

Hand-held Fan Airflow Stimulation Relieves Dyspnea in Lung Cancer Patients

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ABSTRACT

Objective: The main symptom of lung cancer is dyspnea which can lead to depression, anxiety, limited independent activities, and decreased quality of life. The purpose of this study was to identify the effect of airflow stimulation from a hand-held fan as nonpharmacological palliative intervention on dyspnea in patients with lung cancer. **Methods:** This study used open, randomized, controlled, crossover trial design involved 21 participants. Diaphragmatic breathing technique was used in control arm. **Results:** Wilcoxon test result showed that airflow

stimulation significantly influenced dyspnea scale ($P = 0.003$) and respiratory rate (RR) ($P = 0.008$). Combination of airflow stimulation and diaphragmatic breathing can lower both dyspnea scale and RR significantly ($P < 0.0001$). **Conclusions:** This combination can be applied on nonhypoxemic dyspneic lung cancer patients.

Key words: Dyspnea, hand-held fan, lung cancer

Introduction

Lung cancer prevalence with high mortality is increasing. The World Health Organization (WHO) revealed that lung cancer was one of the five most common types of cancer in the world. Lung cancer caused 1.59 million deaths of 8.2 million cancer-related deaths worldwide in the year 2012.^[1] The WHO data for Indonesia showed noncommunicable diseases including cancer caused 13% death and became the third largest cause in the year 2012.^[2] Lung cancer particularly

became the most common noninfection respiratory cases hospitalized in some hospitals in Indonesia.^[3,4]

Lung cancer causes nonspecific manifestations such as dyspnea, hemoptysis, chronic cough, weight loss, and other symptoms commonly found in other lung diseases. Dyspnea occurs in 90% of lung cancer and its prevalence increases near the end of life.^[5] Dyspnea in lung cancer patients is very intrusive and causes discomfort.^[6] Dyspnea limits activities^[7] so that patients require assistance to perform

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daily activities including personal care needs.^[8] Therefore, dyspnea is correlated with lower quality of life and poor clinical outcomes.^[7]

Dyspnea management can be a combination of definitive, palliative, or supportive interventions. Definitive interventions such as surgery, chemotherapy, radiotherapy, and thoracentesis. Palliative or supportive intervention including oxygen administration, pharmacological, and nonpharmacological therapy. Oxygen administration is beneficial for patients with hypoxemia at rest or minimal activity.^[9] Oxygen administration is insignificantly beneficial to reduce dyspnea in nonhypoxemic patients. The previous study showed that palliative oxygen did not improve dyspnea in mild hypoxemia or nonhypoxemia.^[10] Oxygen administration should be observed because it may cause side effects. Oxygen administration through nasal cannula continuously may cause irritation on nasal mucous membrane, epistaxis, and discomfort.^[10] Long-term oxygen therapy may cause side effects such as oxygen toxicity and hypercapnic respiratory failure.^[11,12]

Alternative methods to relieve chronic dyspnea are developing. Some of them use airflow stimulation. The study showed that oxygen administration and airflow can relieve dyspnea and there was no significant difference between both interventions.^[13] A study by Schwartzstein *et al.* in healthy participants showed results that cold airflow directed toward the face on cheeks, nasal mucosa, and pharynx may decrease dyspnea significantly.^[14] Research conducted by Baltzan *et al.* found that airflow from a 42 cm diameter fan directed toward the face can reduce dyspnea in chronic obstructive pulmonary disease patients.^[15]

The fan is then used as a supportive intervention for dyspnea management. However, a systematic review concluded that the use of fan does not have sufficient evidence of relieving dyspnea in patients with nonmalignancy and advanced malignancy disease.^[16] Therefore, it is necessary to study the impact of airflow stimulation from a fan or hand-held fan on dyspnea, especially in nonhypoxemic lung cancer patients.

Methods

Study design

We aimed to identify the effect of airflow stimulation from a hand-held fan on dyspnea in patients with lung cancer. We compared it to the nonpharmacological interventions that can be performed to relieve dyspnea in lung cancer. This study used an open, randomized, controlled, crossover trial design. Block randomization was performed by coauthor to determine the treatment sequences. The results would allocate which participant would be initially in control or intervention group.^[17] The result was concealed from the

patient and investigator. Concealment was carried out by keeping the results of block randomization in a sealed numbered envelope. Investigator would open the envelope right before providing the treatment.

Ethical consideration

This research was approved by the Institutional Ethical Review Board Committee members at nursing faculty of University of Indonesia (No. 0288/UN2.F12.D/HKP. 02.04/2015). Prior to the research, the potential participants were informed with verbal and written description about procedures and that they could withdraw from the study. Participants who agreed to participate in the study provided consent before measurement. Oxygen saturation was measured to determine whether the patient was eligible or not. Oxygen saturation was monitored continuously during treatment to prevent hypoxemia.

Subjects

Participants were recruited from the respiratory ward in one of the national referral hospitals in Indonesia. Investigator made a list of potential participants that was sorted by date of patient's admission. Participants were then selected by consecutive sampling based on sampling criteria. Participants for this study were diagnosed with lung cancer or tumor, had dyspnea Modified Borg Scale (MBS) on 1–6, oxygen saturation >90%, hemoglobin concentrations >10 g/dl, and received oxygen therapy through nasal cannula if only necessary. Patients who experienced fever (>38° C) for 48 h prior to the study were excluded from the study. Participants who met the criteria were divided into control and intervention group by block randomization. Investigator allocated the participants into each arm based on block randomization result precisely after collecting pretest data and before providing the treatment.

Outcome measures

Some participant's characteristics and primary outcome in this study were measured. Characteristics assessed were age, dyspnea scale, qualitative characteristic of dyspnea sensed by participant, medication use, flow of oxygen therapy received, and oxygen saturation. Oxygen saturation was measured and monitored by pulse oximetry (Elitech Pulse Oxymeter Finger-Tip Fox-1). Speed of hand-held fan airflow was measured by a Mini Digital Anemometer (Anemometer HT-81). Primary outcome was dyspnea. Dyspnea was measured subjectively and objectively. Subjective parameter was MBS,^[18] and objective parameters were respiratory rate (RR), use of accessory muscles, and nasal flaring presence.^[19,20] MBS was used as a screening tool and assess dyspnea subjectively. The

MBS is a validated 0–10 ratio scale to rate the severity of dyspnea.^[21,22] Signs as objective parameters were observed by investigator. The measurements were performed right before (pretest) and after (posttest) treatment in each case.

Interventions

Airflow stimulation from hand-held fan was used as adjunct to diaphragmatic breathing exercise, oxygen, and pharmacotherapy. Intervention with hand-held fan in this study combined the principles of previous research about airflow from fan.^[11,14,23,24] A wet damp cloth was used to wipe participant's face without drying, and then airflow from hand-held fan was given.^[11,24] Hand-held fan that we used in this study was a small hand-held fan with three bladed propellers.^[23] The speed of airflow was 4 km/h^[14] measured by a Mini Digital Anemometer. This intervention would be compared to diaphragmatic breathing exercise as a control.

Participants received treatment based on the randomization result written inside the envelope. Participants who were initially allocated to be in control group were guided to do a diaphragmatic breathing exercise. Participants in the intervention group were guided

to do diaphragmatic breathing exercise and got airflow stimulation from a hand-held fan. Each treatment was performed for 5 min in every participant. Each treatment was done 2 times in 2 periods and take turns on each participant.^[25] Treatments were performed crossways in both groups after a washout period for 1 h.^[26] The detail of study procedure is presented in Figure 1.

Statistical analysis

We summarized the baseline characteristic into descriptive statistics, including median, mean, standard deviation, range, 95% confidence interval, and frequencies. We conducted a pretest to check the assumption of negligible carryover effects.^[27] Pretest results showed no evidence of relevant carryover effects. This study was then analyzed as a crossover study. A two-sided $P < 0.05$ was considered to be statistically significant. Normality pretest showed that only pretreatment RR in both groups can be assumed to have normal distribution. Therefore, Wilcoxon signed-ranks were used to analyze the difference between before and after treatments in each group for numerical variables. Meanwhile, accessory muscle used as a

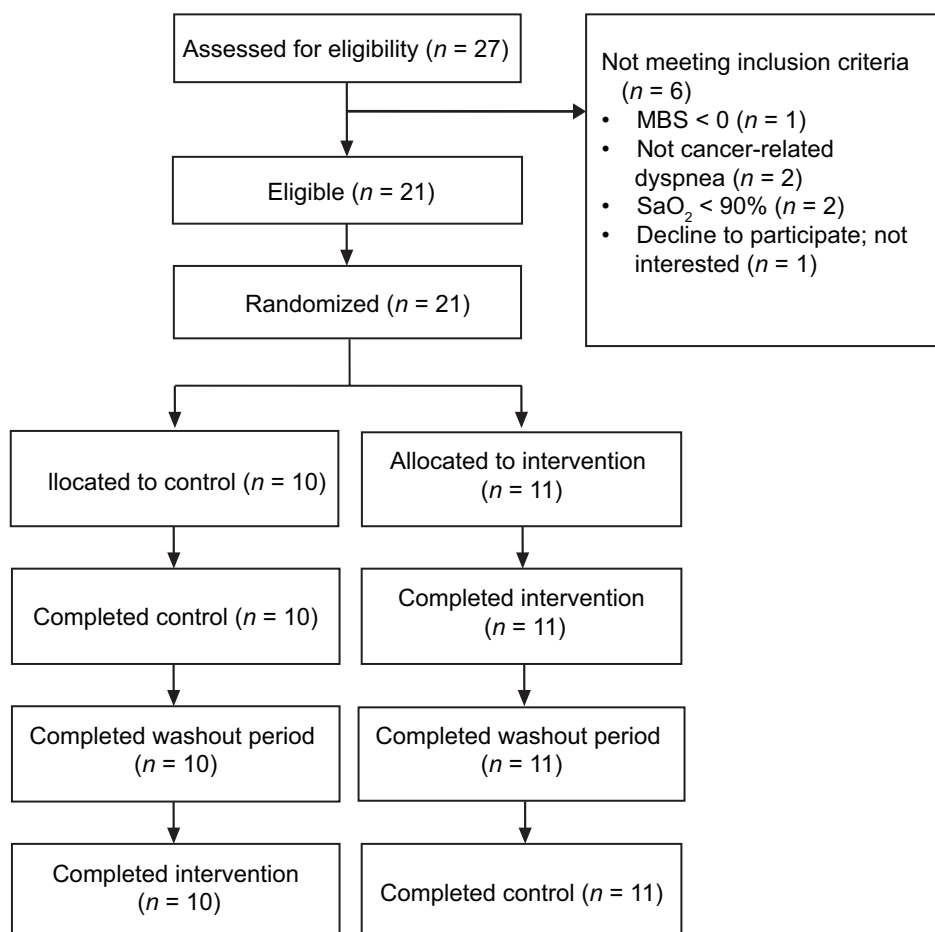


Figure 1: CONSORT flow diagram. MBS = Modified Borg Scale; SaO₂ = Oxygen saturation

categorical variable was analyzed by Marginal homogeneity test. We did not analyze nasal flaring or nostril breathing presence because its data were not dichotomous. On treatment, analysis was conducted to compare the change between two treatments using Wilcoxon signed-ranks test for numerical variables.^[28-30] We did not compare accessory muscle use because there was no difference in frequencies between before and after in each treatment.

Results

This study was conducted from May to July 2015. Twenty-one patients with lung tumor and cancer were involved in this study. Each participant had double role as control and treatment participants. Data were recorded as control group when participants were guided to do diaphragmatic breathing exercise only. The intervention group was stated when participant received a combination of diaphragmatic breathing exercise and hand-held fan airflow stimulation.

Patient characteristics

Characteristic assessment in this study found age average about 53.38 (± 9.21) years. The youngest participant was 38 years old and the oldest was 69 years old. The average of oxygen saturation was 94.19 ($\pm 1.5\%$). The majority of participants (85.7%) were on supplemental oxygen at the time of enrollment. Median use of supplemental oxygen was 2 L/min with a range of 1–3 L/min. Mostly patients used analgesics and steroids (47.6%). Most of the participants felt “chest tightness” (71.4%) and no participants felt “air hunger.” These characteristics were homogeneous in both groups because they compared it to themselves.

Change in parameters

Data for each parameter (before and after) were compared to identify the effect of every treatment given. There were significant changes on dyspnea scale and RR in each group. Details are presented in Tables 1 and 2. There were no changes in accessory muscle use and nostril breathing presence in each group so that we did not analyze it to compare the difference of changes between groups. Only numerical data were continued to be compared between the control and intervention arm. We analyzed the different effects in each arm by subtracting pre- and post-test data of each group. These results were then analyzed by Wilcoxon signed-rank test. There were significant differences between each group on dyspnea MBS and RR. Details are presented in Table 3.

Discussion

Patients with dyspnea generally feel more comfortable near an open window or in front of the fan^[14,31] so that dyspnea is reduced. Its mechanism uses mechanoreceptors

Table 1: Dyspnea scale and respiratory rate in control group (n = 21)

Parameters	Mean \pm SD	Median (minimum-maximum)	P
MBS			
Pre	2.52 \pm 0.75	2 (1.00-4.00)	0.001
Post	1.83 \pm 0.76	2 (0.50-3.00)	
RR			
Pre	28.05 \pm 1.69	28 (25.00-32.00)	0.001
Post	26.00 \pm 1.18	26 (24.00-29.00)	

MBS: Modified Borg Scale, RR: Respiratory rate, SD: Standard deviation

Table 2: Dyspnea scale and respiratory rate in intervention group (n = 21)

Parameters	Mean \pm SD	Median (minimum-maximum)	P
MBS			
Pre	2.57 \pm 0.75	2 (2.00-4.00)	0.001
Post	1.36 \pm 0.73	1 (0.50-3.00)	
RR			
Pre	28.38 \pm 1.32	28 (26.00-31.00)	0.001
Post	25.67 \pm 1.07	26 (24.00-29.00)	

MBS: Modified Borg Scale, RR: Respiratory rate, SD: Standard deviation

Table 3: Difference of dyspnea scale and respiratory rate change between groups

Parameters	Mean \pm SD	Median (minimummaximum)	P
MBS			
Control	0.69 \pm 0.46	1 (0-1)	0.003
Intervention	1.21 \pm 0.56	1 (0-2)	
RR			
Control	2.05 \pm 0.80	2 (1-3)	0.008
Intervention	2.71 \pm 0.85	3 (1-4)	

MBS: Modified Borg Scale, RR: Respiratory rate, SD: Standard deviation

on skin which is innervated by sensory nerve branches of the trigeminal nerve. This study used hand-held fan to produce airflow directed to patient’s face. The result showed that airflow stimulation from a hand-held fan was effective to decrease dyspnea ($P = 0.003$). We used the combination of cool sensation and airflow with a speed of 4 km/h. This speed met patient’s comfort. This combination produced airflow stimulus and cooling sensation on participant’s face. There was no clear mechanism about it, but it is believed that stimulation was detected by respiratory system mechanoreceptors.^[14] Stimulus was then passed following the trigeminal nerve pathways to the brainstem and thalamus to proceed to somatosensory cortex.^[32,33] The somatosensory cortex is one part in the cortex that perceives a sensation of dyspnea.^[34] This stimulation changes the feedback of re-afferent impulse to the somatosensory cortex and modifies dyspnea perception. This modification will decrease sensation of dyspnea.^[14]

The combination of airflow stimulation of hand-held fan and diaphragmatic breathing significantly influenced

dyspnea sensation ($P < 0.001$). The mean of MBS was decreased after the intervention (1.21 units) and also the median (1 unit). This change compared to the minimal clinical significant difference for MBS that is 1 unit.^[35] Comparison showed that airflow stimulation from hand-held fan combined with diaphragmatic breathing was clinically significant to relieve dyspnea. This combination was more effective and beneficial for patients when compared to the diaphragmatic breathing exercise alone.

The results showed that hand-held fan airflow stimulation can lower the frequency of breathing in patients with lung cancer significantly ($P = 0.008$). The combination with diaphragmatic breathing provided significant effect on breathing frequency ($P < 0.001$). Frequency of breathing decreased after treatment because the diaphragmatic breathing trains the patient to take deeper breaths and more effectively maintain lung expansion.^[36,37] However, the frequency of breathing posttreatment was still considered as tachypnea which is more than 25 times/min.^[38] It may happen because the interventions focused on modifying dyspnea perception and were not focused on addressing dyspnea cause.^[23] Frequency of breathing is a compensation to maintain adequate oxygenation. The mean oxygen saturation was not considered hypoxemia (94.2%) but it was lower than when participants received supplemental oxygen (98%–99%). Decline in oxygen saturation caused the participant to take breaths more frequently than normal rate. Related to dyspnea sensation, tachypnea posttreatment was considered reasonable because patient still felt dyspnea sensation after treatment.

This study found no effect of airflow stimulation from a hand-held fan on the use of respiratory accessory muscles. Participants who used respiratory accessory muscles were the patients with pleural effusion whose pleural fluid has not been evacuated. Breathing frequency in these participants was also higher than others. The increased of breathing frequency caused an increase in dyspnea sensation and vice-versa. Rapid breathing frequency may also cause breathing muscle exhaustion, therefore needs assistance from accessory muscle. Oxygen saturation in these participants was lower than the others. The use of accessory muscles for breathing in these patients was used to maintain the volume of inspired air and expand the upper thoracic volume.^[39]

We did not find any effect of airflow stimulation on nasal flaring. No patient experienced nasal flaring or nostrils breathing during and after the research. Nostrils breathing is a sign of respiratory distress.^[20] Dyspnea in this study did not reach the stage of distress so it did not show any sign of respiratory distress such as nostril breathing.

Nostril breathing is associated with tachypnea, and it was found in breathing frequency of 34–40 times/min.^[40] All the participants in this study had RR <34 times/min thus nostril breathing did not present.

Conclusion

Airflow stimulation from hand-held fan decreased dyspnea sensation and breathing frequency in nonhypoxemic dyspneic lung cancer patients. It had no effect on nasal flaring and respiratory accessory muscle use. This study has several implications in palliative nursing such as to enhance nursing knowledge about nursing interventions for patients with lung cancer who experience dyspnea. Nurses also can perform health education to nonhypoxemic patients to relieve dyspnea using airflow stimulation from hand-held fan combined with diaphragmatic breathing. The use of hand-held fan airflow may anticipate improper oxygen administration for example in nonhypoxemic patients. Study with larger sample size and more sensitive objective parameter is still needed to evaluate the impact of airflow stimulation, particularly on dyspnea physiologic parameters. This study is expected to increase motivation and effort to think critically about nonpharmacological intervention to decrease dyspnea sensation. The result may become the background for further research on trigeminal nerve stimulation and dyspnea.

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Conflicts of interest

There are no conflicts of interest.

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