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Pulmonary Rehabilitation and Palliative Care for the Lung Cancer Patient

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Abstract

Pulmonary rehabilitation, as a quality of life intervention, has a role to play in palliative care for lung cancer patients. Combining the art and skills of clinical care, physiological, and behavioral tools, pulmonary rehabilitation can serve to rebuild the functional capacity of patients limited by breathlessness and deconditioning. Exercise programs are the primary tool used to restore and rebuild the patient's endurance by challenging the entire pathway of oxygen transport and improving gas exchange. Other tools of pulmonary rehabilitation include breathing retraining, self-management skills, airway clearance techniques, bronchodilation, smoking cessation and oxygen therapy. Pulmonary rehabilitation is now becoming a part of supportive care for patients undergoing chemotherapy and radiation therapy. The ability to be more active without suffering the consequences of dyspnea on exertion boosts the patient's self-efficacy and allows for an improved quality of life, so that lung cancer patients can participate in their family lives during this therapeutic challenge.

Keywords

dyspnea; exercise; palliative care; pulmonary rehabilitation; quality of life

Introduction

Caring for the lung cancer patient is more than tumor eradication; it is a close collaboration between oncology and palliative care professionals to address the many symptom and quality of life (QOL) issues common in this disease. The cancer specialists address the tumor, while the palliative care specialists address the patient's QOL in all stages of lung cancer.¹⁻³ This article examines the role of pulmonary rehabilitation as an additional component of high quality palliative care for the lung cancer patient, based on experience from a five-year, NCI- (National Cancer Institute) sponsored Program Project.⁴

The NCI-sponsored Program Project tested the effectiveness of interdisciplinary palliative care for patients with early through late stage lung cancer and their family caregivers.⁴ The team included oncologists, surgeons, advanced practice nurses, a social worker, dietitian, chaplain, physical therapist, and pulmonary rehabilitation physician. Patients who were noted to have dyspnea on low-level exertion, experiencing fatigue, or were undergoing lung cancer surgery were referred for pulmonary rehabilitation. The tools of pulmonary rehabilitation included addressing the underlying primary pulmonary disease, an exercise program for lower and upper extremity, breathing retraining to improve gas exchange and ameliorate dyspnea, airway clearance techniques, oxygen therapy with portable component for hypoxemic patients, bronchodilator optimization, self- management training, and problem-solving techniques to overcome roadblocks to an active lifestyle.

In this article, pulmonary rehabilitation is described both in the context of palliative care and as an independent therapeutic option, with a case example illustrating how pulmonary rehabilitation provided concurrently with palliative care can improve a patient's QOL.

Pulmonary rehabilitation

Pulmonary rehabilitation is a comprehensive program that combines the art and skills of clinical care, physiological, and behavioral tools to rebuild the functional capacity of patients limited by breathlessness and deconditioning.⁵ Originally designed for the COPD patient, pulmonary rehabilitation is also functionally restorative for asthma, pulmonary fibrosis, bronchiectasis, cystic fibrosis, and lung cancer patients. These patients experience dyspnea, fatigue, and deconditioning, as they become less active from their disabling response to the disease.⁶ Dyspnea prevalence is estimated as high as 55% to 87% in all stages of lung cancer.⁷ It is common for patients with lung cancer to also have COPD. This is particularly true for patients with an extensive history of smoking. In the Lung Health Studies of a COPD population over 5 years, lung cancer was a frequent cause of death.⁸ COPD is regarded as an independent risk factor for lung cancer, beyond the common risk factor of smoking.

Tools and Disciplines of Pulmonary Rehabilitation

The specific tools of pulmonary rehabilitation may include, but are not limited to, treatment of dyspnea; exercise for endurance, strength, and confidence; breathing retraining to alleviate dyspnea and improve gas exchange; self-management skills; airway clearance techniques; bronchodilation; smoking cessation; and oxygen therapy. Pulmonary rehabilitation skills and disciplines are best structured into a lifetime self-management program. Pulmonary rehabilitation tools are also applicable in preparing high-risk patients for perioperative complications from thoracic surgery.⁹ Table 1 summarizes the components of pulmonary rehabilitation.

Exercise

The driving engine of pulmonary rehabilitation is an exercise program targeted to build endurance. Exercise training enables the patient to live an active lifestyle, associated with a better quality of life.¹⁰ The training challenges the entire pathway of oxygen transport from lungs, to circulation, to tissues – delivering oxygen to metabolically active cells. Exercise improves gas exchange by boosting oxygen transport, enhancing cellular uptake and utilization while enabling more efficient CO₂ elimination.¹¹ In so doing, exercise is the most effective means to resolve dyspnea from exertion over the long term.¹² In the early days of pulmonary rehabilitation, the mechanism for this improvement was unclear, since COPD patients were viewed as so limited by their lung disease that they were unable to exercise at a high enough work rate to achieve a training effect. Eventually, it was determined that many of these patients were able to achieve a training effect, as evidenced by a detectable increase in their anaerobic threshold.¹³

Additionally, an important ventilatory limitation is the tendency of COPD/emphysema lungs to hyperinflate during exercise due to progressive air trapping.¹⁴ The mechanism may be described as follows: Airway obstruction, the hallmark of COPD, limits the expiratory airflow rate. This is not a major impediment to breathing at quiet rest, as breath rate is slow enough to fully exhale in order to accommodate the next inhalation. However, when the patient tries to exert, such as in walking or stair climbing, the breath rate increases. At higher breath rates, the patient's lungs do not have time to fully empty before taking the next inhalation. Each breath traps more air, until there is no room left to inhale. This is termed, dynamic hyperinflation and becomes the patient's *ventilatory limitation* to exercise.¹⁵ Exercise training is effective in creating an enhanced ventilatory efficiency – the ability to eliminate CO₂ while breathing less. The patient achieves a higher work rate while breathing at a lower breath rate – delaying reaching his/her ventilatory limitation.¹⁶ Functionally, the patient is able to be more active and less limited by breathlessness. Other rehabilitative tools enhance the positive effect of exercise.¹⁷ Bronchodilators help to open the airways allowing more air to escape.¹⁶ Pursed lips breathing – a method of breathing that improves the efficiency of gas exchange while slowing exhalation enables the patient to exercise at a lower breath rate. This enables the patient to empty their lungs to accommodate the next breath and is particularly effective during exertion.¹⁸ This technique is commonly taught by palliative care nurses. Endurance and strength are important even for patients with limited life expectancy.¹⁹

Self-management

Patients learn methods of self-management in pulmonary rehabilitation that boost confidence and engender self-efficacy.¹⁷ They develop a better understanding of their illness, thus demystifying it. They gain skills in energy efficiency, which relieves or delays breathlessness. Patients become participants in their own care. Practically, the patient is in contact with his or her health professionals intermittently, whereas they live with disease continuously. Patients, guided by their clinicians, who are in control of his or her disease, are able to live relatively normal lives with confidence and quality. This concept is referred to as collaborative self-management.²⁰ Self-management is associated with better control over their chronic illness, free from the fear of suffocation.

Oxygen Therapy

Hypoxemia may occur as a result of gas exchange deficit due to the cancer or ventilatory impairment from chronic lung disease such as COPD or pulmonary fibrosis. If the patient is hypoxemic at rest, during sleep, or with exercise, that patient may be prescribed supplemental oxygen.²¹ Providing oxygen prevents tissue hypoxia and enables the patient to exercise longer before reaching ventilatory limitation.

Oxygen therapy has a unique set of roles in patients with lung cancer. Active patients benefit substantially from a portable oxygen system, such as a small cylinder with an oxygen-conserving device or a portable oxygen concentrator to enhance mobility and range of activity away from home. Some insurance carriers resist providing portable oxygen because of the added expense, requiring extensive medical documentation before approving. Pursuing oxygen portability to maintain an active life is standard care in pulmonary rehabilitation.⁵

Some patients with more advanced cancers require high flow oxygen in order to maintain arterial oxygenation. In the hospital, high flow systems are available to meet these high flow requirements.²² However, at home, high flow oxygen may be impractical. Such patients may benefit from a reservoir cannula that improves the efficacy of oxygen therapy, with lesser amounts of oxygen delivered by a less cumbersome oxygen system. At some point in their disease progression, these patients may not be able to achieve adequate oxygenation at any flow setting. Those patients would likely benefit from opiates, which should be initiated before they reach this point.

At the end of life, the goal of oxygen therapy transitions from achieving target oxygen saturation to preventing or reversing dyspnea. At this point, opiates that suppress the respiratory drive take center stage, as they relieve dyspnea irrespective of oxygen saturation. Patients on high flow oxygen eventually will be transitioned to opiates, either in addition to or as monotherapy, to provide comfort and prevent the feeling of suffocation.²²

There are patients who experience a symptomatic benefit from high flow oxygen, but who are not hypoxemic. Several studies have shown that they would derive the same symptomatic benefit from high flow room air.²³ Rather than stopping the oxygen at this point, a reasonable strategy would be to continue the high flow oxygen, introduce opiates, then transition off oxygen.

Benefits of pulmonary rehabilitation

While pulmonary rehabilitation programs have been around since the late 1960's, and results have always been impressive, there is now extensive literature on the effectiveness of each component. Always at the top of the list is exercise performance, coupled with a reduction in dyspnea. However, pulmonary rehabilitation is more than an exercise program; it is the comprehensive management of a disabling illness resulting in a better quality of life. Clearly, this is consistent with the goals of palliative care. As the science accumulates, more is being discovered about the nature of chronic lung diseases – particularly COPD. Combined insight from pulmonary physiology, genetics, COPD phenotypes, and genetics expressions enriches our understanding as to how the disease behaves clinically. Psychologically, more is known about the behavioral response to the disease and how to redirect it. The benefits of pulmonary rehabilitation are summarized in Table 2.

COPD and Lung Cancer

While patients with COPD and lung cancer have two primary causes of dyspnea as well as a deconditioning component, pulmonary rehabilitation is effective in alleviating each cause. An additional contributing factor to functional impairment is loss of lung volume from cancer, surgical removal of lung tissue, or the effects of radiation. With progressive dyspnea at lower levels of exertion, the patient fears that his or her life will end with suffocation and this weighs heavily.²⁴

Many of the strategies effective for COPD patients will also apply to the lung cancer patient.⁶Patients may derive symptomatic resolution from bronchodilators, exercise programs, oxygen therapy, and breathing retraining techniques.²⁰Pulmonary rehabilitation following hospitalization enables the patient to recover faster, more completely, and with fewer functional limitations from dyspnea, weakness, or fatigue.²⁵Patients are able to build their strength and endurance in order to focus on meaningful activities.

If the patient is a smoker, the pulmonary rehabilitation team may provide a smoking cessation program.²⁶If the patient is being weighed down by fatigue, pulmonary rehabilitation with its exercise program, breathing retraining, and functional strategies may provide energy to go on.⁶The patients themselves must gain control over their lives and maintain an active lifestyle, guided by their clinician and supported by their exercise programs.²⁰

Lung cancer symptoms

Dyspnea

Most patients typically suffer from dyspnea on exertion. Dyspnea is the feared result of any attempt to exert.^{27,28}The natural maladaptive response is to avoid dyspnea by becoming inactive, sedentary, and consequently deconditioned. This response adds further dyspnea, when the patient does try to exert himself/herself.²⁹Thus, inactivity alone is damaging, as it impedes the ability of the patient to be active. This is “dyspnea on top of dyspnea”.²⁹

The clinical tools of pulmonary rehabilitation are both physiologically- and behaviorally-based.⁵ Patients referred for pulmonary rehabilitation derive symptomatic benefit, as they are able to perform more daily activity while experiencing less dyspnea.³⁰ The relief of dyspnea is a shared priority of both pulmonary rehabilitation and palliative care.

The treatment of dyspnea has several long-term and short-term entry points; they are physiological, psychological, physical, and combinations of each.³¹ Over the short-term, there is medication, meditation, and breathing retraining. Over the long-term, exercise can be highly effective. The best strategies include treating the underlying cause, while at the same time providing therapies aimed at symptom suppression.²⁸ Dynamic hyperinflation in the COPD patient causes dyspnea on exertion, and the treatment centered on exercise is actually multimodal. Anxiety, fear of dyspnea, and pain are important modifiers that amplify the dyspnea experience.²⁴ Thus, dyspnea treatment should include a long-term preventative component centered on exercise as well as rapid relief for breakthrough symptoms such as a bronchodilator, a fan to blow air against the face, distraction, and pursed lips breathing.^{18,32} This complicated phenomenon may be suppressed or controlled to relieve the patient from a heavy symptomatic burden. As with management of all symptoms, effective dyspnea management will help the caregivers as well by reducing their own distress.³³

By relieving the patient from the symptomatic burden associated with chemotherapy, pulmonary rehabilitation may enable the patient to tolerate more intense and, perhaps, more efficacious cancer treatment.³⁴ Exercise training for the patient who can tolerate it is even more effective in minimizing fatigue and improving vitality, aerobic capacity, muscular strength, and physical and functional activity in cancer patients undergoing chemotherapy.³⁵ Breathing retraining techniques and medications to reduce inflammation and open airways, in addition to exercise, is now becoming a part of supportive care for patients undergoing chemotherapy and radiation therapy,^{36,37} leading to a reduction in dyspnea and fatigue.

While evidence of chemotherapy and chemo-radiation benefit is rapidly accumulating, there is a paucity of research that specifically addresses pulmonary rehabilitation for radiation therapy alone. This is also an opportunity for pulmonary and palliative care collaboration, since radiation therapy is often palliative. Patients undergoing radiation therapy may experience fatigue and dyspnea and therefore benefit from pulmonary rehabilitation. Some of the referenced studies addressed combined chemo-radiation therapy. It is reasonable to speculate that some of the benefit described in the chemo-radiation research was partially due to a reduction of dyspnea and a psycho-educational approach; including both in palliative care and pulmonary rehabilitation has been described as promising.³⁸

Fatigue

Fatigue is a very common symptom described by pulmonary rehabilitation patients.³⁹ It is also a frequent complaint expressed by lung cancer patients. Fatigue is distressing and multidimensional, with both physiological and emotional components and is difficult to measure in the clinic, but easily recognized. Fatigue can affect sleep quality and mental health, in general, and exert a negative impact on motivation. It is closely related to dyspnea. Muscle fatigue is a physiologically measurable variable that only weakly correlates with the

emotional and physical experience. Multidimensional fatigue and depression scales are helpful in assessing fatigue. There is a close relationship between fatigue, age, chronic illness, and inactivity.⁴⁰ Exercise programs may be strategically designed to enable patients to be active, while enduring less physical discomfort and the feeling of emotional and physical exhaustion. During an exercise program, patients learn that such control is possible and enabling.³⁵ This is especially applicable for patients undergoing chemo-radiation therapy. Pulmonary rehabilitation engaged during and following treatment may help stave off dyspnea and fatigue and ameliorate those symptoms that do occur.^{25,41} The learned ability to modulate fatigue during challenging situations is a valuable pulmonary rehabilitation component. As with any skill, it takes continuous practice.

Discussion

The diagnosis of lung cancer is a life-altering experience within a landscape of uncertainty.⁴² The fear of pain, breathlessness, weakness, and fatigue manifests early in the disease. As treatment ensues, these fears tend to recede, only to resurface as the disease progresses and health status declines. Quality of life interventions are as critical as the disease-focused therapies.⁴³

Palliative care teams, including physicians, nurses, social workers, physical therapists, occupational therapists, psychologists, chaplains, and sometimes pulmonologists, oncologists and surgeons attend to patients with lung cancer and their families.⁴⁴ Active treatment of pain, dyspnea, and fatigue are critical components of lung cancer treatment.^{24,45,46} Insomnia frequently accompanies the diagnosis and management of lung cancer patients – either primary or associated with sleep-disordered breathing.⁴⁷ An active lifestyle with purpose can be an effective distraction from oppressive symptoms.¹⁰ The physical effects of lung cancer are matched with psychological symptoms given the often-late stage at diagnosis.

Palliative care and pulmonary rehabilitation are complementary to optimize functional capacity and minimize symptom burden.⁴⁸ Pulmonary rehabilitation is designed to optimize functional status through both physiological and behavioral means in order to restore the patient's ability to live an active and enjoy life. Patients are taught self-management with both quality of life and self-efficacy as major goals. Exercise training is the engine that powers pulmonary rehabilitation; it is the most effective means to minimize or prevent dyspnea on exertion.^{49,50} Pulmonary rehabilitation programs tend to be discreet programs lasting 4-6 weeks; sometimes, ideal clinical strategy over the long-term for a chronic and progressive illness, it is highly effective in building function over the short-term. A reinforcement program is beneficial in lengthening the benefit and the palliative care team can reinforce the pulmonary rehabilitation principles in their ongoing interaction with patients.

Palliative care is a long-term comprehensive approach that can be parallel to or integrative with cancer treatment, while pulmonary rehabilitation may be instituted to resolve specific issues. For example, pulmonary rehabilitation specifically addresses a COPD impediment to lung cancer surgery by improving endurance, strength, gas exchange, and airway clearance.

It would therefore be reasonable to incorporate pulmonary rehabilitation as a subcomponent of palliative care for the lung cancer patient. Not everyone needs pulmonary rehabilitation, but most benefit from palliative and supportive care. Pulmonary rehabilitation focuses on skills and techniques to maximize a patient's ability to function in life. In specific instances and indications, it is reasonable to integrate pulmonary rehabilitation into the multidisciplinary management.⁵¹

Case History

BR was a 68-year-old female, who had never smoked, with stage IV lung cancer. She presented with pleural effusions and underwent a talc pleurodesis. She had been treated with erlotinib for the past 1.5 years with stable disease. She had a history of breast cancer with local recurrence and underwent a completion mastectomy 2 years ago. Her initial lung function tests were forced vital capacity (FVC) = 40%, forced expiratory volume in 1 sec (FEV₁) = 48%, FEV₁/FVC = 92%, diffusing capacity = 54%, total lung capacity = 48% predicted. These pulmonary function studies indicate a restrictive ventilatory defect likely due to loss of ventilating lung volume.

She was referred to pulmonary rehabilitation because of dyspnea on exertion and cough. She had no previous history of lung disease. She had difficulty in swallowing pills and she had panic attacks from anxiety. Her pulmonary rehabilitation intervention consisted of problem solving for her anxiety and swallowing pills, strategies for managing her cough via a cough algorithm, pursed lips breathing for dyspnea and improved gas exchange, and a progressive submaximal walking program. Her functional status was monitored with a 272-meter timed walk. Her initial walk time was 4 minutes, and most recent time was 3 minutes and 5 seconds with minimal dyspnea. She is presently active, walking with her husband, shopping, and maintaining her functional status. Her cough is rare and non-productive. Her long-term dyspnea management is through her walking program. Exertional and breakthrough dyspnea are controlled via pursed lips breathing. While her prognosis is likely limited to 3-6 months, the combination of pulmonary rehabilitation and palliative care is preserving her QOL.

In the above case, a palliative care nurse worked closely with pulmonary rehabilitation to provide a comprehensive QOL assessment and teach BR and her family techniques to control and manage BR's dyspnea and accompanying symptoms.

Conclusions

As illustrated in the case study above, BR suffered from dyspnea on exertion and a cough as a result of her stage IV lung cancer. Her anxiety prevented her from swallowing pills and caused panic attacks. In order to improve BR's QOL, her anxiety, cough, and dyspnea needed to be addressed. Pulmonary rehabilitation was used in conjunction with palliative care as a complementary strategy to address BR's symptoms. Whereas palliative care and pulmonary rehabilitation functioned hand-in-hand to improve BR's QOL, palliative care was a long-term comprehensive approach that could be integrated into the cancer treatment, and pulmonary rehabilitation was the strategy used to resolve specific issues, namely BR's dyspnea, cough, and anxiety.

Palliative care offers important symptom management. It is comprehensive and multidisciplinary in its approach, as it encompasses all domains of the human experience for both the patient and caregiver. Palliative care charts a path through a terrain of uncertainty. No longer is palliative care reserved for end of life, when all other treatment is exhausted. Quality of life is not just a concept; rather, it is the overriding goal of all cancer care. Palliative care is designed to break down cancer treatment barriers, enabling the patient to live with cancer. Palliative care encompasses the full range of pharmacological and supportive options. Pulmonary rehabilitation may serve as one of those options.

References

1. Rueda JR, Sola I, Pascual A, Subirana Casacuberta M. Non-invasive interventions for improving well-being and quality of life in patients with lung cancer. *Cochrane Database Syst Rev*. 2011; (9):CD004282. [PubMed: 21901689]
2. Hoekstra J, Vernooij-Dassen MJ, de Vos R, Bindels PJ. The added value of assessing the 'most troublesome' symptom among patients with cancer in the palliative phase. *Patient Educ Couns*. 2007; 65(2):223–229. [PubMed: 16965886]
3. Temel JS, Greer JA, Muzikansky A, et al. Early palliative care for patients with metastatic non-small-cell lung cancer. *N Engl J Med*. 2010; 363(8):733–742. [PubMed: 20818875]
4. Koczywas M, Cristea M, Thomas J, et al. Interdisciplinary palliative care intervention in metastatic non-small-cell lung cancer. *Clin Lung Cancer*. 2013; 14(6):736–744. [PubMed: 23871439]
5. Ries AL, Bauldoff GS, Carlin BW, et al. Pulmonary Rehabilitation: Joint ACCP/AACVPR Evidence-Based Clinical Practice Guidelines. *Chest*. 2007; 131(5 Suppl):4S–42S. [PubMed: 17494825]
6. Nici L. The role of pulmonary rehabilitation in the lung cancer patient. *Semin Respir Crit Care Med*. 2009; 30(6):670–674. [PubMed: 19941224]
7. Williams AC, Grant M, Tiep B, Kim JY, Hayter. Dyspnea Management in Early-Stage Lung Cancer: A Palliative Perspective. *J Hosp & Pall Nsg*. 2012; 14(5)
8. Anthonisen NR, Connett JE, Enright PL, Manfreda J. Lung Health Study Research G. Hospitalizations and mortality in the Lung Health Study. *Am J Respir Crit Care Med*. 2002; 166(3):333–339. [PubMed: 12153966]
9. Nici L. Preoperative and postoperative pulmonary rehabilitation in lung cancer patients. *Thorac Surg Clin*. 2008; 18(1):39–43. [PubMed: 18402200]
10. Troosters T, Gosselink R, Janssens W, Decramer M. Exercise training and pulmonary rehabilitation: new insights and remaining challenges. *Eur Respir Rev*. 2010; 19(115):24–29. [PubMed: 20956162]
11. Bowen TS, Cannon DT, Murgatroyd SR, Birch KM, Witte KK, Rossiter HB. The intramuscular contribution to the slow oxygen uptake kinetics during exercise in chronic heart failure is related to the severity of the condition. *J Appl Physiol* (1985). 2012; 112(3):378–387. [PubMed: 22033530]
12. Wasserman K, Sue DY, Casaburi R, Moricca RB. Selection criteria for exercise training in pulmonary rehabilitation. *Eur Respir J Suppl*. 1989; 7:604s–610s. [PubMed: 2803414]
13. Casaburi R, Patessio A, Ioli F, Zanaboni S, Donner CF, Wasserman K. Reductions in exercise lactic acidosis and ventilation as a result of exercise training in patients with obstructive lung disease. *Am Rev Respir Dis*. 1991; 143(1):9–18. [PubMed: 1986689]
14. O'Donnell DE, Bertley JC, Chau LK, Webb KA. Qualitative aspects of exertional breathlessness in chronic airflow limitation: pathophysiologic mechanisms. *Am J Respir Crit Care Med*. 1997; 155(1):109–115. [PubMed: 9001298]
15. Ofir D, Laveneziana P, Webb KA, Lam YM, O'Donnell DE. Mechanisms of dyspnea during cycle exercise in symptomatic patients with GOLD stage I chronic obstructive pulmonary disease. *Am J Respir Crit Care Med*. 2008; 177(6):622–629. [PubMed: 18006885]

16. Casaburi R, Porszasz J. Reduction of hyperinflation by pharmacologic and other interventions. *Proc Am Thorac Soc*. 2006; 3(2):185–189. [PubMed: 16565430]
17. Hill K, Vogiatzis I, Burtin C. The importance of components of pulmonary rehabilitation, other than exercise training, in COPD. *Eur Respir Rev*. 2013; 22(129):405–413. [PubMed: 23997066]
18. Tiep BL, Burns M, Kao D, Madison R, Herrera J. Pursed lips breathing training using ear oximetry. *Chest*. 1986; 90(2):218–221. [PubMed: 3731893]
19. Jensen W, Bialy L, Ketels G, Baumann FT, Bokemeyer C, Oechsle K. Physical exercise and therapy in terminally ill cancer patients: a retrospective feasibility analysis. *Support Care Cancer*. 2014; 22(5):1261–1268. [PubMed: 24317851]
20. Tiep BL. Disease Management of COPD With Pulmonary Rehabilitation. *CHEST Journal*. 1997; 112(6):1630.
21. Celli BR, MacNee W, Force AET. Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. *Eur Respir J*. 2004; 23(6):932–946. [PubMed: 15219010]
22. Tiep B, Carter R, Zachariah F, et al. Oxygen for end-of-life lung cancer care: managing dyspnea and hypoxemia. *Expert Rev Respir Med*. 2013; 7(5):479–490. [PubMed: 24138692]
23. Abernethy AP, McDonald CF, Frith PA, et al. Effect of palliative oxygen versus room air in relief of breathlessness in patients with refractory dyspnoea: a double-blind, randomised controlled trial. *Lancet*. 2010; 376(9743):784–793. [PubMed: 20816546]
24. Williams AC, Grant M, Tiep B, Kim JY, Hayter J. Dyspnea Management in Early Stage Cancer: A Palliative Perspective. *J Hosp Palliat Nurs*. 2012; 14(5):341–342. [PubMed: 24058283]
25. Glatki GP, Manika K, Sichletidis L, Alexe G, Brenke R, Spyrtos D. Pulmonary rehabilitation in non-small cell lung cancer patients after completion of treatment. *Am J Clin Oncol*. 2012; 35(2): 120–125. [PubMed: 21378541]
26. Daniel M, Keefe FJ, Lyna P, et al. Persistent smoking after a diagnosis of lung cancer is associated with higher reported pain levels. *J Pain*. 2009; 10(3):323–328. [PubMed: 19254679]
27. Bausewein C, Booth S, Gysels M, Kuhnrich R, Haberland B, Higginson IJ. Understanding breathlessness: cross-sectional comparison of symptom burden and palliative care needs in chronic obstructive pulmonary disease and cancer. *J Palliat Med*. 2010; 13(9):1109–1118. [PubMed: 20836635]
28. Henoch I, Bergman B, Danielson E. Dyspnea experience and management strategies in patients with lung cancer. *Psychooncology*. 2008; 17(7):709–715. [PubMed: 18074408]
29. Wadell K, Webb KA, Preston ME, et al. Impact of pulmonary rehabilitation on the major dimensions of dyspnea in COPD. *COPD*. 2013; 10(4):425–435. [PubMed: 23537344]
30. Mishra SI, Scherer RW, Snyder C, Geigle PM, Berlanstein DR, Topaloglu O. Exercise interventions on health-related quality of life for people with cancer during active treatment. *Cochrane Database Syst Rev*. 2012; 8:CD008465. [PubMed: 22895974]
31. Hui D, Morgado M, Vidal M, et al. Dyspnea in hospitalized advanced cancer patients: subjective and physiologic correlates. *J Palliat Med*. 2013; 16(3):274–280. [PubMed: 23398052]
32. Schwartzstein RM, Lahive K, Pope A, Weinberger SE, Weiss JW. Cold facial stimulation reduces breathlessness induced in normal subjects. *Am Rev Respir Dis*. 1987; 136(1):58–61. [PubMed: 3605841]
33. Malik FA, Gysels M, Higginson IJ. Living with breathlessness: a survey of caregivers of breathless patients with lung cancer or heart failure. *Palliat Med*. 2013; 27(7):647–656. [PubMed: 23703238]
34. Dimeo F, Fetscher S, Lange W, Mertelsmann R, Keul J. Effects of aerobic exercise on the physical performance and incidence of treatment-related complications after high-dose chemotherapy. *Blood*. 1997; 90(9):3390–3394. [PubMed: 9345021]
35. Adamsen L, Midtgaard J, Andersen C, Quist M, Moeller T, Roerth M. Transforming the nature of fatigue through exercise: qualitative findings from a multidimensional exercise programme in cancer patients undergoing chemotherapy. *Eur J Cancer Care (Engl)*. 2004; 13(4):362–370. [PubMed: 15305905]
36. Pasqua F, D'Angelillo R, Mattei F, et al. Pulmonary rehabilitation following radical chemoradiation in locally advanced non surgical NSCLC: Preliminary evidences. *Lung Cancer*. 2012; 76(2):258–259. [PubMed: 22386840]

37. Tarumi S, Yokomise H, Gotoh M, et al. Pulmonary rehabilitation during induction chemoradiotherapy for lung cancer improves pulmonary function. *J Thorac Cardiovasc Surg.* 2015; 149(2):569–573. [PubMed: 25451483]
38. Chan CW, Richardson A, Richardson J. Managing symptoms in patients with advanced lung cancer during radiotherapy: results of a psychoeducational randomized controlled trial. *J Pain Symptom Manage.* 2011; 41(2):347–357. [PubMed: 21131165]
39. Wong CJ, Goodridge D, Marciniuk DD, Rennie D. Fatigue in patients with COPD participating in a pulmonary rehabilitation program. *Int J Chron Obstruct Pulmon Dis.* 2010; 5:319–326. [PubMed: 21037955]
40. Meek PM, Lareau SC. Critical outcomes in pulmonary rehabilitation: assessment and evaluation of dyspnea and fatigue. *J Rehabil Res Dev.* 2003; 40(5 Suppl 2):13–24. [PubMed: 15074450]
41. Nazarian J. Cardiopulmonary rehabilitation after treatment for lung cancer. *Curr Treat Options Oncol.* 2004; 5(1):75–82. [PubMed: 14697159]
42. Maguire R, Papadopoulou C, Kotronoulas G, Simpson MF, McPhelim J, Irvine L. A systematic review of supportive care needs of people living with lung cancer. *Eur J Oncol Nurs.* 2013; 17(4): 449–464. [PubMed: 23246484]
43. Koczywas M, Williams AC, Cristea M, et al. Longitudinal changes in function, symptom burden, and quality of life in patients with early-stage lung cancer. *Ann Surg Oncol.* 2013; 20(6):1788–1797. [PubMed: 23143593]
44. Higginson IJ, Bausewein C, Reilly CC, et al. An integrated palliative and respiratory care service for patients with advanced disease and refractory breathlessness: a randomised controlled trial. *Lancet Respir Med.* 2014; 2(12):979–987. [PubMed: 25465642]
45. MacDonald N. Cancer cachexia and targeting chronic inflammation: a unified approach to cancer treatment and palliative/supportive care. *J Support Oncol.* 2007; 5(4):157–162. discussion 164–156, 183. [PubMed: 17500503]
46. O'Driscoll M, Corner J, Bailey C. The experience of breathlessness in lung cancer. *Eur J Cancer Care (Engl).* 1999; 8(1):37–43. [PubMed: 10362952]
47. Yennurajalingam S, Chisholm G, Palla SL, Holmes H, Reuben JM, Bruera E. Self-reported sleep disturbance in patients with advanced cancer: Frequency, intensity, and factors associated with response to outpatient supportive care consultation - A preliminary report. *Palliat Support Care.* 2013:1–9.
48. Reticker AL, Nici L, ZuWallack R. Pulmonary rehabilitation and palliative care in COPD: Two sides of the same coin? *Chron Respir Dis.* 2012; 9(2):107–116. [PubMed: 22498494]
49. Marciniak CM, Sliwa JA, Spill G, Heinemann AW, Semik PE. Functional outcome following rehabilitation of the cancer patient. *Arch Phys Med Rehabil.* 1996; 77(1):54–57. [PubMed: 8554474]
50. Shannon VR. Role of pulmonary rehabilitation in the management of patients with lung cancer. *Curr Opin Pulm Med.* 2010; 16(4):334–339. [PubMed: 20531082]
51. Rivas-Perez H, Nana-Sinkam P. Integrating pulmonary rehabilitation into the multidisciplinary management of lung cancer: A review. *Respir Med.* 2015

Table 1
Components of Pulmonary Rehabilitation and Team members

<ul style="list-style-type: none">• Assist the patient to understand the disease, its course, and their ability to change that course• Teach the patient about the anatomy and physiology of pulmonary function• Encourage the patient to live an active life, including daily exercise• Urge the patient to cease smoking• Teach the patient about upper and lower extremity exercise training• Encourage the patient to understand and express their feelings• Suggest ways for the patient to eliminate or cope with insomnia• Discuss how the patient communicates with physicians• Discuss daily rituals prescription for home – long-term management, including:<ul style="list-style-type: none">– Breathing retraining– Medications, bronchodilators, inhaled steroids, oral medications– Clearing secretions– Oxygen– Daily exercise– Prevent flare-ups– Rapid action plan for flare-ups• Encourage the patient to join a patient support group• Stress the importance of completing advance directives
<p>Pulmonary Rehabilitation Team</p> <ul style="list-style-type: none">• Physician• Nurse• Respiratory therapist• Physical therapist• Occupational therapist• Social worker• Dietitian/nutritionist• Psychologist

Table 2
Benefits of Pulmonary Rehabilitation

- Reduced dyspnea
- Less fatigue
- Improved strength and endurance
- Increased self-efficacy
- Decreased depression and anxiety
- Greater ability to live an active lifestyle
- Enhanced ability to perform activities of daily living
- Better self-management
- Optimize pharmacotherapy
- Better adherence to oxygen therapy
- Facilitate smoking cessation (Paone)
- Improved quality of life
- Prevention of exacerbations
- Ability to recognize and treat exacerbations in early stages
- Better able to enjoy leisure activities
- Some patients may be able to go back to work

Source: 12, 27