Original Article

# The Role of Incentive Spirometry On Exercise Capacity,Breathing Symptoms, Depression Rate, and Quality of Life in NSCLC Patients with Chemotherapy

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## Abstract

**Backgrounds:** Pulmonary rehabilitation is a non-pharmacological therapy that improves breathing capacity in lung cancer patients. This study aimed to determine the effects of incentive spirometry (IS) on exercise capacity, breathing symptoms, depression rates, and quality of life in lung cancer patients with chemotherapy.

**Method:** This quasi-experimental study was done through purposive sampling of 32 lung cancer patients who underwent chemotherapy for at least three cycles at Dr. Moewardi General Regional Hospital, Surakarta, from December 2019 to February 2020. Experimental group performed exercise using IS for four weeks alongside their standard chemotherapy, whereas control group received only standard chemotherapy. Data on 6 minutes walking test (6-MWT) to evaluate exercise capacity, breathing symptoms (BORG scale), level of depression (HRSD questionnaire), and quality of life (SGRQ questionnaire) in both groups were collected at baseline and at the end of the fourth week.

**Results:** Experimental group showed higher value of 6-MWT (72.75±152.50 meters vs. 31.81 ± 27.67, P=0.010), a decrease in the BORG scale (-1.78±1.72 vs. -0.38±1.67, P=0.013), Hamilton's score improvement (-2.25±5.12 vs. -4.25±5.34, P=0.075), and improvement in the SGRQ value (-10.77±9.82 vs. -0.08±11.16, P=0.752) compared to those of control group.

**Conclusion:** Incentive spirometry significantly increased exercise capacity, reduced symptoms of shortness of breath lowered depression, and improved the quality of life for lung cancer patients with chemotherapy.

**Keywords:** 6-MWT, BORG, HRSD, SGRQ

## INTRODUCTION

Lung cancer is the second leading cause of cancer. Patients with lung cancer who survived for more than five years had a 35% drop in quality of life. As many as 15% of lung cancer patients are able to adjust to chronic symptoms.[1,2]

Chemotherapy induces lung fibrosis. People with lung cancer feel dyspnea, which causes them to restrict their activity, rest more frequently, and recover slowly after strenuous activities. Chemotherapy can lead to depression and a decline in quality of life. Breathing exercises are

required immediately to assist with breathing difficulties. People with lung cancer have a higher rate of psychological stress and depression, as well as a lower quality of life than people with other forms of cancer. Good breathing enable patients with lung cancer to improve their endurance and quality of life, allowing them to carry out their daily lives. The objectives of medical rehabilitation programs in non-operable lung cancer cases are to preserve and enhance patients' functional ability, lessen the severity of dyspnea, and thus minimize depression and improve quality of life.[3–5]

Incentive spirometry (IS) exercises can improve oxygen intake during inspiration, oxygen perfusion from the alveoli to the blood vessels, oxidative enzymes, myoglobin resistance to oxygen, and lung function. Increased muscle strength and pulmonary volume following inspiration will be optimized, affecting the elasticity of the pulmonary recoil, increasing the mileage of 6-MWT, improving breathing, lowering the degree of tightness, and increasing daily life activity.[6–12]

## METHOD

This quasi-experimental study was done through purposive sampling of 32 non-small cell lung carcinoma (NSCLC) patients who underwent chemotherapy for at least three cycles at Dr. Moewardi General Regional Hospital, Surakarta, from December 2019 to February 2020. Samples with even numbers participated in the incentive spirometry group, while samples with odd numbers were included in control group.

NSCLC patients over the age of 40 who were non-operable, scored 70-90 in performance status, had at least three cycles of chemotherapy with platinum base regimens, were able to do incentive spirometry, and were willing to participate in the study by completing a written consent were eligible for this study. Exclusion criteria were lung cancer patients with acute infections, patients who were unable to perform the IS maneuver, patients with severe cardiac issues, patients with neurological deficits who were unable to sit upright, patients who had grade 3 vomiting side effects, and patients who experienced pleural effusion during the study.

Patients with acute infections during the trial, lost to follow up, deceased, or exhibited pleural effusion during the study meet the criteria for discontinuation. Four weeks of IS exercises were given to the experimental group alongside the standard chemotherapy, whereas subjects in the control group received only standard chemotherapy. The 6 minutes walking test (6-MWT) to evaluate exercise capacity, breathing symptoms (BORG scale), level of depression (HRSD questionnaire), and quality of life (SGRQ questionnaire) results were noted at baseline and by the end of the fourth week for all subjects.

Data of all variables were analyzed using SPSS 21 for Windows. Analysis of normally distributed data was conducted with an unaltered t-test, while abnormally

distributed data was performed using Mann-Whitney. The result is considered to be statistically significant when P<0.05.

## RESULTS

There were 36 patients recruited for this study, but two patients in the experimental group were not eligible due to their inability to perform IS techniques because of their clinical conditions and two patients in the control group passed away. The remaining 32 participants who completed the four-week trial period were divided into two groups, 16 in the experimental group and 16 in the control group.

The experimental group age averaged 56.25±12.92 years, and in the control group, an average of 63.06±9.71 years. Chemotherapy cycles in the treatment group averaged 3.81±1.05 times, and in the control group, an average of 3.56±0.96times.

Table 1. Characteristics of ResearchSubject

| Characteristics | Group | | P |
|---|---|---|---|
| | Experimental | Control | |
| Gender | | | |
| Male | 12 (75.0%) | 9 (56.3%) | 0.246 |
| Female | 4 (25.0%) | 7 (43.8%) | |
| Age[a] | 56.25±12.92 | 63.06±9.71 | 0.102 |
| Education[b] | | | |
| Non- School | 2 (12.5%) | 1 (6.3%) | 0.179 |
| Elementary | 9 (56.3%) | 6 (37.5%) | |
| JuniorHigh School | 1 (6.3%) | 2 (12.5%) | |
| Senior High School | 4 (25.0%) | 7 (43.8%) | |
| Job[c] | | | |
| Labor | 3 (18.8%) | 3 (18.8%) | 0.193 |
| Housewives | 1 (6.3%) | 4 (25.0%) | |
| Retirement | 0 (0.0%) | 3 (18.8%) | |
| Farmers | 7 (43.8%) | 3 (18.8%) | |
| Private | 2 (12.5%) | 2 (12.5%) | |
| Self employed | 3 (18.8%) | 1 (6.3%) | |
| Types of lungs cancer[c] | | | |
| AdenoCa | 8 (50.0%) | 10 (62.5%) | 0.384 |
| large cell | 0 (0.0%) | 1 (6.3%) | |
| Squomous cell | 8 (50.0%) | 5 (31.3%) | |
| Smokers[c] | | | |
| Former smokers | 4 (25.0%) | 8 (50.0%) | 0.144 |
| Non- smoking | 12 (75.0%) | 8 (50.0%) | |
| Drugs of chemotherapy | | | |
| Cisplatin[c] | 15 (93.8%) | 11 (68.8%) | 0.172 |
| Carboplatin[c] | 1 (6.3%) | 5 (31.3%) | 0.172 |
| Pemetrexed[c] | 5 (31.3%) | 3 (18.8%) | 0.685 |
| Pakliktasel[c] | 2 (12.5%) | 5 (31.3%) | 0.394 |
| Docetaxel[c] | 4 (25.0%) | 5 (31.3%) | 1.000 |
| Gemsitabine[c] | 4 (25.0%) | 2 (12.5%) | 0.654 |
| Navelbine[c] | 1 (6.3%) | 2 (12.5%) | 1.000 |
| Cycle of chemotherapy[LY717][b] | 3.81±1.05 | 3.56±0.96 | 0.370 |

Note:[a]. Normal numerical data, Independent test samples test, t-test; b. Abnormal numerical dataor ordinal data, Mann Whitney test; [c]. nominal categorical data; frequency (%), Chi-square/Fisher exact test; the significant result if the test produces P<0.05.

Quantitative characteristic variables, i.e., age and chemotherapy cycles in the control group and treatment after being tested for normality data with Shapiro-Wilks tests, all showed that the age variables were normally distributed, so that homogeneity tests were conducted with pair t-test for independent samples. The homogeneity test results of variable age characteristics showed value of P=0.102, and for the chemotherapy cycle, value of P=0.370. The value of P>0.05 means the variable characteristics of the lifespan and chemotherapy cycle are homogeneous or do not differ between the treatment group and the control group.

Males were predominant in the experimental group (75.0%), contrary to the control group where females were slightly higher (56.3%). There were 9 subjects (56.3%) in the experimental group that graduates from elementary school only. High school graduates were 43.8% in the control group. Occupations in the experimental group were predominantly farmers (43.8%), whereas in the control group, occupations were evenly distributed, with the majority being housewives (25.0%).

Adenocarcinoma (50.0%) and squamous cell carcinoma (50.0%) were found to be equal in the experimental group. In comparison, Adenocarcinoma (62.5%) were the most common type of cancer cells found in the control group, with squamous cell carcinoma following after. Non-smoking subjects were predominant in the experimental group (75.0%) and equal to smoking subjects in the control group (50.0%). The most widely used therapy was Cisplatin, in both experimental (93.8%) and control group (68.8%). None of the characteristics mentioned above showed significant correlation (P>0.05) among both groups.

The 6-MWT examination of pre, post, and post-pre differences in experimental and control groups can be seen in Table 2.

Pre-test of 6-MWT in the experimental group obtained an average of 248.00±3.02, and post-test 6-MWT averaged 323.13±103.26. The difference between the 6- MWT post and pre-test obtained increased about 72.75±52.20. Pre-test 6-MWT in the control group obtained an average of 214.13±91.48, and post-test 6-MWT averaged 211.00±102.45. The difference between the 6-MWT post-pre in control group is about 31.81±27.67.

In the experimental group, the vlue of P=0.001, which means there were statistically significant changes in 6-MWT. While the control group gets value of P=0.776, which means that in the control group, there was no significant 6-MWT change. The provision of incentive spirometry treatment effectively improve 6-MWT, as evidenced in the non-paired difference test at the post-pre difference value (P=0.010).

Examination of pre, post, and differences in post-pre treatment and control groups can be seen in Table 3.

Table 2. 6-MWT Difference Test Between experimental group and control group

| Group | 6-MWT | | | |
|---|---|---|---|---|
| | Pre | Post | P | Post – Pre |
| Experimental (*Spirometri*) | 248.00±83.02 | 323.13±103.26 | 0.001[c] | 72.75 ±52.20 |
| Control | 214.13±91.48 | 211.00±102.45 | 0.776[d] | 31.81 ±27.67 |
| P | 0.213[b] | 0.004[a] | | 0.010[b] |

Note: The observation results have described the meanof SD, [a]. test of different groups of unpaired passed normal variable data (independent t-test), [b]. test different groups of ungrouped did not pass the normal variable data (Mann Whitney), [c]. test different groups of pairs pass the normal variable data (Pair t-test), [d]. test different groups of pairs do not pass normal variable data (Wilcoxon rank test). Significant result test is indicated by P<0.05.

Table 3. The Difference in Shortness of Breath test between the experimental Group and the Control Group

| Group | Shortness of Breath | | | |
|---|---|---|---|---|
| | Pre | Post | P | Post – Pre |
| Experimental (*Spirometri*) | 3.25±1.88 | 1.47±1.12 | 0.004[d] | -1.78±1.72 |
| Control | 2.44±1.71 | 2.06±1.34 | 0.383[c] | -0.38±1.67 |
| P | 0.287[b] | 0.184[a] | | 0.013[b] |

Note: The results of the observations are described with the mean SD, [a]. test different groups of un-paired passed normal variable data (independent t-test) [b]. test different groups of not paired did not pass normal variable data (mann whitney), [c]. test different groups of pairspassed normal variable data (Pair t-test), [d]. testdifferent groups of pairs did not pass normal variable data (wilcoxon rank test). Significant result if the test yields P<0.05.

Table 4. Hamilton Score Difference Test(Depression) between the experimental group and the control group.

| Group | Hamilton Score | | | |
|---|---|---|---|---|
| | Pre | Post | P | Post – Pre |
| Experimental (*Spirometri*) | 10.75±5.25 | 6.50±5.55 | 0,006[c] | -4.25±5.34 |
| Control | 13.94±6.78 | 11.69±6.76 | 0,109[d] | -2.25±5.12 |
| P | 0,147[a] | 0,038[b] | | 0,075[b] |

Note: The results of the observations are described with mean SD, [a]. t est of different groups of ungroupspassed the normal variable data (independent t test), [b]. test different groups of ungrouped do not pass normal variable data (Mann Whitney), [c]. test different groups of pairspass normal variable data (Pair t-test), [d]. test different groups of pairs do not pass normal variable data (Wilcoxon rank test). Significant ifthe result test P<0.05.

Table 5. SGRQ (Quality of Life) Score Pre,Post, and Difference of Post-Pre experimental and Control Groups.

| Group | SGRQ Score | | | |
|---|---|---|---|---|
| | Pre | Post | P | Post – Pre |
| Experimental (*Spirometri*) | 39.57 ±17.41 | 28.80 ±13.52 | 0,001[c] | -10.77 ±9.82 |
| Control | 45.56 ±12.48 | 45.63 ±17.35 | 0,979[c] | 0.08 ±11.16 |
| P | 0,227[a] | 0,005[a] | | 0,002[b] |

Note: The observations' results were described with the mean SD, [a] unpaired group difference test passed normal variable data (independent t- test). [b] the unpaired group difference test did notpassed normal variable data (Mann Whitney). [c]the paired group difference test passed normalvariable data (Pair t-test). [d] the paired group difference test does not normal variable data (Wilcoxon rank test), significant if the test resulted in P<0.05.

Hamilton's examinations of the pre, post, and post-pre differences of treatment and control groups are shown in Table 4. Based on the Shapiro Wilk test, the distribution of Hamilton's observation data on the unpaired group difference test passed the normal variable data with the independent t-test, namely the pre-test data. In contrast, the data that did not pass the normal variable data was assessed with the Mann Whitney test, namely the pre-test and post-pre test data. The pairwise difference test in the experimental group passed the normal variable data assessed with the paired t-test, while the control group that did not pass the normal variable

data was calculated with the Wilcoxon rank test.

Hamilton's pre-test score in the experimental group is about 10.75±5.25, and Hamilton's post-test is about 6.50±5.55. The score in Hamilton's post and pre-test in experimental group is decreased (improvement) about 4.25±5.34. Hamilton's pre-test in control group score is about 13.94±6.78, and Hamilton's post-test score is about 11.69±6.76. Hamilton's post and pre-test scores in the control group show decrease (improvement) about -2.25±5.12.

The p-value of the experimental group is P=0.006, which means that there were significant declines in Hamilton's score. In contrast, the p-value of control group is P=0.109, which means that the control group did not have significantly decreased Hamilton's score. Subjects who were given IS show decrease in Hamilton's score better than the control group, it means that giving IS could improve depression.

SGRQ examination pre, post, and the difference in pre-post treatment and control groups can be seen in Table 5. Based on the Shapiro Wilk test, the distribution data from the SGRQ score in the unpaired group difference test which passed the normal variable data, was assessed by independent t-test. In contrast, the data that did not pass the normal variable data was assessed by Mann Whitney test. The paired difference test in the experimental group and the control group which passed the normal variable data assessed by the paired t-test.

SGRQ pre-test score in the experimental group is about 39.57±17.41 and SGRQ post-test score about 28.80±13.52. The SGRQ scorein the post and pre-test in the experimental group decreased (improvement) about -10.77±9.82. SGRQ pretest score in the control group is about 45.56±12.48 and SGRQ posttest score about 45.63±17.35. The SGRQ score the pre and post-test in the control group increased (worsening) about -0.08±11.16.

The p-value in experimental group is P=0.001, which means that the experimental group significantly decrease in the SGRQ score. In contrast, the p-value in control group is P=0.979, it shows that the control group did not significantly change the SGRQ score. Subjects who were given IS show a decrease in SGRQ better than the control group. The IS effectively improved quality of life; this was evidenced in the unpaired difference test on the post-pre difference value (P=0.002).

## DISCUSSION

The gender of patients in IS group was mostly male with 12 male patients (75.0%), while in control group was mostly female, with 9 female patients (56.3%). The mean age in IS group 56.25±12.92 years and around 63.06±9.71 years in the controlgroup. Type of cancer cells in the IS groupwas Adenocarcinoma and Squamous cell, each about 8 patients (50.0%), while in the control group, were mostly Adenocarcinoma. From various studies, it

can be seen that lung cancer patients' characteristics are dominated by men at the age of 40 and smokers. Adenocarcinoma type remains the most common cause.

The experimental group mostly not smoke whose were 12 patients (75.0%), while thecontrol group former smokers and non-smokers had the same proportion, whose were 8 patients (50.0%). Smoking habits have a strong association with the incidence of lung cancer; females who smoke passively are at a higher risk of developing lung cancer than those who are not exposed to secondhand smoke. Approximately 80% oflung cancer deaths were estimated to be dueto smoking.[13]

Education in experimental group mostly elementary school, whose were 9 patients (56.3%), the control group mostly with high school education, whose are 7 patients (43.8%), the treatment group's occupation was primarily farmers, whose were 7 patients (43.8%), while in the control group,the patients' occupation was almost housewife, whose were 4 patients (25.0%).

Mostly chemotherapy drug was Cisplatin in both experimental and control groups. Chemotherapy cycles mean value in the experimental group was about 3.81±1.05 times and in the control group was about 3.56±0.96 times. The decrease in DLCo value was obtained by 10% after three cycles of chemotherapy; therefore, this study was conducted on patients at least three cycles of chemotherapy. Cisplatin can cause a decrease in the diffusion capacity of the alveolar-capillary membrane.[14,15]

In contrast, carboplatin can cause hypersensitivity reactions and has low pulmonary toxicity. Still, researchers have not found studies explicitly comparing the level of toxicity in the lungs between Cisplatin and carboplatin. Platinum compounds have pulmonary side effects, including interstitial lung disease, particularly cryptogenic organizing or eosinophilic pneumonia, and diffuse alveolar damage.[14,15]

Pulmonary rehabilitation is a non-pharmacological therapy aimed at improving pulmonary function, reducing respiratory complaints, and improving patients' quality of life. *Breathing exercises* are one of the most commonly used pulmonary rehabilitation exercises because they are cheap and easy to do on patients with *incentive spirometry. Incentive spirometry* increases intrapleural and intra alveolar pressures after deep inhalation and through increasing transpulmonary pressure gradients.[2,16]

Goulnar, et al in 2009 found that the 6-MWT was an easy, safe and inexpensive way to assess lung function. They found there was a decrease distance of the 6-MWT after two cycles of chemotherapy. Tarumi, et al reported an increment of lung function in the form of an increment in forced vital capacity (FVC) and forced expiratory volume in 1 minute (FEV1) in lung cancer patients with chemoradiotherapy who undergo pulmonary rehabilitation for 10 weeks. Tokarski, et al found that pulmonary rehabilitation increased oxygen partial pressure (pO2) and oxygen saturation

(SaO2) associated with increased KVP and FEV1 during first-line chemotherapy.[10]

Incentive spirometry consists of a mouthpiece and three balls which are similar with volume inspiration value which is 600 ml, 900 ml, and 1200 ml. The balls will slowly rise on maximum inspiration, then hold your breath as long as possible. Incentive spirometry practice strengthens inspiratory muscles so which will improve pulmonary function. Respiratory symptoms or shortness of breath can be reduced, cause an increment of exercise capacity, and ultimately improve the patient's quality of life.[17]

Symptoms of shortness of breath are estimated to occur in 55-87% of lung cancer patients. Pulmonary rehabilitation is needed to treat shortness of breath, exercise resistance, strength, confidence, and retrain breathing to relieve shortness of breath and improve air exchange. Pulmonary rehabilitation helps relieve chemotherapy-related symptoms to enhance tolerance and efficacy of chemotherapy drugs. Pulmonary rehabilitation programs to help reduce shortness of breath are carried out for 4-6 weeks.[10,18]

The questionnaire for shortness of breath symptoms that are often used to evaluate chronic pulmonary rehabilitation is the BORG scale. This study uses the BORG scale to assess the exercise results because this questionnaire is subjective, simple, easy, and validated.

Changes in lung volume, lung mechanics, and airway in lung cancer stimulate the stretching of receptors in the trachea and bronchi. The increase in lung volume activates mechanoreceptors in the respiratory muscles, which are thought to mediate the length-tension relationship with changes in chest wall ratio. The mechanismfor improving dyspnea due to exercise is the adaptation to peripheral muscle function leading to increased oxygen extraction and utilization, which reduces metabolic acidosis, the need for ventilation,and improves lung mechanics.[13]

The average level of depression in this study lung cancer patients had mild depression. Depression and anxiety significantly contribute to functional disability, perceptions of poor health, and poor well-being in chronic disease. Depression occurs in patients with chronic symptoms and limited airflow. Chemotherapy can reduce oxygen capacity, especially during exercise. Depression is known to cause agitation or anergia and fatigue, which add to the patient's functional limitations so that depression impacts the patient's quality of life. Research by Wei Lu, et al in 2012 showed a significant reduction in symptoms of depression and anxiety caused by shortness of breath. It decreased the ability to perform daily activities and showed an increase in the quality of life after surgery in lung cancer patients. The exercise, disease education, and psychosocial support components of a rehabilitation program may have contributed, separately or in combination, to reducing depression.[11,13,19,20]

Lung cancer patients have complaints such as shortness of breath, coughing,

weakness, anxiety, depression, difficulty sleeping, and pain. This causes even though lung cancer patients experience a survival rate of more than fiveyears, there is a decrease in the quality of life in 35% of cases. Patients with respiratory disorders have skeletal muscle dysfunction, reduced exercise ability,symptoms such as dyspnea, coughing, fatigue, anxiety, depression, and impaired quality of life.[2,11,20]

They measure the quality of life using the SGRQ questionnaire, which assesses several components, namely symptoms, activity, and the impact caused by the disease.[19] Scale 0, which is the best health status, and scale 100, which is the worst health status, the average value of the SGRQ scale in this study is below 50. This study proves that lung cancer patients undergoing chemotherapy have anaverage score of not lousy health status, but not good health status.

Tiwary, et al in 1989 found improvement in symptoms of shortness of breath and clinical improvement in COPD patients using incentive spirometry in line with the progress of the patient's quality of life. Glatkii et al in 2011 reported that pulmonary rehabilitation increased CVP and FEV1 in cancer patients who underwent both surgery and chemotherapy, followed by an increase in quality of life.[13]

This research has limitation such as subjectivity in answering questionnaires, small research population, and less research time.

## CONCLUSION

Based on the study results, it can be concluded that there were significant improvement between the experimental and control group on exercise capacity, symptoms of breathlessness, depression level, and quality of who underwent chemotherapy.

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