<ul style="list-style-type: none"> ○ মেরুদণ্ডে টি.বি. ○ ট্রান্সভারস ময়েলাইটিস ○ স্পাইনাল টিউমার ○ মাল্টিপল স্কেলেরোসিস ○ অন্যান্য

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
৬.	এ.এস.আই.এ. ইম্পায়ারমেন্ট স্কেল	<ul style="list-style-type: none"> ○ কমপ্লিট-এ ○ ইনকমপ্লিট-বি ○ ইনকমপ্লিট-সি ○ ইনকমপ্লিট-ডি ○ নরমাল-ই
৭.	সাধারণ স্বাস্থ্য	<ul style="list-style-type: none"> ○ চমৎকার ○ খুব ভালো ○ ভালো ○ সাধারণ ○ দুর্বল
৮.	সিস্টেমিক রোগের ইতিহাস	<ul style="list-style-type: none"> ○ ডায়াবেটিস ম্যালিটাস ○ উচ্চ রক্তচাপ ○ স্ট্রোক ○ কার্ডিয়াক অ্যারেস্ট ○ হাঁপানি ○ অন্যান্য

অংশ- ঘ: চিকিৎসা সম্পর্কিত তথ্য (ফিজিওথেরাপিস্টদের দ্বারা
পূরণকৃত)

(প্রাক-পরীক্ষার ডেটা)

দয়া করে সঠিক উত্তরে টিক (✓) চিহ্ন দিন

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
১	শ্বাস প্রশ্বাসের হার (প্রতি মিনিটে)	..... (বার)
২	পালসের হার (প্রতি মিনিটে) (পালস অক্সিমিটার দ্বারা পরিমাপকৃত)	.....
৩	ফুস্ফুসের আয়তন (সিসি) (স্পাইরোমিটার দ্বারা পরিমাপকৃত)	.....
৪	রক্তে অক্সিজেনের মাত্রা (পালস অক্সিমিটার দ্বারা পরিমাপকৃত)	.....
৫	শক্তির মাধ্যমে যে পরিমাণ বায়ু বের হয় (FVC) (স্পাইরোমিটার দ্বারা পরিমাপকৃত)	.....
৬	শ্বাস নিতে অসুবিধা	<input type="radio"/> গুরুতর <input type="radio"/> মাঝারি <input type="radio"/> মৃদু <input type="radio"/> হয় না
৭	বুকে চাপ অনুভব	<input type="radio"/> গুরুতর <input type="radio"/> মাঝারি <input type="radio"/> মৃদু <input type="radio"/> হয় না
৮	গভীর শ্বাস গ্রহণের সময় মাথা ঘোরা	<input type="radio"/> হয় <input type="radio"/> হয় না
৯	কাশির সময় ব্যথা	<input type="radio"/> গুরুতর <input type="radio"/> মাঝারি <input type="radio"/> মৃদু <input type="radio"/> হয় না

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
১০	কাশির সময় খুতু নিঃসরণ	<ul style="list-style-type: none"> ○ গুরুতর ○ মাঝারি ○ মৃদু ○ হয় না
১১	শ্বাস-প্রশ্বাস বিঘ্নিত হওয়াতে ঘুম ভেঙ্গে যাওয়া	<ul style="list-style-type: none"> ○ হয় ○ হয় না
১২	অবসাদ	<ul style="list-style-type: none"> ○ হ্যাঁ ○ না

অংশ- ঘ: চিকিৎসা সম্পর্কিত তথ্য (ফিজিওথেরাপিস্টদের দ্বারা
পূরণকৃত)

(পরীক্ষার পরের ডেটা)

দয়া করে সঠিক উত্তরে টিক (✓) চিহ্ন দিন

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
১	শ্বাস প্রশ্বাসের হার (প্রতি মিনিটে)	..... (বার)
২	পালসের হার (প্রতি মিনিটে) (পালস অক্সিমিটার দ্বারা পরিমাপকৃত)	.....
৩	ফুস্ফুসের আয়তন (সিসি) (স্পাইরোমিটার দ্বারা পরিমাপকৃত)	.....
৪	রক্তে অক্সিজেনের মাত্রা(পালস অক্সিমিটার দ্বারা পরিমাপকৃত)	.....
৫	শক্তির মাধ্যমে যে পরিমাণ বায়ু বের হয় (FVC) (স্পাইরোমিটার দ্বারা পরিমাপকৃত)	.....
৬	শ্বাস নিতে অসুবিধা	<ul style="list-style-type: none"> ○ গুরুতর ○ মাঝারি ○ মৃদু ○ হয় না
৭	বুকে চাপ অনুভব	<ul style="list-style-type: none"> ○ গুরুতর ○ মাঝারি ○ মৃদু ○ হয় না
৮	গভীর শ্বাস গ্রহণের সময় মাথা ঘোরা	<ul style="list-style-type: none"> ○ হয় ○ হয় না
৯	কাশির সময় ব্যথা	<ul style="list-style-type: none"> ○ গুরুতর ○ মাঝারি ○ মৃদু ○ হয় না

সিরিয়াল	প্রশ্ন	প্রতিক্রিয়া
১০	কাশির সময় খুতু নিঃসরণ	<ul style="list-style-type: none"> ○ গুরুতর ○ মাঝারি ○ মৃদু ○ হয় না
১১	শ্বাস-প্রশ্বাস বিঘ্নিত হওয়াতে ঘুম ভেঙ্গে যাওয়া	<ul style="list-style-type: none"> ○ হয় ○ হয় না
১২	অবসাদ	<ul style="list-style-type: none"> ○ হ্যাঁ ○ না

Research Title:

Effectiveness of Active Cycle of Breathing Technique on Tetraplegic SCI Patient at CRP in Bangladesh.

Experimental Physiotherapy Guideline:

In experimental group, along with all the conventional physiotherapy patient will be given 10 Minutes of ACBT or until the chest feels clearer.

Which will not be given in the control group.

Duration of the treatment:

The duration will be 3 times in a week for 4 weeks for a total of 12 treatment sessions.

Treatment Protocol of ACBT:

• **Positioning**

Instruction:

ACBT can be performed in sitting or in a postural drainage position. Initially they could start in a sitting position until they are comfortable and confident to try different ones. Extensive evidence supports its effectiveness in sitting or gravity assisted positions. Although, the best position for the patient to do the ACBT in will depend on their medical condition and how well it works for them.

• **Breathing Control**

(6 breaths/set)

Instruction:

- a. Breathe in and out gently through the nose if the patient can. If they cannot, breathe through their mouth instead (patient breathe according to his own rate)
- b. If they breathe out through their mouth, it's best to use breathing control with 'pursed lips breathing'.
- c. Try to let go of any tension in their body with each breath out and keep their shoulders relaxed.
- d. Gradually try to make the breaths slower.
- e. Try closing their eyes to help them to focus on their breathing and to relax.
- f. Breathing control should continue until the person feels ready to progress to the other stages in the cycle.

• **Deep Breathing Exercise or Thoracic Expansion Exercise**

(3-5 times/set)

Instruction:

- a. Try to keep their chest and shoulders relaxed.
- b. Take a long, slow and deep breath in, through their nose if they can.

- c. At the end of the breath in, hold the air in their lungs for 2-3 seconds before breathing out (this is known as an inspiratory hold)
- d. Breathe out gently and relaxed, like a sigh. Don't force the air out.
- e. Repeat 3 – 5 times. If the patient feels light-headed then it is important that they revert back to the breathing control phase of the cycle.

- **Huffing or Forced Expiratory Technique**

(1-2 huffs together/set)

Instruction:

- a. Exhaling through an open mouth and throat instead of coughing.
- b. For a medium volume huff that helps to move secretions that is lower down in the patient's airways. To perform this huff, Take a normal-sized breath in and then an active, long breath out until their lungs feel quite empty. Tell to imagine them to steam up a mirror.
- c. For a high volume huff that helps to move secretions in patient's upper airways. To perform this huff, Take a deep breath in, open their mouth wide and huff out quickly.

- **Coughing**

Instruction:

Coughing should be incorporated if huffing alone does not clear their sputum. However, if it does clear their sputum, then they may not need to cough. It is very important to avoid long bouts of coughing as these can be very tiring and may make them feel breathless, or make their throat or chest sore or tight. They should only cough if the sputum can be cleared easily, if not, return to the beginning of the cycle.

References:

- Larner, E., and Gale, P., (2004). THE ACTIVE CYCLE OF BREATHING TECHNIQUE (ACBT).
- The Active Cycle of Breathing Techniques. Association of Chartered Physiotherapists in Respiratory Care. Leaflet no.GL-05. Available at <http://www.acprc.org.uk/dmdocuments/GL-05%20ACBT.pdf>
- Bronchiectasis Toolbox: The Active Cycle of Breathing. <http://bronchiectasis.com.au/physiotherapy/techniques/the-active-cycle-of-breathing-technique> (Accessed on 2nd July, 2018)
- Oxford University Hospitals. The Active Cycle of Breathing Techniques.p3 <https://www.ouh.nhs.uk/patient-guide/leaflets/files/11659Pbreathing.pdf>. (Accessed 2nd July, 2018).
- Association of Chartered Physiotherapists in Respiratory Care. The Active Cycle of Breathing Techniques. 2011, GL-05 p2 http://www.acprc.org.uk/Data/Publication_Downloads/GL-05ACBT.pdf (Accessed 1st July, 2018).



CRP
Centre for the
Rehabilitation
of the Paralyzed

Centre for the Rehabilitation of the Paralyzed (CRP)
Department of Physiotherapy

Head Office: CRP- Savar, CRP- Chapain, Savar Dhaka-1343, Bangladesh
Tel: +880 02 7745464-5, Fax: 7745069, E-mail: contact@crp-bangladesh.org, www.crp-bangladesh.org

Ref: CRP/PT/202/30/18.11.20

Date: 18.11.20

**Research Title: Effectiveness of Active Cycle of Breathing Technique on
Tetraplegic SCI Patient at CRP in Bangladesh.**

Conventional Physiotherapy Treatment for Tetraplegic SCI Patient in CRP:

1. Positioning
2. Deep Breathing Exercise
(10 Rep.×1 Set)
3. Breathing Relaxation
(10 Rep.×1 Set)
4. Chest Mobilization
(10 Rep.×1 Set)
5. Spirometry
(10 Rep.×1 Set)
6. Clapping, Shaking, Vibration
(10 Rep.×1 Set)
7. Peak Flow Meter
(10 Rep.×1 Set)
8. Purse Lip Breathing
(10 Rep.×1 Set)
9. Respiratory Group
1 hour/on a single day of every week
10. Assisted Coughing
(10 Rep.×1 Set)
11. Glossopharyngeal Breathing
(10 Rep.×1 Set)

[N.B.: Repetition varies according to the patient's condition]

Mohammad Anwar Hossain

Sr. Consultant & Head of PT

Associate Prof. BHPI

CRP, Savar, Dhaka. -1343

CRP-Mirpur, Dhaka, Plot: A/5, Block- A, Section- 14, Mirpur, Dhaka- 1206, Tel: 02 9025562-4, Fax: 02 9025561, Email: dgm-mirpur@crp-bangladesh.org. CRP-
Ganakbari, PO: Dhamsana, P.S: Ashulia, Savar, Dhaka, Tel: 02 7789227, Email: ganakbari@crp-bangladesh.org. AK Khan CRP- Chittagong, Kalurghat, Mohra,
Chadgaon, Chittagong, Tel: 031- 2573412, Email: chittagong@crp-bangladesh.org. Afsar Hossain CRP- Rajshahi, House no: 11, Mohishbathan, Rajshahi Court Rajpara,
Rajshahi, Tel: 0721 771709, Email: rajshahi@crp-bangladesh.org. CARSA Foundation- CRP, Barisal, 12 Gonopara, Barisal Sadar, Barisal, Phone: 0431 71556, Email:
barisal@crp-bangladesh.org. CRP- Mouvibazar, 836 Sayed Muztaba Ali Road, Poachim Bazar, Tel: 0861 52469, E-mail: mouvibazar@crp-bangladesh.org
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