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Effect of the self-efficacy-enhancing active cycle of breathing technique on lung cancer patients with lung resection: A quasi-experimental trial

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ABSTRACT

Purpose: Enhancing self-efficacy during the active cycle of breathing technique is essential for realizing the full benefit of pulmonary rehabilitation among lung cancer patients. This study aimed to explore the effect of self-efficacy-enhancing active cycle of breathing technique (SEE-ACBT) among patients with lung resection.

Method: A quasi-experimental trial with a pre-post test design was performed. The control group (n = 81) received routine perioperative care, and the intervention group (n = 81) received SEE-ACBT in addition to routine perioperative care. The primary outcome measure was 24-h wet sputum weight. Other outcomes included the 6-min walk test (6MWT), Borg scale, postoperative pulmonary complications (PPC), exercise self-efficacy, hospitalization cost, duration of oxygen inhalation, and days of postoperative hospital stay.

Results: The sputum weight in the intervention group gradually increased from postoperative day 1, day 2, to day 3 and was significantly higher than that of the control group on day 2 and day 3 ($P = 0.000$). An average of ¥5047 (US$ 767.6) in hospitalization costs was saved in the intervention group ($P = 0.003$). Exercise self-efficacy (79. 0 VS 71.7,$P = 0.006$), 6MWT (471.8 m VS 371.6 m,$P = 0.000$), and duration of oxygen inhalation (33.9 h VS 53.1 h, $P = 0.000$) among patients in the intervention group improved significantly compared with the control group. No significant differences in PPC and days of postoperative hospital stay were found.

Conclusions: SEE-ACBT is an effective and economical short-term pulmonary rehabilitation method. Pulmonary rehabilitation should focus on increasing motivational behaviours. Further studies should be implemented to explore the long-term effects of SEE-ACBT.

1. Introduction

Lung cancer has the highest morbidity and mortality of cancers worldwide and is the primary cause of death in male cancer patients (Rueda et al., 2011). Potential curative resection has become the most effective treatment for patients diagnosed with early non-small cell lung cancer. Weak respiratory muscles and sputum retention have been suggested as contributors to the development of a higher incidence of postoperative pulmonary complications (PPC) (Welvaart et al., 2011), which has a reported rate of 19–59% (Garcia-Miguel et al., 2003). Pneumonia and atelectasis are the most common complications. PPC is associated with a worse long-term outcome after thoracic surgery and contributes to a significant increase in health care costs and duration of hospital stay (Lugg et al., 2016). Many physiotherapists have attempted to improve this situation, for example, by applying incentive spirometry (Agostini et al., 2013) and exercise therapy (Pouwels et al., 2015). These physiotherapies are common and effective long-term rehabilitation methods for lung cancer patients; however, they are time-consuming, and the extended preoperative exercise programmes associated with them may delay the date of surgery (Sommer et al., 2016).

The active cycle of breathing technique (ACBT) is a short-term secretion clearance technique (Lewis et al., 2012) derived from the forced expiration technique, which consists of breathing control and huff. A typical ACBT cycle consists of breathing control, thoracic expansion exercises and the forced expiration technique. The frequency of ACBT is flexible, but all parts of the cycle must be included and interspersed with breathing control. ACBT provides short-term improvement of secretion clearance that corresponds to postoperative fast-track recovery for lung resection. However, according to our previous study (Zhong et al., 2016), patients were reluctant to perform the breathing exercise because of pain, weakness, diffidence, or overdependence; sometimes, they did not realize the benefits of the active breathing exercise.

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Therefore, enhancing their exercise confidence is crucial to overcoming the barriers of administering ACBT.

Bandura defined self-efficacy as confidence in one's ability to perform certain actions in specific situations (Bandura, 1997). According to Bandura's self-efficacy theory, the development of self-efficacy is determined by four key information sources: direct mastery experience, vicarious experience, verbal persuasion and emotional arousal. Exercise self-efficacy is defined as a person's confidence in his or her capability to perform specific physical activities under specific circumstances (Bandura, 1997). Exercise self-efficacy has been demonstrated to be an influential predictor of physical activity, and people who have higher self-efficacy expectations acquire a greater sense of energy, reduced effort, a more positive affect, and a more revitalized feeling during and after physical activity (Lee et al., 2008). Pulmonary rehabilitation is not limited to exercise training; it also includes health education and behaviour changes to promote long-term adherence to health-enhancing behaviour (Spruit et al., 2013). Self-efficacy-based pulmonary rehabilitation is recommended for promoting behaviour changes to improve health status (Bentsen et al., 2010; Benzo et al., 2011).

We conducted a quasi-experimental trial to evaluate the effect of the self-efficacy-enhancing active cycle of breathing technique (SEE-ACBT) on patients with curable lung resection. The primary hypothesis was that patients who received the SEE-ACBT treatment would show more sputum clearance, improvements in the 6-min walk test (6MWT) and decreased PPC compared with the control group. Other outcomes, including the exercise self-efficacy score, hospitalization costs, duration of oxygen inhalation, and days of postoperative hospital stay, were also studied.

2. Methods

2.1. Study design

We conducted a quasi-experimental trial with a pre-post test design. We allocated patients to the control group or intervention group according to their time of admission. Patients who were admitted to hospital from September 2016 to December 2016 were assigned to the control group and patients admitted from January 2017 to April 2017 were allocated to the intervention group. The patients in the control group received routine perioperative care, and the patients in the intervention group received SEE-ACBT in addition to routine perioperative care.

2.2. Participants

Eligible participants who were awaiting resectable lung cancer surgery were recruited from the thoracic surgery department of a cancer centre in Guangzhou, China. The inclusion criteria were as follows: scheduled for resectable lung cancer surgery after meeting the diagnostic criterion of lung cancer; aged at least 18 years; able to read and understand Chinese. The exclusion criteria were as follows: could not complete the 6MWT or the allocated ACBT exercise (e.g., due to disability or other comorbidities); had cancer metastasis; had lung cancer combined with other advanced cancer; had undergone a total pneumonectomy; or had any psychiatric disorder or cognitive impairment diagnosed by mental health professionals.

2.3. Sample size

Considering that few studies have examined the use of ACBT in lung cancer patients, we conducted a preliminary experiment with 15 patients per group. The sample size was calculated using multiple outcomes testing. Among the multiple outcomes, the smallest clinically significant difference in wet sputum weight in g was 11.9 g, with a standard deviation (SD) of 29.32 g. Finally, we obtained the largest sample size based on the primary outcome of wet sputum weight. We estimated a dropout rate of approximately 20% with 80% power and 5% significance and determined that a sample size of 80 per group was needed.

2.4. Ethical consideration

Ethical approval was obtained from Ethics Committee of the University and the Cancer Centre before the study was conducted. The researchers approached eligible participants to explain the study aims and collect their informed consent. The patients were informed that they could withdraw from the study at any time without influencing their future treatment and care.

2.5. Intervention

The patients in the control group received routine perioperative breathing exercise, including deep breathing and effective cough exercise. The primary nurses taught the patients routine breathing exercises on the first day of admission and the day before surgery and in the morning of each postoperative day, and encouraged them to deliver 3–5 times a day.

The patients in the intervention group received SEE-ACBT in addition to routine perioperative care. The ACBT consisted of breathing control, thoracic expansion exercises, and the forced expiration technique, interspersed with breathing control, as shown in Table 1. The patients assumed a relaxed seated or reclined position before starting. Fig. 1 presents the intervention cycle. The patients were encouraged to repeat the cycle 3–5 times as tolerated and to perform more cycles if they felt the secretion was sufficiently high in the proximal airways, and each session lasted 15–20 min. The self-efficacy-enhancing intervention was designed to promote self-efficacy for the ACBT exercise (Bentsen et al., 2010; Larson et al., 2014; Zhang et al., 2014) using four key information sources - direct mastery experience, vicarious experience, verbal persuasion and emotional arousal – which were provided during the ACBT training session. Table 2 presents the strategies used in the self-efficacy-enhancing intervention.

SEE-ACBT was conducted by 2 senior oncology nurses who had more than 10 years of experience caring for lung cancer patients. Both the nurses participated in 2 training sessions with the researchers before the study. The researchers placed some posters of ACBT on the ward in advance of the study. The patients in the intervention group first received a booklet that emphasized how to perform the ACBT exercises and improve their exercise self-efficacy (including some vivid, easily understood pictures of ACBT). The booklet and poster were used to help the patients master the ACBT skills and to remind the patients to exercise. A face-to-face intervention involving groups of 3–5 patients was provided before surgery, and the patients were encouraged to

Table 1
Active cycle of breathing technique procedure.

Breathing control	Slow, deep breathing; inhaling through the nose and holding for 1–3 s, then exhaling through pursed lips from mid-to-low lung volume (to clear the secretion from the peripheral airways) using diaphragmatic breathing. Repeat this procedure for several minutes.
Thoracic expansion exercise	Active, deep inspiration with passive, relaxed exhalations, with or without breath holding.
Forced expiration technique	As you sense the secretion entering the larger central airway, breathe in normally and squeeze the secretion out by contracting the abdominal and chest wall muscles while holding the mouth and glottis open and whispering the word “huff” (sounds similar to a forced sigh) during exhalation. Perform 2–3 huffs, starting at low volume, followed by 2–3 huffs at a higher volume, followed by relaxed breathing control.