

Original Article

Management of Dyspnea With High-Flow Nasal Air or Fan
—A Randomized Controlled Crossover Trial

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Abstract

Context. High-flow nasal therapy (HFNT) may relieve severe dyspnea, but its role compared to other treatment options in palliative care remains unclear.

Objectives. Assess the effect and feasibility of HFNT with air compared to fan therapy in relieving dyspnea among nonhypoxemic patients with incurable cancer.

Methods. This prospective, randomized, controlled, crossover trial compared airflow delivered by HFNT and fan. The duration of both interventions was 30 minutes. Change in dyspnea was measured using a numeric rating scale (NRS) from 0 to 10. The overall benefits and adverse events of the interventions were assessed. (Trial identifier, NCT05257850).

Results. Thirty-six patients with dyspnea on NRS ≥ 3 , and oxygen saturation $\geq 88\%$ were enrolled, and 28 patients completed the trial. The median NRS for dyspnea decreased from 5.0 (interquartile range [IQR] 4.0–6.5) to 3.5 (IQR 2.0–5.8, $P = 0.001$) with HFNT with air and from 5.0 (IQR 4.0–7.0) to 2.5 (IQR 1.0–7.0, $P = 0.012$) with fan. The median change in dyspnea on NRS was -1.0 (IQR 0.0 to -2.8) for both HFNT with air and fan, with no significant difference between the therapies ($P = 0.935$). Over half of the patients reported that both therapies relieved their dyspnea and that they adapted well to them.

Conclusion. The effect of airflow through HFNT or fan on dyspnea did not differ in nonhypoxemic patients with advanced cancer. Both therapies seemed to give slight relief on dyspnea without significant adverse events. Thus, the choice between HFNT with air or fan should be made according to the patients' preferences. *J Pain Symptom Manage* 2026;71:8–15. © 2025 The Authors. Published by Elsevier Inc. on behalf of American Academy of Hospice and Palliative Medicine. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)

Key Words

Dyspnea, high flow nasal therapy, fan, advanced cancer

Implications for Practice

This prospective trial compared the effect of HFNT with room air and fan in relieving dyspnea. The relief in dyspnea did not differ between HFNT with air and fan among nonhypoxemic patients with advanced cancer. However, both treatments seemed to provide slight improvement in dyspnea and may be considered feasible.

Introduction

Dyspnea is a common and distressing symptom in patients with advanced cancer especially at the end-of-life.^{1–3} As the management of dyspnea is challenging, new treatment options are needed.

Airflow directed to the face or upper airways can relieve dyspnea.^{4–6} Patients with advanced cancer and

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dyspnea are shown to benefit from the airflow delivered by fan,⁷ while oxygen therapy has not been shown to have any additional benefit for easing dyspnea in nonhypoxemic patients.^{4,7,8}

High-flow nasal therapy (HFNT) is a technique based on a device that can deliver humidified and warmed gas to the nostrils through a nasal cannula at high flow rates. High flow nasal oxygen (HFNO) has become one of the treatment choices for acute hypoxemic respiratory failure. In addition, HFNT may also be provided without supplemental oxygen using room air to achieve the benefits through airflow.⁹ The high gas flow flushes a part of the anatomical dead space, improves alveolar ventilation and minimizes inspiratory resistance and thereby reduces the work of breathing and thus dyspnea.^{9,10}

Hui et al. have shown that both noninvasive ventilation (NIV) and HFNT can alleviate dyspnea in patients with advanced cancer who had persistent dyspnea despite of supplemental oxygen.¹¹ HFNT has advantages compared to NIV with facemask as HFNT allows patients to eat and communicate which improves the comfort and dignity of the patients especially during palliative care phase.^{12,13} Interestingly, both HFNO and HFNT with air have been demonstrated to significantly reduce dyspnea in nonhypoxemic cancer patients.¹⁴

Some preliminary data and case reports suggest that HFNO can be used in relieving dyspnea in hypoxemic patients with advanced cancer in palliative care,^{15–19} but the role and applications of HFNT in patients with advanced cancer at the end of life is still unclear and needs more evaluation.

Many studies have shown that airflow delivered by a fan is effective in relieving dyspnea among patients with advanced diseases.⁶ The use of fan therapy does not require special equipment or special skills from the staff and is widely used in the context of palliative care to relieve dyspnea. However, fan and HFNT with air have not previously been compared.

This trial aimed to compare the effect and describe the feasibility of HFNT with air and fan therapy in relieving dyspnea among nonhypoxemic patients with advanced cancer. Our hypothesis was that HFNT is superior to fan in relieving dyspnea in this patient population.

Material and Methods

This was a prospective randomized controlled crossover trial reported according to the CONSORT guidelines.²⁰

Patients

The patients were recruited between April 2022 and December 2024 from the wards of the Tampere

University Hospital or Pirkanmaa Hospice (Tampere, Finland). Inclusion criteria were metastatic or locally advanced and incurable cancer, dyspnea ≥ 3 on numeric rating scale (NRS), no significant hypoxemia (oxygen saturation $\geq 88\%$ without supplemental oxygen), age ≥ 18 years, decision to withhold resuscitation and intensive care by the attending physician, and capability to give a written informed consent. Patients with decreased level of consciousness, insufficient cooperation, an immediately treatable cause of dyspnea, or a need for ventilatory support during the same hospitalization before the trial intervention were excluded. During the trial, all other symptomatic treatments for dyspnea (e.g. opioids) were allowed.

Set-Up and Interventions

In this prospective randomized controlled crossover trial, airflow was delivered through OptiflowTM nasal cannula (Fisher & Paykel Healthcare, Auckland, New Zealand) by using LumisTM HFT device (ResMed Pty Ltd, Bella Vista, Australia), a humidified and warmed high-flow system, and a floor fan. The appropriately sized nasal cannula for HFNT was selected for each patient.

Enrolled patients were randomly assigned by a 1:1 ratio based on computer-generated simple randomization to receive HFNT with air or fan first for 30 minutes, after which a crossover of treatments was performed after a washout period (15 minutes or until the NRS for dyspnea was ≥ 3 or at the same level as in the beginning of the first treatment). The computer-generated randomization sequence was held by a person who did not participate in patient recruitment or study interventions and the treatment group was advised to the study personnel by phone after enrollment. At the initiation of the HFNT, air flow rate was set to 25 l/min, temperature to 37°C and humidity to level 3 in the device. The settings were then adjusted according to the patient's preference. No supplemental oxygen was used at the initiation, but oxygen was allowed to be given if the oxygen saturation fell under 88% during the treatment. The floor fan was initially placed 60 cm away from the patient's face and the airflow speed was adjusted according to the patient's wishes. The airflow at the patient's face level was then measured by an anemometer.

End Points and Assessments

Dyspnea was measured by numeric rating scale (NRS) from 0 (no dyspnea) to 10 (the worst possible dyspnea) immediately before and after the treatment with HFNT with air or fan. The primary end point of the trial was the difference between dyspnea after treatment with HFNT with air and fan. Secondary end points included change in dyspnea following treatment with HFNT or fan and the proportion of the patients

whose dyspnea decreased ≥ 1 on NRS by the treatments.

Feasibility of the interventions was assessed by patients' compliance with the therapies, experienced adverse effects, willingness to use the treatment again and observed adverse events. The overall benefit and adaptation related to the interventions were assessed by presenting the following statements for the patients: "Therapy relieved my dyspnea," "Therapy was beneficial for me," "I adapted well to the therapy," "Therapy was unpleasant," and "I would like to use the therapy again for my dyspnea" and the patients replied by using Likert-type scale running from 1 (totally disagree) to 5 (totally agree). Adverse events experienced by the patients were asked and serious adverse events leading to death or serious deterioration of the patients were recorded. Especially, pain, anxiety and dry mouth were assessed with NRS from 0 (no symptom) to 10 (worst possible symptom) before and after the interventions. Oxygen saturation, breathing frequency and heart rate were measured as well. Detailed study protocol is included as a supplement.

Statistical Analyses

We determined the sample size for 2-tailed paired sample t-test to have statistical power of 80% with an alpha error of 5% to find a difference in dyspnea alleviation of 1.0 on NRS between the treatments (HFNT with air vs. fan). A score of 1.0 point on the NRS was used as a minimal clinically important difference (MCID) in the intensity of refractory dyspnea.^{21–23} We assumed an SD of 1.5 for the NRS dyspnea score (effect size hence being 0.66). Based on these, we would need 21 subjects to successfully go through both interventions. Due to possible dropouts or missing data, we originally aimed at 40 subjects, but due to slow recruitment and unexpectedly low drop-out rate, we stopped recruitment after enrolling 36 subjects of whom 28 subjects went through both treatments.

As the data turned out to be non-normally distributed, we decided to use nonparametric statistics. A comparison between groups was performed by using Wilcoxon test for continuous variables and McNemar test for categorical variables when appropriate. As there are no formal sample size calculations easily available for nonparametric tests, a sample size 15% higher is often used to compensate for the poorer power of nonparametric tests.²⁴ As our final sample (28 subjects) was 1.33 times higher than the predetermined based on sample size calculations (21 subjects), we assume to have reached the predetermined 80% statistical power to find a difference in dyspnea alleviation of at least 1.0 on NRS. Statistical significance was set at $P < 0.05$. Analyses were performed with IBM SPSS Statistics version 29.0.1.0 (Armonk, NY: IBM Corp).

Ethics

The trial was approved by the Ethics Committee of Tampere University Hospital (R20049; May 7, 2020), Tampere, Finland, and all subjects gave their written informed consent. Before initiation, this trial was registered at clinicaltrials.gov (Trial Identifier: NCT05257850). The trial was conducted also in accordance with Finnish laws, regulations, and the Declaration of Helsinki.

Results

Patients

Thirty-six patients were enrolled in this trial. Before starting the first trial intervention, dyspnea decreased to <3 on NRS in three patients and oxygen saturation to $<88\%$ in another three patients leading to exclusion of these six patients. Two patients interrupted the trial during the first treatment period. Thus, 28 patients completed the entire trial and used both treatment interventions (Fig. 1).

Baseline characteristics of the patients at the time of inclusion are shown in Table 1. All patients had Do Not Resuscitate (DNR) order in place and 87% of the patients were receiving palliative care without ongoing or planned oncologic therapies. Median survival of the patients was 21 days (interquartile range [IQR] 7–53) after the trial. At the end of the follow-up 31.12.2024, all except one patient had died.

Sixteen patients (53%) were randomized to use HFNT with air first and 14 (47%) to use fan first. For 1 patient, the flow rate of HFNT was adjusted to 20 L/min after 2 minutes and the temperature to 34°C after 21.5 minutes. All the other patients were satisfied with the initial settings of HFNT device throughout the intervention.

The median distance of the fan from the patients' face was 60 cm (range 45–70 cm) and the median air flow was 1.0 m/s (range 0.53–2.25) at the level of the patients' face.

Effect of Interventions on Dyspnea

Changes in dyspnea with HFNT with air and fan are presented in Fig. 2. The median NRS for dyspnea decreased from 5.0 (IQR 4.0–6.5) to 3.5 (IQR 2.0–5.8, $P = 0.001$) with HFNT with air (Fig. 2A) and from 5.0 (IQR 4.0–7.0) to 2.5 (IQR 1.0–7.0, $P = 0.012$) with the fan (Fig. 2B). There was no significant difference in the median NRS scores for dyspnea between HFNT with air and with fan after treatment ($P = 0.987$).

To check for possible carry-over effect, we compared the baseline NRS scores between the therapies and analyzed if the effect of either therapy was dependent on treatment order. There was no statistically significant difference in the baseline NRS scores for dyspnea

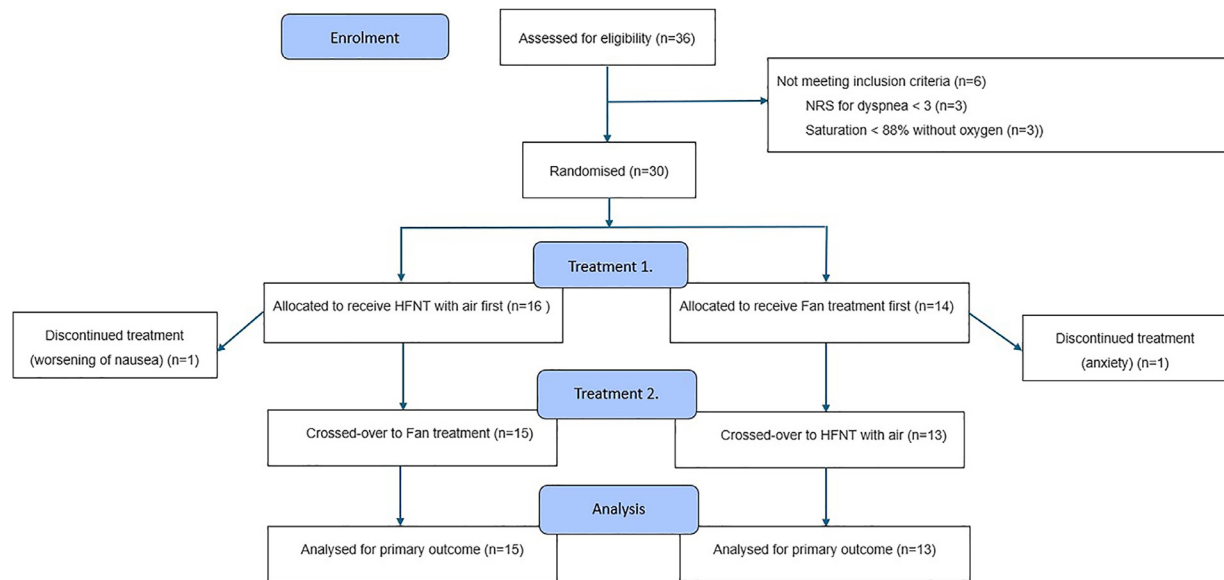


Fig. 1. Flow chart of the patients according to CONSORT diagram.

between the therapies ($P = 0.958$), and the order of treatment had no statistically significant effect on the change in dyspnea with either intervention.

The median change in dyspnea on NRS was -1.0 for both HFNT with air and with fan (IQR 0.0 to -2.8), with no significant difference between the treatments ($P = 0.935$). Dyspnea decreased by at least one point on NRS in 61% and 64% of the patients receiving HFNT with air and fan therapy, respectively ($P = 1.000$).

Feasibility of the Treatments

Patients fully or partially agreeing with the statements concerning the overall satisfaction and unpleasantness of the interventions are presented in Table 2. With both interventions, over half of the patients found the therapies to relieve their dyspnea. The proportion

of patients adapting well to the therapy was 79% for HFNT with air and 68% for fan. No statistically significant differences concerning these statements were found between the therapies.

With HFNT with air there was a statistically significant decrease in the NRS for dry mouth but no change in pain, anxiety, respiratory rate, saturation or heart rate (Table 3). With fan there was a statistically significant change in the distributions of oxygen saturation and NRS for pain, anxiety and dry mouth. However, changes in median values were negligible or minor and none showed impairment (Table 3). Additionally, the only significant difference between the treatments was that the fan slightly improved the oxygen saturation. Oxygen saturation remained over 88% in all the patients and no supplemental oxygen was needed during the interventions.

One patient interrupted fan therapy due to anxiety after 8 minutes, while another patient with gastrointestinal cancer could not continue HFNT after 7 minutes due to worsening of nausea. No serious adverse events occurred.

Discussion

To our knowledge, this is the first trial to compare HFNT with air and fan in relieving dyspnea. In this randomized cross-over trial among nonhypoxemic patients with incurable cancer, we found that both HFNT without oxygen and fan relieved dyspnea and patients adapted well to both therapies. The effect of HFNT with air and fan did not differ in this patient group.

Although the effect of both therapies on dyspnea was small, it is in line with previous HFNT study results in cancer patients. In the study of Takase et al., dyspnea

Table 1
Patient Characteristics

Total, n	30
Male, n (%)	17 (56.7)
Age, years, median (range)	75 (53–90)
Cancer type, n (%)	
Pulmonary	11 (36.6)
Gastrointestinal	9 (30.0)
Renal	4 (13.3)
Gynecologic	2 (6.7)
Prostatic	2 (6.7)
Lymphoma	2 (6.7)
Primary lung cancer or lung metastases, n (%)	20 (66.7)
Cardiopulmonary comorbidities, n (%)	
Obstructive lung disease	9 (30.0)
Heart failure	7 (23.3)
Place of intervention, n (%)	
Hospice	9 (30.0)
Palliative care ward	8 (26.7)
Oncology ward	7 (23.3)
Other hospital ward	6 (20.0)

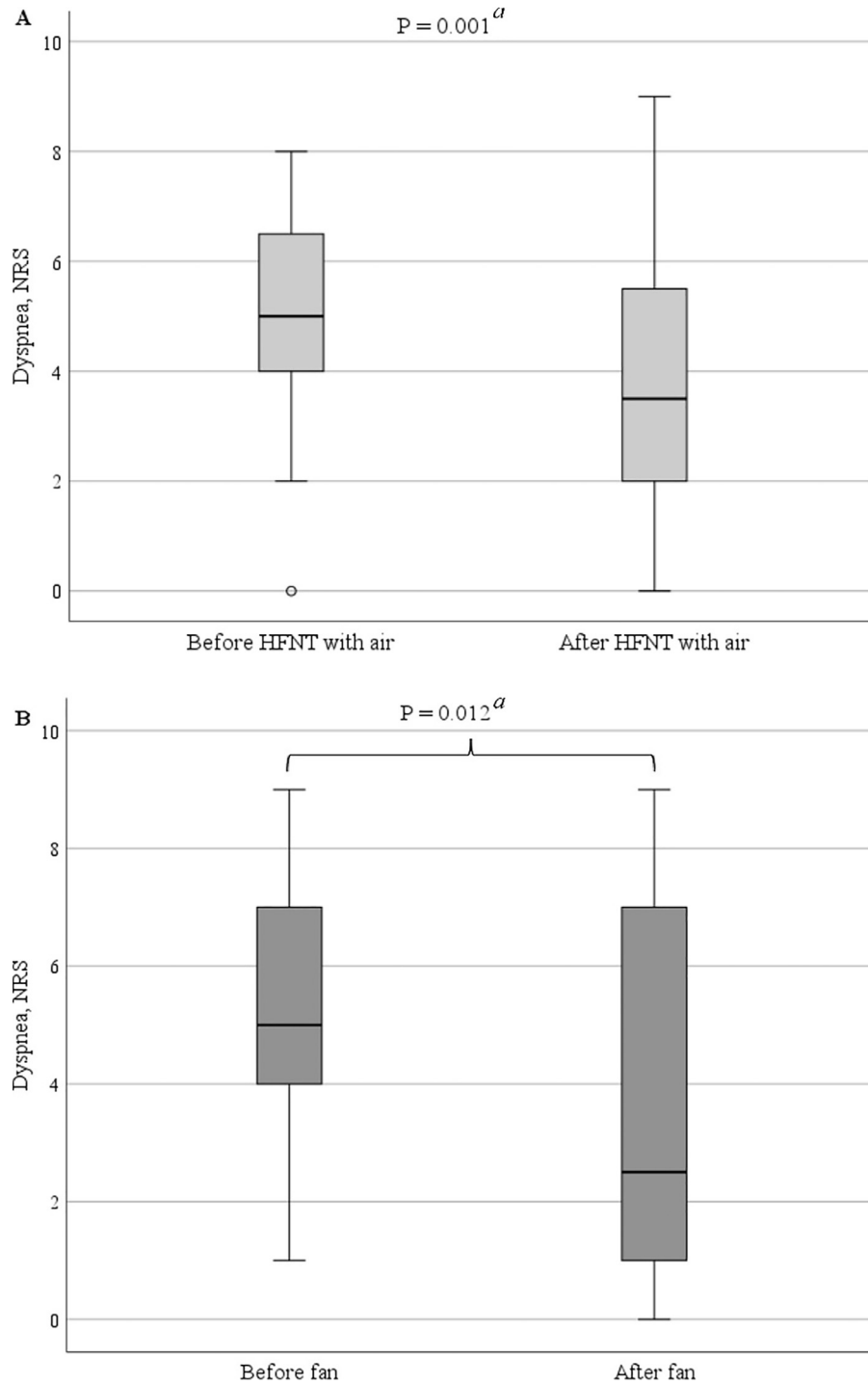


Fig. 2. Dyspnea measured with numerical rating scale (NRS) before and after interventions with high-flow nasal therapy (HFNT) with air (2A) and fan (2B).

^aWilcoxon test.

was reduced by 1.3 units on the Borg scale during the first hour on HFNT and by 1.4 units after 24 hours of treatment in hospitalized patients with advanced cancer.¹⁹ Compared to our trial, the reduction in dyspnea was slightly greater in the study by Takase et al. where

all patients except one used HFNT with oxygen.¹⁹ In the trial by Hui et al., in nonhypoxemic cancer patients HFNT with air decreased dyspnea by 1.4 points on NRS in the first five minutes and by 1.8 points in 10 minutes.¹⁴ In comparison, Booth et al. reported that a

Table 2
Proportion of Patients Agreeing Completely or Partly With the Statements Concerning the Interventions

	HFNT With Air	Fan	<i>P</i> -Value ^a
Therapy relieved my dyspnea, <i>n</i> (%)	16 (57.1)	15 (53.6)	1.000
Therapy was beneficial for me, <i>n</i> (%)	18 (64.3)	12 (42.9)	0.146
I adapted well to the therapy, <i>n</i> (%)	22 (78.6)	19 (67.9)	0.508
Therapy was unpleasant, <i>n</i> (%)	10 (35.7)	10 (35.7)	1.000
I would like to use the therapy again for my dyspnea, <i>n</i> (%)	15 (53.6)	13 (46.4)	0.774

HFNT, high-flow nasal therapy.

^aWilcoxon test.

hand-held fan decreased dyspnea by 1.0 points on NRS in five minutes.²⁵ Even a minor reduction in dyspnea in patients with advanced diseases and especially at the end-of-life can be clinically significant.

HFNO therapy has become a standard first-line treatment for acute hypoxemic respiratory failure⁹ and increasing evidence also supports the use of HFNT among patients with chronic respiratory insufficiency caused by end stage diseases.²⁶ Further, some case reports and clinical studies have highlighted the potential benefit and feasibility of HFNT in relieving dyspnea even among patients in end-of-life care and in palliative care settings.^{12,16–19}

Airflow directed to the patient's face by a fan has shown to relieve dyspnea in patients with advanced diseases in many studies and has become a commonly used therapy in palliative care especially in nonhypoxemic patients.^{4–6}

However, management of dyspnea with HFNT with air or fan has not been previously compared. In an uncontrolled study by Takase and colleagues, patients with advanced cancer adapted to HFNT and showed relief of dyspnea.¹⁹ Our results are in line with the study by Takase et al., but as we included only nonhypoxemic cancer patients and compared HFNT with air to fan, our trial brings new insights into the clinical use of HFNT in palliative care setting.

There are reports showing the superiority of HFNO compared to conventional oxygen therapy in relieving

dyspnea in hypoxemic patients with advanced diseases in emergency settings. These patients are characterized with severe dyspnea leading to high respiratory rate, ≥ 30 /min, which can explain the superiority of HFNO therapy over standard oxygen.^{27,28} Further, Ruangsombon et al. and Zu et al. demonstrated that HFNO alleviated dyspnea more effectively than standard oxygen therapy in hypoxemic patients also in the palliative stage.^{27,28} It might be that in our trial HFNT was not more effective than the fan because the patients were not hypoxemic, and the median respiratory rate was only 20/min before both interventions. These results suggest that HFNT might have greatest benefit in alleviating dyspnea among hypoxemic patients in palliative phase suffering from high respiratory rate.

Based on previous research findings of Hui et al., it seemed that higher airflow rate with HFNT might enhance the benefit of the therapy in relieving dyspnea.¹⁴ In the present trial we used HFNT at a relatively low flow rate of 25 l/min according to the patients' preferences, but in turn, this may have diminished the effectiveness of the HFNT in our trial. However, simple fan therapy might be more useful if high flow rates are not warranted.

In the current trial the relatively short intervention time in using HFNT could also affect the results compared to those presented by Takase et al.¹⁹ In their study, dyspnea was relieved within the first hour of HFNT, and the imminent response was also associated with long-term benefit.¹⁹ On the other hand, in the former trial of Hui et al. comparing high and low flow rates on relieving dyspnea in patients with cancer, the positive effect of HFNT appeared already after five minutes of treatment.¹⁴ It would be important to conduct new clinical trials to test and compare the effect of different flow rates of HFNT on treatment efficacy in relieving dyspnea among patients in palliative care.

HFNT is well tolerated in patients with cancer according to previous studies.^{14,19,28} Also, in our trial three quarters of the patients adapted well to HFNT and half of them were willing to use it again. Our results are in line with the study of Ruangsombon et

Table 3
Measurements and Symptoms Before and After the Interventions

	HFNT With Air			Fan			<i>P</i> -Value ^b
	Before	After	<i>P</i> -Value ^a	Before	After	<i>P</i> -Value ^a	
Respiratory rate, 1/min, median (IQR)	20 (17–24)	20 (16.3–24)	0.326	20 (18–28)	20 (16–24)	0.101	0.614
Oxygen saturation, %, median (IQR)	94 (91–96)	94 (92–96)	0.871	93 (91–95)	94 (92–97)	0.003	0.035
Heart rate, 1/min, median (IQR)	86 (75–94)	87 (74–95)	0.568	86 (76–95)	85 (72–93)	0.706	0.840
Pain, median NRS (IQR)	2.0 (0.0–4.5)	2.0 (0.0–3.8)	0.343	2.0 (0.5–6.0)	2.0 (0.0–4.0)	0.002	0.161
Anxiety, median NRS (IQR)	3.0 (0.5–6.5)	2.0 (1.0–6.0)	0.242	3.0 (1.0–6.5)	2.0 (0.0–5.8)	0.027	0.449
Dry mouth, median NRS (IQR)	5.0 (2.0–6.5)	3.0 (1.0–5.8)	0.031	4.0 (2.5–6.5)	4.0 (2.0–5.0)	0.020	0.625

IQR, interquartile range; HFNT, high-flow nasal therapy.

^aWilcoxon-test.

^b*P*-value between treatment induced change by HFNT with air and Fan (Wilcoxon test).

al. in which 78% of the participants preferred to continue using HFNT after the study period.²⁷ Even with the small sample size, we were able to demonstrate an improvement in dyspnea score without significant adverse effects. The interruption of the trial by two patients (one with fan and one with HFNT) was likely related to the overall symptom burden of the patients suffering from end-stage cancer rather than the interventions itself.

This was a single center trial with a limited sample size from a heterogeneous patient group which must be considered when interpreting the generalizability of the results. Cross-over study design was mainly chosen due to the well-known difficulties in recruiting patients in palliative care suffering from breathlessness. Even though we did not find differences in baseline dyspnea score between the treatments and the treatment order did not affect the effect of either treatment on dyspnea, a carry-over effect related to the previous treatment modality could not be totally ruled out due to the cross-over setting and relatively short wash-out period. We evaluated tolerability and feasibility of the treatments only with descriptive terms and we did not have any pre-defined thresholds for feasibility. The duration of interventions (30 minutes) may be regarded relatively short to achieve all the benefits of the therapies. However, relief in dyspnea has been reported even after ≤ 1 hour of use with both the therapies^{6,11,19} and we think that a longer study period might have been too burdensome for our frail patients approaching end-of-life. Finally, it is impossible to know if the small relief of dyspnea by both therapies was related to the intervention itself or whether the dyspnea would have been decreased naturally over time.

Although HFNT has been mostly well tolerated in clinical trials, there has been concern about the appropriate initiation and weaning time of HFNT and the goals of care in patients at the end-of-life^{15,29,30} as the treatment of dyspnea should not cause discomfort and increase suffering. Thus, further studies are needed to verify the best clinical indications and settings of HFNT to alleviate dyspnea in patients with life-limiting diseases and especially in the phase of palliative care when the goal of care is to relieve and prevent suffering.

Conclusion

The effect of HFNT with room air or fan in relieving dyspnea did not differ among nonhypoxemic patients with advanced cancer and limited prognosis. Both therapies seemed to have small effect on dyspnea and may be considered feasible. Thus, the choice between HFNT and fan in the management of dyspnea in palliative care should be individualized according to patients' preferences.

Authors' Contributions

S.L.-K., J.T.L., and L.L. were responsible for the trial design, but all the authors participated in this. S.L.-K., H.A.R., R.P.P., H.H., and T.K. recruited the patients. H.A.R., S.L.-K., R.P.P., J.T.L., and L.L. made the analysis of the data. All the authors contributed to the analysis and interpretation of data and writing and drafting of the article. All authors approved the final version of the article.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at [doi:10.1016/j.jpainsymman.2025.08.033](https://doi.org/10.1016/j.jpainsymman.2025.08.033).

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