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Original Article

Impact of Pulmonary Rehabilitation on Hospitalization Duration, IL-6 Levels, and Respiratory Muscle Power in Hospitalized Community-Acquired Pneumonia Patients

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Abstract

Background: *Pneumonia is acute inflammation of the lung parenchyma. The long duration of hospitalization is associated with increased morbidity, nosocomial infections and treatment costs.*

Methods: *The study was conducted from May to November 2019 at Saiful Anwar Hospital, Malang, with 40 pneumonia patients in the non-intensive community inpatient room divided into 2 groups. The treatment group performed pulmonary rehabilitation measures consisting of breathing exercise, effective coughing techniques, clapping, postural drainage and respiratory muscle training using spirometry incentives.*

Results: *The duration of hospitalization for the treatment group was 2.25 days shorter (p<0.001). The average IL-6 level in the 5th day of the treatment group was lower than without treatment, that was 54.43 pg/ml (p=0.221). The mean of pressure threshold loading in the group without treatment was 31.5 cmH_2O on first day and 36.35 cmH_2O on the 5th day (p <0.001) and on first day treatment group was 32.9 cmH_2O and 39.35 cmH_2O on the 5th day (p=0.001), and the mean value of the 5th day of the treatment group was higher than without treatment (P = 0.015). the mean of the 5th day of the treatment group was higher than without treatment (p=0.06).*

Conclusion: *Pulmonary rehabilitation as adjunctive therapy shortens the duration of hospitalization. In both groups there was a decrease in IL-6 levels on the 5th day compared to zero and the lower IL-6 levels were not significant in the treatment group. There was a significant increase in the value of pressure threshold loading inspiration and expiration day five compared to day zero in the two groups and there was a significant increase in the Pressure Threshold Loading Inspiration mean treatment group compared to no treatment on the 5th day, but the Pressure Threshold Loading Expiration rate showed no significant increase.* ***(J Respirol Indones 2022; 42(1): 34–42)***

Keywords: *Chest physiotherapy; Community pneumonia; Duration of hospitalization; Interleukin-6*

Pengaruh Rehabilitasi Paru terhadap Durasi Rawat Inap, Kadar IL-6, Kekuatan Otot Respirasi pada Pasien Pneumonia Komunitas Rawat Inap

Abstrak

Latar belakang: *Pneumonia adalah peradangan akut pada parenkim paru. Durasi rawat inap yang lama berhubungan dengan meningkatnya angka morbiditas, infeksi nosokomial serta biaya perawatan.*

Metode: *Penelitian dilakukan dari Mei sampai November 2019 di RSUD Dr. Saiful Anwar, Malang, dengan 40 pasien pneumonia komunitas rawat inap ruang non intensif dibagi menjadi 2 grup. Pada grup perlakuan dilakukan tindakan rehabilitasi paru yang terdiri dari breathing exercise, teknik batuk efektif, clapping, postural drainage serta latihan otot pernafasan dengan alat insentif spirometry.*

Hasil: *Durasi rawat inap grup perlakuan lebih pendek 2,25 hari (P<0,001). Rerata kadar IL-6 hari ke5 grup perlakuan lebih rendah dibanding tanpa perlakuan yaitu 54,43 pg/ml(p=0.221). Rerata inspirasi pressure threshold loading grup tanpa perlakuan hari nol adalah 31,5 cmH_2O dan 36,35 cmH_2O pada hari ke-5 (p<0.001) dan grup perlakuan hari nol adalah 32,9 cmH_2O dan 39,35 cmH_2O pada hari ke-5 (p=0.001), serta nilai rerata hari ke-5 grup perlakuan lebih tinggi dibandingkan tanpa perlakuan (P=0,015).Rerata ekspirasi pressure threshold loading grup tanpa perlakuan hari nol adalah 16,3 cmH2O dan 18,75 cmH2O pada hari ke-5 (p=0.001) dan pada grup perlakuan hari nol adalah 18,3 cmH_2O dan 20,0 cmH_2O pada hari ke-5 (p=0.004), Rerata hari ke-5 grup perlakuan lebih tinggi dibandingkan tanpa perlakuan (P=0,06).*

Kesimpulan: *Rehabilitasi paru sebagai terapi penunjang memperpendek durasi rawat inap. Pada kedua grup terdapat penurunan kadar IL-6 pada hari ke-5 dibandingkan hari nol serta kadar IL-6 yang lebih rendah tidak bermakna pada grup perlakuan. Terdapat peningkatan bermakna nilai rerata Inspirasi dan Ekspirasi Pressure Threshold Loading hari ke-5 dibandingkan hari nol pada kedua grup dan terdapat peningkatan bermakna rerata Inspirasi Pressure Threshold Loading grup perlakuan dibandingkan tanpa perlakuan pada hari ke-5, namun rerata Ekspirasi Pressure Threshold Loading didapatkan peningkatan tidak bermakna signifikan.* ***(J Respirol Indones 2022; 42(1): 34–42)***

Kata kunci: *Chest physiotherapy; Pneumonia komunitas; Durasi rawat inap; Interleukin-6*

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INTRODUCTION

Lower respiratory tract infections, including pneumonia, are third among the top 30 causes of mortality worldwide. The World Health Organization (WHO) estimates that pneumonia kills 1.6 million people each year, primarily children and the elderly. Pneumonia is the eighth leading cause of mortality in the United States and the most prevalent cause of death from infectious diseases among patients of all ages. In developed countries such as the United States, the incidence of pneumonia is 12 cases per 1,000 persons, with a 15% mortality rate.[1]

Pneumonia and influenza are the sixth and seventh leading causes of mortality in Indonesia, according to the South East Asian Medical Information Center (SEAMIC) Health Statistics. Pneumonia is one of the top ten hospitalized diseases in Indonesia, with a crude fatality rate (CFR) of 7.6%, the highest when compared to other diseases.[2]

Interleukin-6 (IL-6) is a pleiotropic cytokine with broad biological activity in immune regulation, hematopoiesis, inflammation, and oncogenesis. The selection of IL-6 among other inflammatory cytokines is based on its rapid development, detection from plasma when inflammatory stimuli appear, and the availability of examination kits. It can be easily detected compared to other cytokines.[3] Interleukin-6 is important because it may be identified during the early host response to infection and can stimulate the migration of activated T cells in vitro.[4] Therefore, this study was carried out to investigate the levels of IL-6 in community-acquired pneumonia (CAP) patients admitted to a non-intensive ward at Saiful Anwar Hospital in Malang.

Pulmonary rehabilitation is a group of treatments designed to increase respiratory efficiency, increase lung expansion, strengthen the respiratory muscles, and remove secretions from the respiratory system. Pneumonia patients have increased sputum production, and it is difficult to expel. This means that pulmonary rehabilitation can be used as an additional therapy for pneumonia patients. However, some literature still says that there is no significant benefit when pulmonary rehabilitation is given to pneumonia patients. The purpose of pulmonary rehabilitation is not only to help expel secretions but also to increase the strength of the respiratory muscles, which consist of the muscles of inspiration and expiration. The value of inspiratory and expiratory muscle strength can be assessed by inspiratory and expiratory pressure threshold loading.

Until now, no research has been carried out on pulmonary rehabilitation associated with length of stay, IL-6 levels, and respiratory muscle strength in community pneumonia patients hospitalized in a non-intensive room at Saiful Anwar Malang Hospital. Therefore, researchers are interested in conducting this research. In addition, researchers consider that pulmonary rehabilitation is essential in managing non-intensive ward inpatient community pneumonia patients to save costs.

METHOD

This research was conducted by the experimental method pre-post-test control group design in community-acquired pneumonia (CAP) patients hospitalized in non-intensive wards at Dr. Saiful Anwar Hospital, Malang in June-November 2019. Samples were obtained by consecutive sampling with simple random sampling on pneumonia patients in non-intensive wards which met the inclusion and exclusion criteria. Patients between the ages of 18 and 65 who were willing to participate and gave informed consent were eligible for this research. Patients with HIV/AIDS, patients with acute or chronic cerebrovascular illness, patients with contraindications for pulmonary rehabilitation, pneumonia patients who have proved to be resistant to empiric treatment, pulmonary TB patients, and patients with ongoing hemoptysis or a history of hemoptysis in the last 3 months were excluded in the research.

The sampling of this research was carried out in the emergency room and the non-intensive inpatient wards of Saiful Anwar Hospital, Malang, with the consent of the patient and the patient's family, who signed the informed consent in the consultation

room located in each ward. Forty CAP patients who met the inclusion and exclusion criteria and were willing to participate in the study were divided into 2 groups: the control and the treatment group. Patients in the treatment group will get pulmonary rehabilitation from the physical medicine and rehabilitation department staff at Saiful Anwar Hospital in Malang, which will include chest physiotherapy methods like as clapping, coughing, deep breathing techniques, postural drainage, and inspiratory muscle training. On day zero and day five, both groups' IL-6 levels and the value of their inspiratory and expiratory pressure threshold loading will be assessed. The paired T-test will be used to determine the effect of pulmonary rehabilitation on IL-6 levels and inspiratory and expiratory pressure threshold loading values. Meanwhile, the Mann Whitney test will be used to measure the effect of pulmonary rehabilitation on the length of hospitalization of patients.

Processing and data analysis using IBM SPSS software version 24.0. The research data are presented in the form of mean +/- SD. Then the normality test was carried out with the Shapiro-Wilk test and the Kolmogorov-Smirnov test. If the normality of the data is met ($P \geq 0.05$), proceed with the independent parametric T-test. If the normality of the data is not met, then a non-parametric test with the Mann Whitney test is performed. Statistical tests were carried out with the SPSS 24 program with 95% confidence level, alpha = 0.05.

RESULTS

In this study, the average duration of hospitalization for patients in the control group was 7.60 days, with the most extended treatment period being 10 days and the shortest treatment period being 5 days. Patients who received pulmonary rehabilitation therapy had a shorter hospitalization period, with an average of 5.35 days. The most extended hospitalization period was 7 days, and the shortest hospitalization period was 4 days. There is a difference in the hospitalization period of 2.25 days. In the Mann Whitney test, the difference in hospitalization was statistically significant ($P<0.001$).

Table 1. Analysis of the duration of hospitalization in the treatment and control groups

Duration of Hospitalization	Control	Treatment
Mean (+/-SD)	7.6±1.53 days	5.35±0.671 days
Median (+/- IQR)	8±2 days	5±1 days
Mann Whitney Test Results	$P<0.001$	

The level of IL-6 in the controlgroup on day zero was 67.76 pg/ml and after being given standard therapy (antibiotics) on day five was 54.43 pg/ml. There was a decrease in IL-6 level on day zero compared to day five in the control group. However, the Wilcoxon test revealed that there was no statistically significant change in IL-6 levels on day zero versus day five ($P=0.502$).

The level of IL-6 in the group that received treatment on day zero was 36.27 pg/ml, while the level after five days of rehabilitation was 34.36 pg/ml. The levels of IL-6 of the treatment group decreased on day five, however the Wilcoxon test revealed no significant difference between IL-6 levels on day zero and day five ($P=0.628$).

On the fifth day, the treatment group's IL-6 level was 34.56 pg/ml, whereas the control group's level was 54.43 pg/ml. As a result, the levels of IL-6 on day five were lower in the treatment group than in the control group. The Mann Whitney test, however, revealed no significant change in IL-6 levels on day five between the control and treatment groups ($P=0.221$).

Table 2. Analysis of IL-6 Levels on Day Zero and Day Five in the Treatment and Control Groups

IL-6 Levels	Treatment	Control
Day Zero		
Mean (+/- SD)	36.27±60.14 pg/ml	67.76±79.01 pg/ml
Median (+/-IQR)	9.96±51.88 pg/ml	39.21±107.49pg/ml
Day five		
Mean (+/- SD)	34.36±69.4pg/ml	54.43±76.74 pg/ml
Median (+/-IQR)	6.38±29.13 pg/ml	22.75±68.05 pg/ml
Wilcoxon Test Results	$P=0.628$	$P=0.502$
Mann Whitney Test Results	Day five $P= 0.221$	

Because the difference in IL-6 days zero between the control and treatment groups was discovered to be highly substantial in the study data, a separate test was performed to assess whether the difference was statistically significant. On day zero,

the average IL-6 level in the treatment group was 36.27±60.14 pg/ml, while it was 67.74±79.01 pg/ml in the control group. The Mann Whitney test, with *P*=0.086, indicates that there is no significant difference in IL-6 levels on day zero between the treatment and control groups.

The average inspiratory pressure threshold loading (IPTL) value in the day zero treatment group was 31.5 cmH_2O and increased to 36.35 cmH_2O on the 5th day of conventional therapy. Therefore, through the Wilcoxon test, *P*<0.001, it can be concluded that conventional therapy (antibiotic therapy) significantly increases the value of IPTL.

In the treatment group, the IPTL average value on day zero was 32.9 cmH_2O. This value increased after giving pulmonary rehabilitation for 5 days to 39.35 cmH_2O. The Wilcoxon test (*P*=0.001) shows that further pulmonary rehabilitation therapy can considerably raise the value of the IPTL.

Table 3. Analysis of IPTL Value on Day Zero and day five of the Treatment and control Groups

Threshold Loading Inspiration	Treatment	Control
Day Zero		
Mean (+/- SD)	32.9 ±8.81 cmH_2O	31.50±4.39 cmH_2O
Median (+/-IQR)	35.5±15.5 cmH_2O	31 ± 8.5 cmH_2O
Day five		
Mean (+/- SD)	39.35±3.29cmH_2O	36.35± 5,18 cmH_2O
Median (+/-IQR)	41 ± 2.25 cmH_2O	38.5 ± 11 cmH_2O
Wilcoxon Test Results	*P*=0.001	*P*<0.001
Mann Whitney Test Results	Day five: *P*=0.015	

On day five, the treatment group's average inspiratory pressure threshold loading was 39.35 cmH_2O, which was greater than the control group's value of 36.35 cmH_2O. As a result, while the Mann-Whitney test yielded a significant value of *P*=0.015, it can be inferred that following adjunctive therapy, there was an increase in the average pressure threshold loading value of 3.15 cmH_2O compared to the control group.

The average expiratory pressure threshold loading in the control group was 16.3 cmH_2O on day zero and climbed to 18.75 cmH_2O on day five. As a result of the Wilcoxon test (*P*=0.001), conventional treatment can significantly boost the expiratory pressure threshold loading value.

On day zero, the average expiratory pressure threshold loading in the treatment group with pulmonary rehabilitation as supplementary therapy was 18.3 cmH_2O. On the fifth day, this number climbed to 20.0 cmH_2O. According to the Wilcoxon test (*P*=0.004), administering pulmonary rehabilitation treatment can significantly increase the average expiratory pressure threshold load value.

Table 4. Analysis of the IPTL Expiration Value on Day Zero and Day Five of the Treatment and Control Groups

Threshold Loading Ekspiration	Treatment	Control
Day Zero		
Mean (+/- SD)	18.3±2.17 cmH_2O	16.3±3.59 cmH_2O
Median (+/-IQR)	19 ± 3.5 cmH_2O	18 ± 6.5 cmH_2O
Day five		
Mean (+/- SD)	20 ± 0 cmH_2O	18.75±1.91 cmH_2O
Median (+/-IQR)	20 ± 0 cmH_2O	20 ± 3 cmH_2O
Wilcoxon Test Results	*P*=0.004	*P*=0.001
Mann Whitney Test Results	Day five: *P*= 0.06	

On day five, the treatment group's average expiratory pressure threshold loading was 20.0 cmH2O, which was greater than the control group's value of 18.75 cmH_2O. The Mann Whitney test, however, revealed that the results were not statistically significant (*P*=0.06). Nonetheless, on day five, the treatment group had a greater average expiratory pressure threshold loading than the control group, albeit this difference was not statistically significant.

DISCUSSION

In this study, the average hospitalization period for patients receiving standard therapy was 7.60 days, with the most extended treatment period being ten days and the shortest treatment period being five days. Patients who received standard treatment plus pulmonary rehabilitation had a shorter hospitalization period, with an average of 5.35 days. The most extended hospitalization period was seven days, and the shortest hospitalization period was four days. There is a difference in the hospitalization period of 2.25 days. This is consistent with a study conducted by Yang et al. who showed that chest physiotherapy (osteopathic manipulative) reduced the length of hospital stay by 2.0 days (mean difference (MD): 2.0

days, 95% CI = -3.5 to -0.6) and 1.4 days (MD: 1.4 days, 95% CI = -2.8 to -0.0).[5]

This study also had similar results to those of Carratalà et al., who stated that three steps of physiotherapy reduced the duration of hospitalization by two days in pneumonia compared to standard conventional therapy and had significant economic implications.[6]

However, the results of this study were different from those of Jose and Corso, who stated that there was no difference between the treatment and control groups in lung function, C-reactive protein (CRP), or length of hospital stay.[7]

In this study, pulmonary rehabilitation consisted of two main components: chest physiotherapy and respiratory muscle training. Chest physiotherapy consists of effective coughing techniques, deep breathing techniques, clapping and postural drainage. The goal of chest physiotherapy is to improve the patient's respiratory status and accelerate recovery by increasing airway clearance in lung disease associated with hypersecretion and reducing airway resistance. Chest physiotherapy is best used for patients with excessive secretions (more than 30 ml/day) and poor coughing ability. Chest physiotherapy used as an adjunctive treatment in primary pneumonia is useful for assisting clearance of inflammatory exudate in patients whose airways or lung parenchyma are pathologically affected by microbial infection.

Respiratory muscle strength training (RMST) focuses on increasing inspiratory and expiratory muscle capacity. The mainly trained muscles are the muscles that help with breathing, namely the inspiratory muscles consisting of the diaphragm and the external intercostals as the primary muscles and the sternocleidomastoid as the auxiliary muscles. The forces for expiration consist of the internal intercostals and abdominal muscles such as the rectus transversus and obliques. Respiratory muscle strength training will increase the strength and endurance of the diaphragm muscle and reduce lung hyperinflation, thereby reducing shortness of breath. The two main components of the exercise described above will improve the clinical condition of pneumonia patients and accelerate the length of their hospitalization.

This study showed that the average value of IL-6 levels on day five of the treatment and control groups was lower than on day zero. This is consistent with the theoretical hypothesis that IL-6 levels decrease with improvement in pneumonia. This study was based on the results of research by Bacci et al. that showed a significant decrease in IL-6 levels on day one and day seven, where the median value of IL-6 decreased from 24 pg/ml to 8 pg/ml with P= 0.016.[8]

On the 5th day of the treatment group, the level of IL-6 was 34.56 pg/mL, while in the control group it was 54.43. It can be concluded that the levels of IL-6 on day five were lower in the treatment group than in the control group. This indicates that CAP patients in the treatment group had faster clinical improvement than those without treatment. The levels of IL-6 on day five were lower in the treatment group, although not statistically significant (P>0.05). From the research of Andrijevic et al., hospitalized community pneumonia patients with elevated IL-6 had a 93.4% higher risk of higher mortality. A cut-off value of 20.2 pg/ml IL-6 showed a sensitivity of 84% and a specificity of 87% for predicting mortality. In this study, there was an improvement in pneumonia and a decrease in IL-6 levels on day five.[9]

In the research of Martin et al., it was found that high levels of IL-6 had a high predictive value for the early and late failure of therapy on day one and for the late loss of treatment on day three, suggesting that IL-6 was a good marker for progression to treatment failure. This is because of this study, which showed that in the treatment group, there were low levels of IL-6 on day five, which was followed by the improvement of pneumonia patients' treatment success.[10]

Interleukin-6 plays an essential role during the transition between innate and acquired immunity. Acute inflammation begins with infiltration by neutrophils, which are then replaced by monocytes and T cells after 24–48 hours to prevent tissue damage due to accumulation of proteases (secreted by neutrophils) and ROS (Reactive Oxygen Species)

at the site of inflammation. Endothelial cells and other vascular elements activated by microbes, together with IL-1, TNF, and IL-6, produce various chemokines. Interleukin-6 also induces neutrophil apoptosis, thereby resolving acute neutrophil infiltration.

An immunological response develops in pneumonia. When Toll-like receptors (TLR2, TLR1, and TLR6) attach to pathogenic molecules that are phagocytized, they activate the Nucleotide-binding Oligomerization Domain (NOD) signal, which initiates the body's immune system via NF-Kβ. Macrophages that phagocytize infections will create surface proteins from these microorganisms at the Major Histocompatibility Complex binding site (MHC). These MHCs will then express proteins that attract particular T cells, which will aid in the activation of cytokines and suitable antibodies. PRR activation results in the production of pro-inflammatory molecules like as TNF-α, IL-1β, IL-2, IL-6, IL-8, and IFN-γ, as well as anti-inflammatory cytokines that stimulate both cellular and reversal responses.[11,12]

Because of the inflammation caused by microorganism infection, IL-6 levels will rise in the first 6 hours of pneumonia. After the improvement in pneumonia, IL-6 levels will decrease, which corresponds to a shorter hospitalization period in the group without treatment (standard therapy (antibiotics) plus, pulmonary rehabilitation). In this study, the levels of IL-6 on the fifth day were lower in both groups than on the first, which corresponded to the improvement in pneumonia following therapy. On the fifth day, the treatment group's IL-6 levels were lower than the control group's.

The baseline values for IL-6 levels in the two groups were different. The treatment group had lower IL-6 levels than the control group. This was due to the fact that the treatment group had a lower average PSI value than the control, and the PSI value represented the severity of the pneumonia. As a result, the amount of IL-6, a biomarker for inflammation, is very certainly connected to the severity of pneumonia. The difference in IL-6 levels at zero days between the both groups, however, was not statistically significant, suggesting that the baseline results for differing IL-6 levels might be related to the overall standard variation across patients.

The goal of respiratory muscle strength training (RMST) is to increase inspiratory and expiratory muscular capacity. RMST improves diaphragm muscle strength and endurance while decreasing lung hyperinflation and shortness of breath. This training also enhances the usage of respiratory muscle savings, lowering oxygen consumption and enhancing exercise tolerance.

According to the findings of this study, the average value of inspiratory pressure threshold load increased considerably on day five compared to day zero in both the treatment and control groups, with the treatment group having a higher average value on day five than the control group. Similarly, the average value of the expiratory pressure threshold loading rose on day five compared to day zero in both the treatment and control groups. On the fifth day, the average value of the expiratory pressure threshold loading in the treatment group was greater than in the control group. These findings point to an increase in the strength of both the inspiratory and expiratory muscles.

This is in accordance with the research of Enright et al. who found that after training there was a significant increase in Pimax and SPimax ($p<0.05$), TDIcont ($P<0.05$), TR ($P<0.05$), vital capacity ($P<0.05$), TLC ($P<0.05$), and PWC ($P<0.05$), and reductions in anxiety scores ($P<0.05$) and depression scores ($P<0.01$) were noted in group 1 patients compared to group 3 patients. Only group 3 patients showed significantly improved Pimax and SPimax (both $P<0.05$). There was no statistically significant difference between the groups of patients. An 8-week program of high-intensity inspiratory muscle training (IMT) produced considerable advantages for CF patients, including increased IMF and diaphragmatic thickness (during contraction), increased lung capacity, enhanced PWC, and improved psychosocial status.[13]

In the study of Ramirez et al., where the aim of this study was to evaluate the effect of a specific inspiratory muscle training protocol on inspiratory muscle structure in patients with chronic obstructive

pulmonary disease. Fourteen patients (male, FEV_1, 24±7% predicted) were randomized to inspiratory or sham muscle groups. Breathing was monitored using a respiratory device threshold for 30 minutes per day, five times a week, for 5 consecutive weeks. The inspiratory training group was subjected to an inspiratory load equivalent to 40 to 50% of their maximal inspiratory pressure. Biopsies of the external intercostal muscles and the vastus lateralis (control muscle) were taken before and after the training. Muscle samples were processed for morphometric analysis using monoclonal antibodies against myosin I and II heavy chain isoforms. An increase in inspiratory muscle strength and endurance was observed in the inspiratory training group. This increase was associated with an increase in the proportion of type I fibres (about 38%, $P<0.05$) and in the size of type II fibres (about 21%, $P<0.05$) in the external intercostal muscles. No changes were observed in the control muscles. This study demonstrates that inspiratory training causes particular functional enhancement of inspiratory muscles as well as adaptive changes in the anatomy of the external intercostal muscles.[14]

The EPT value in the control group on the fifth day compared to day zero increased significantly ($P<0.05$), while in the control group and the comparison of the EPT value on the fifth day, the two groups got an increased but not significant value ($P>0.05$). This is because the upper limit of the maximum EPT measurement is 20 cmH_2O, in some patients, an EPT value of 20 cmH_2O has been obtained from day zero.

In this study, the duration of muscle training inspiration was five days with two sets of exercises in the morning and two sets of activities in the afternoon, with a daily minimum of ten minutes. According to the literature, it is recommended that the duration of activity be thirty minutes per day, which is divided into one to two training sessions with a minimum duration of three to five minutes. It is recommended that exercise be done every day. Functional improvement and adaptive structural changes can occur after five weeks of training. Most of the training benefits will disappear after six months without exercise.[15]

The study by Ramirez et al. found that inspiratory muscle training was associated with structural changes in the muscles, as assessed by the fibre type and fibre size distribution. In particular, the proportions of type I fibre ($P<0.05$) and type II fibre size ($P<0.05$) increased after training. This study aimed to evaluate structural changes in the respiratory muscles of patients with COPD after a specific respiratory muscle training program. Significant increases were observed in the proportion of type I fibres (about 38%) and the size of type II fibres (about 21%) of the external intercostal muscles after the training period. These findings suggest that the superficial intercostal muscles of patients with severe COPD can express structural remodeling. The functional improvement caused by inspiratory muscle training (in terms of inspiratory muscle strength and endurance) can be partially explained by structural adaptations in the inspiratory muscles.[14]

Several studies have reported that inspiratory muscle strength and endurance can be increased with specific training, while other studies have not found significant changes in inspiratory muscle function.[16,17] Differences in studies of inspiratory training can differ by differences either in duration or in inspiratory muscle loading. Taking this into consideration, targeted inspiratory muscle training has been shown to increase inspiratory muscle function when the intensity is measured and reaches 20% of the PImax.[14]

The research findings of Ramirez et al. highlight three main concepts. First, muscle response; Research shows that the external intercostal muscles of patients with COPD retain the capacity to improve after a short training period. Similar findings were also found in the peripheral muscles of patients with COPD after general muscle training. This response was demonstrated in the inspiratory muscle group of patients with severe airflow obstruction in one study. Second, functional and structural changes; the results allowed us to hypothesize that the increase in muscular endurance and inspiratory muscle strength after specific training could be associated with changes in the isoform of MyHC (as obtained by an increase in MyHC-I-expressing fibres) and an

increase in fibre size (especially in type II fibres). Other factors, such as adaptation to additional inspiratory loading (e.g., decreased dyspnea), learning of specific manoeuvres, or even the placebo effect, may also increase inspiratory muscle strength and endurance. The third is specificity; it was found that inspiratory muscle training had a specific functional and structural impact only on trained muscles. This study included data from unaffected muscles (legs) as a negative control. When the pre- and post-training results were compared, no changes were observed either in fibre size or in the proportion of fibre types of the vastus lateralis (control muscle).

Similarly, effects on other respiratory muscle groups (e.g., changes in expiratory muscle function) were not found. These facts support the conclusion that inspiratory training has only a specific effect on the trained muscles and the hypothesis that structural adaptation occurs only in the inspiratory muscles. However, the study design did not enable us to gain total confidence in the structural changes in the external intercostals representing the inspiratory muscles in general. The diaphragm is the most important of the inspiratory muscles. Still, there are apparent ethical and practical difficulties in repeatedly accessing the diaphragm of healthy subjects or stable patients with COPD, even if a thoracotomy is performed for other reasons (e.g., reduced lung volume). lung, lung cancer, or transplant).[14]

CONCLUSION

Pulmonary rehabilitation can reduce the length of stay for pneumonia patients at Saiful Anwar Hospital in Malang's non-intensive wards. When compared to the control group, pulmonary rehabilitation reduced IL-6 levels on the fifth day. In CAP inpatients, however, it was not statistically significant. Furthermore, there was a drop in IL-6 levels on the fifth day as compared to day zero. Nonetheless, it was not statistically significant in either the treatment or control groups. In both the treatment and control groups, the average value of inspiratory and expiratory pressure threshold loading rose considerably on day five compared to day zero in community pneumonia patients hospitalized in a non-intensive ward at Saiful Anwar Hospital, Malang. On day five, the average value of inspiratory pressure threshold loading was much greater. Nonetheless, the average value of the expiratory pressure threshold loading in the treatment group was negligible (P>0.05) when compared to the control group.

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