



Impact on quality of life after vagus nerve and phrenic nerve guided systematic nodal dissection for non-small cell lung cancer patients: a prospective, single-arm clinical trial

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Background: Patients with non-small cell lung cancer (NSCLC) suffer a decrease in quality of life (QOL) after receiving curative lobectomy and mediastinal lymph node dissection via video-assisted thoracoscopic surgery (VATS). We aimed to explore the preliminary influence of our modified approach called the duo-nerve-guided systematic nodal dissection (SND) on patients' QOL.

Methods: Between October 2018 and March 2019, 21 patients were enrolled from the First Affiliated Hospital of Sun Yat-sen University and received curative lobectomy and duo-nerve-guided SND for clinical stage I to IIIA NSCLC. Participants' QOL was evaluated by Functional Assessment of Cancer Therapy-Lung (FACT-L) questionnaire before operation and at 1- and 3-month postoperatively.

Results: The overall QOL scores at 1 month after surgery were significantly lower than those before surgery (116.13 *vs.* 126.63, $P=0.001$), while there was no significant difference in the overall QOL score between preoperative and 3 months after surgery. In particular, among the 5 subscales, physical well-being (PWB), functional well-being (FWB), and trial outcome index (TOI) significantly declined at 1 month after surgery. However, each subscale showed significant improvement at 3 months after operation compared with that at 1 month and basically returned to the level at baseline. In addition, there was a significant improvement in the emotional well-being (EWB) domain 3 months after surgery (23.00 *vs.* 18.00, $P=0.001$).

Conclusions: As evidenced by patients' QOL at 3 months after receiving duo-nerve-guided SND being not significantly different from that at baseline, the improved SND procedure has positive effects on the fast recovery of NSCLC patients.

Keywords: Non-small cell lung cancer (NSCLC); quality of life (QOL); vagus nerve; phrenic nerve; lymph node dissection

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Introduction

Lung cancer is the leading cause of death among cancer patients in China (1). According to the European Society of Thoracic Surgeons (ESTS) guideline for lung

cancer resection, systematic nodal dissection (SND) is recommended for most operable non-small cell lung cancer (NSCLC) patients so as to ensure complete resection (2). Video-assisted thoracoscopic surgery (VATS) has

been widely used in radical resection of NSCLC for its shorter hospital stay (3) and lower incidence of related pain (4) compared with thoracotomy. However, the short (1–3 months)- and long-term (12 months) quality of life (QOL) of patients receiving VATS have been significantly affected, especially in terms of physical condition (5). Nerve injury is one of the major causes that lead to the deterioration of QOL (6,7). Persistency of nerve injury-related symptoms such as persistent cough greatly affect patients' QOL. Previous several reports have speculated that C-fibers arising from vagal afferent nerve play an important role in regulating cough reflex (7,8).

Though previous studies have emphasized the importance of nerve preservation during lung cancer surgery and provided useful techniques, most of these studies have been case reports or retrospective analyses (6,9,10). Some articles have put forward the ideas of surgical modification and nerve protection (11); however, prospective evaluation of the clinical efficacy of the modified procedure has been rarely conducted.

We previously established a modified procedure called the duo-nerve-guided SND that emphasizes preserving the vagus and phrenic nerves during lymph node dissection. We divided mediastinal lymph nodes into 3 areas according to the anatomical site of the two nerves, and dissected the lymph nodes in these 3 areas separately (12). This modified procedure may reduce symptoms such as persistent cough and dyspnea and enhance recovery of QOL. However, further exploration and analysis of the influence of our modified approach on patients' QOL have not been carried out. By comparing changes in QOL scores between preoperative and postoperative 1 and 3 months, we aimed to explore the preliminary influence of our modified approach on patients' QOL. We present the following article in accordance with the TREND reporting checklist (available at <https://dx.doi.org/10.21037/atm-21-5820>).

Methods

Study design and participants

We conducted this prospective, single-arm pilot study at the First Affiliated Hospital of Sun Yat-sen University. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee and Institutional Review Board of

Guangdong Association Study of Thoracic Oncology (No. A2018-006) and informed consent was taken from all the patients. The study protocol was registered in the Chinese Clinical Trial Registry (Identifier: ChiCTR1800018461)

The patient eligibility criteria were as follows: (I) aged 18–75 years; (II) without preoperative neoadjuvant chemoradiotherapy; (III) scheduled for thoracoscopic radical resection of lung cancer with SND; (IV) an Eastern Cooperative Oncology Group (ECOG) performance status score of 0 or 1. The exclusion criteria were as follows: (I) a history of other malignant tumor in 5 years prior to this study; (II) HIV seropositive; (III) pregnant or lactating; (IV) tumor mixed with small-cell lung cancer; (V) a history of neurological or psychiatric disorders, including epilepsy or dementia. The withdrawal criteria included: (I) histopathological confirmation of non-R0 resection of NSCLC intraoperatively or postoperatively; (II) final diagnosis was not NSCLC; (III) failure to complete the questionnaire as requested in the protocol.

Preoperative data collection

Preoperative evaluation was conducted including computed tomography (CT) scans of the chest. Additional CT scans of the abdomen along with magnetic resonance imaging (MRI) of the head would be used to exclude distant metastasis or could be replaced by positron emission tomography-computed tomography (PET-CT) scan. Endobronchial ultrasonography (EBUS) was conducted if necessary, but was not routinely used. All participants were staged according to the 8th edition of the American Joint Committee on Cancer (AJCC) lung cancer staging classification (13). Patients were enrolled in the study 1 or 2 days before their surgery and completed the questionnaire for assessment of QOL.

Outcome measures

The Functional Assessment of Cancer Therapy-Lung (FACT-L) questionnaire was used to evaluate QOL (Appendix 1). The simplified Chinese version of FACT-L is of good reliability, validity, and responsiveness for patients with lung cancer in China (14). The FACT-L consists of 36 items with 5 subscales to measure the QOL of patients with lung cancer in the past 7 days. Each subscale uses a Likert scale of 0 to 4, with 0 indicating “not at all” and 4 “very much”. The 5 subscales are: emotional well-being (EWB; 6 items), functional well-being (FWB; 7 items),

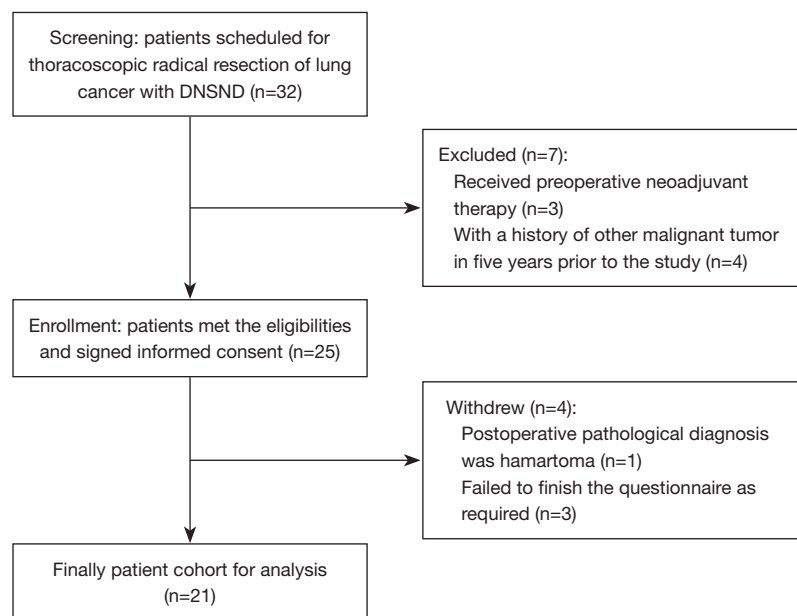


Figure 1 Flowchart of the study. DNSND, duo-nerve-guided systematic nodal dissection.

physical well-being (PWB; 7 items), and social well-being (SWB; 7 items), and lung cancer subscale (9 items). Trial outcome index (TOI) was the sum of FWB, PWB, and lung cancer subscale. The score of the QOL was the sum of all items, with higher scores representing better QOL. Some of the items need to be reversely coded for the calculation. These reverse coding questions are similar to setting some trap questions which can prevent patients making obvious logic errors in finishing the questionnaires.

To ensure that the range of scores of each domain would be equivalent to scores for the complete measurement, the 4 subscales scores (PWB, SWB, EWB, FWB) were prorated. For example, the PWB subscale has 7 items and if only 6 were answered, the prorated score for the PWB would be computed by multiplying the sum of individual PWB items by 7 and then dividing the sum by 6 (15).

Surgery and postoperative follow-up

All patients included in our study received duo-nerve-guided SND during the surgery (12). Participants returned to the hospital for their regular visits at 1- and 3-month after the surgery during which they were asked to complete a follow-up paper-based FACT-L questionnaire. Data on demographic characteristics, lifestyle, operative information, and clinical outcomes of the eligible participants were collected.

Statistical analysis

Characteristics of participants were presented as means and standard deviations for continuous variables and frequencies and percentages for categorical variables. The scores of QOL were non-normally distributed, and we use the median to represent scores of QOL. Wilcoxon matched-pairs signed-rank tests were performed to compare the differences between preoperative baseline QOL scores and those at 1- and 3-month time points for the overall and subscales of QOL. Statistical significance was considered when P value <0.05. The analyses were performed using SPSS version 22 (IBM-SPSS, Inc., Armonk, NY, USA).

Results

Overview of the trial and Patients' characteristics

Between 8 October 2018 and 31 March 2019, 32 patients were screened for eligibility, and 25 eligible patients were enrolled after signing informed consents. There were 4 patients who withdrew from the study, among whom, 3 failed to finish the questionnaire as required and 1 was diagnosed with hamartoma according to the postoperative pathological examination. Eventually, 21 patients were included in the final analysis (*Figure 1*).

Among the 21 participants, the mean age was 56.43 ± 10.05 years and 52.4% (11/21) of them were male.

Table 1 Clinical characteristics of the 21 patients who underwent curative lobectomy and duo-nerve-guided SND for NSCLC (n=21)

Variable	Number of patients (%)
Age	56.43±10.05
Gender	
Male	11 (52.4)
Female	10 (47.6)
Smoking	
Yes	9 (42.8)
No	12 (57.2)
BMI	
<18	1 (4.8)
18–23	8 (38.1)
>23	12 (57.1)
Tumor location	
RUL	8 (38.1)
RML	2 (9.5)
RLL	1 (4.8)
LUL	2 (9.5)
LLL	8 (38.1)
Histology	
Squamous cell carcinoma	2 (9.5)
Adenocarcinoma	17 (81.0)
Other type	2 (9.5)
Preoperative TNM stage	
T stage	
T1	13 (61.9)
T2	7 (33.3)
T3	1 (4.8)
N stage	
N0	16 (76.2)
N1	1 (4.8)
N2	4 (19.0)
Clinical stage	
I	15 (71.4)
II	2 (9.5)
III	4 (19.1)

Data presented as the number of patients or mean ± standard deviation. Figures in parentheses indicate percentage. SND, systematic nodal dissection; NSCLC, non-small cell lung cancer; BMI, body mass index; TNM, tumor, node metastasis; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; LUL, left upper lobe; LLL, left lower lobe.

Table 2 Postoperative clinical data of the 21 patients who received the new procedure

Variable	Value
Operation duration (min)	159.57±44.2
Blood loss (mL)	55.42±25.41
Chest tube retention time (day)	3.67±1.32
Postoperative hospital stay (day)	3.81±0.93
Number of upstaging	7 (33.3)
Number of dissected lymph nodes	28.86±11.36

Data presented as the number of patients or mean ± standard deviation. Figures in parentheses indicate percentage.

A total of 9 participants (42.8%) were current smokers. Participants were diagnosed as T1 (61.9%), T2 (33.3%), and T3 (4.8%) preoperatively. A total of 16 participants were diagnosed as N0 preoperatively, while others were diagnosed as N1 (1/21), and N2 (4/21) respectively (*Table 1*). The mean operation duration, blood loss during surgery, chest tube retention time, and postoperative hospital stay were 159.57±44.2 min, 55.42±25.41 mL, 3.67±1.32 d, and 3.81±0.93 d, respectively (*Table 2*).

QOL

Results of pre- and post-comparisons of QOL and its domains [physical status, social and family conditions, emotion status, functional status, lung cancer subscale (LCS), TOI] between baseline and the 1-month follow-up and between baseline and the 3-month follow-up are presented in *Figure 2*. The overall score of the QOL declined significantly at 1 month after surgery (126.63 vs. 116.13, P=0.001). There was no significant difference in the overall QOL score between 3 months after surgery and the baseline (126.63 vs. 131.17, P=0.001). The scores of the subscales PWB (27.00 vs. 23.00, P=0.002), FWB (25.00 vs. 20.00, P=0.001), and TOI (80.50 vs. 72.00, P=0.001) were significantly reduced from baseline to 1 month after surgery, whereas these scores were significantly improved at 3 months after surgery compared to 1 month after surgery. There were no significant differences between baseline and the 3-month follow-up in the scores of PWB (27.00 vs. 26.00, P=0.812), FWB (25.00 vs. 23.00, P=0.396), and TOI (80.50 vs. 82.50, P=0.614). In addition, there was a significant improvement in the EWB domain at 3 months

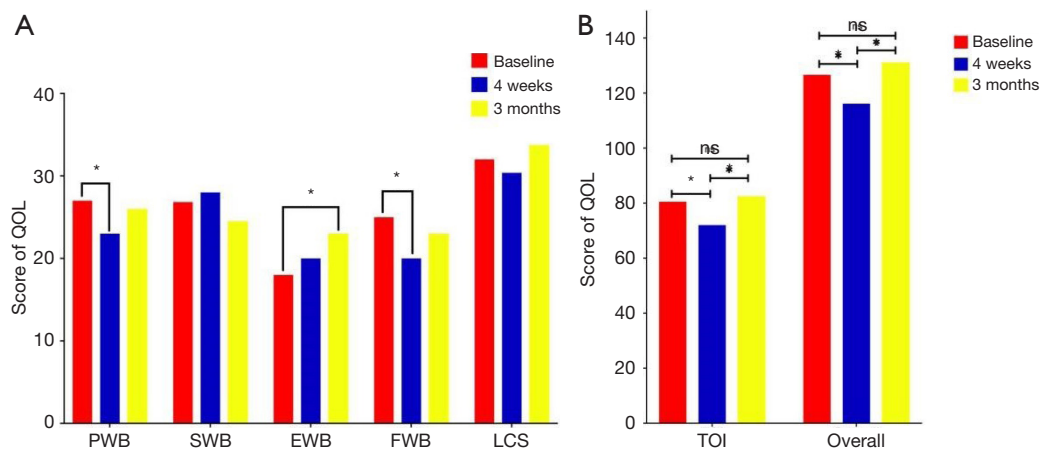


Figure 2 Comparison between preoperative and postoperative score change of FACT-L. *, P value is calculated by Wilcoxon matched-pairs signed-ranks test between preoperative score and 4 weeks postoperative score, preoperative score and 3 months postoperative score, indicates $P < 0.05$. QOL, quality of life; PWB, physical well-being; SWB, social well-being; EWB, emotional well-being; FWB, functional well-being; LCS, lung cancer subscale; TOI, trial outcome index; FACT-L, Functional Assessment of Cancer Therapy-Lung.

Table 3 Changes of the detailed items in the FACT-L questionnaire

Detailed items in FACT-L	Preoperative baseline		Postoperative 1 month		Postoperative 3 months	
	Mean value		Mean value	P value*	Mean value	P value*
Pain	3.48		2.71	0.034*	3.43	0.564
Fatigue	3.57		2.86	0.026*	3.62	1.000
Worry about getting worse	2.43		2.71	0.437	3.33	0.005*
Nervous	2.90		3.29	0.201	3.71	0.009*
Proud of coping with the illness	3.14		3.05	0.809	3.86	0.008*
Fear of death	2.62		2.86	0.418	3.43	0.017*
Dyspnea	3.57		3.10	0.039*	3.57	1.000
Coughing	3.14		2.48	0.046*	3.48	0.088
Anorexia	3.67		3.24	0.047*	3.67	0.861

The mean values in the table have positive conversion, and higher scores represent better QOL; P value*: The changes between baseline and postoperative 1-month QOL score were statistically significant or the changes between baseline and postoperative 3 months QOL score were statistically significant; P value is calculated by Wilcoxon matched-pairs signed-ranks test. FACT-L, Functional Assessment of Cancer Therapy-Lung; QOL, quality of life.

after surgery compared to the baseline (18.00 *vs.* 23.00, $P = 0.001$).

Changes in the scores of specific items in FACT-L questionnaires

To identify specific changes in QOL and its dimensions, we analyzed the changes of scores in each item in the

questionnaire, as shown in *Table 3*. In the PWB domain, there were significant decreases in the scores of items related to “pain” and “fatigue” at 1 month after surgery (3.48 *vs.* 2.71, $P = 0.034$; 3.57 *vs.* 2.86, $P = 0.026$, respectively). However, there was no significant difference in the above items between baseline and the 3-month follow-up. As to the subscale of EWB, scores of items including “worry about getting worse”, “fear of death”, and “proud of coping

with the illness” did not change significantly at 1 month after surgery, but significantly improved at 3 months after surgery compared to the baseline (2.43 *vs.* 3.33, $P=0.005$; 2.62 *vs.* 3.43, $P=0.017$; 3.14 *vs.* 3.86, $P=0.008$, respectively). In the LCS domain, scores for “shortness of breath”, “cough”, and “anorexia” decreased significantly at 1 month after surgery (3.57 *vs.* 3.10, $P=0.039$; 3.14 *vs.* 2.48, $P=0.046$; 3.67 *vs.* 3.24, $P=0.047$), whereas there was no significant difference in scores between baseline and the 3-month follow-up.

Discussion

This study explored the preliminary effects of the modified mediastinal lymph node dissection along the vagus nerve and phrenic nerve on the QOL of patients undergoing radical resection of NSCLC. We found that the score of overall and most dimensions of QOL of the participants had significantly deteriorated 1 month following the surgery, but returned back to the baseline at 3 months after surgery.

The overall QOL deteriorated significantly from baseline to the 1-month follow-up, especially in physical conditions. This result was consistent with previous studies about the impact of VATS lobectomy on patients’ QOL (5). Factors such as pain, anorexia, dyspnea, and fatigue are considered as the major causes of the lower QOL among NSCLC post-surgery (5,16). In our study, most of the dimensions of the QOL basically returned back to the level at preoperative baseline 3 months after surgery. Previous studies have reported that the QOL failed to return to the baseline level at 3 months, even at 6 months or to 1 year after surgery, especially in their physical well-being domains (5,17). Findings from our study indicate that our modified procedure significantly accelerate patient recovery of postoperative QOL. Reasons for the fast recovery might be that the modified procedure tackled some important factors preventing postoperative recovery of patients’ QOL such as persistent symptoms of dyspnea (58%), fatigue (69%), and cough (42%) (5,18-20), which were reported to be related to the injury of vagus and phrenic nerves. Phrenic nerve palsy after lobectomy can significantly reduce lung volume, which directly leads to significant reduction of respiratory parameters of forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) (21). Dysfunction of vagus nerve can lead to postoperative shortness of breath, chest tightness, and other respiratory symptoms (22-24). Furthermore, damage of the pulmonary C-fibers which derive from the vagus nerve can result in

postoperative persistent cough (7). The duo-nerve-guided SND implemented in this trial focused on preserving these two nerves so as to alleviate the symptoms mentioned above, which may enhance fast recovery of postoperative QOL.

Results of this study showed significant improvement in patients’ emotional well-being 3 months after surgery compared to that at the baseline, indicating a potentially positive impact of the modified procedure on patients’ emotional improvement. By contrast, previous studies showed no statistically significant improvement in EWB in patients with conventional SND, which might be due to the combined effects of intensified pain and limited daily activities post-operatively (25). From the itemized analysis of the EWB domain, we found that patients’ fear of death and worry about the deterioration of their physical conditions were significantly reduced compared with those before the operation, which might be due to the fewer postoperative complications and enhanced recovery (12). Meanwhile, the score of “coping with disease” significantly increased compared with that before surgery, suggesting that the psychological burden of participants may have been reduced and the subjective experience of coping with the disease significantly improved. The faster and enhanced recovery with fewer physical complications after surgery using the modified procedure were accompanied with significant improvement in participants’ mental health, which showed a great potential of this modified procedure with positive impacts on both physical and mental well-beings of patients.

There were still some limitations in our study. First, this was a pilot study with a limited sample size that intended to explore the initial effects of a modified and innovative procedure on patients’ postoperative recovery. The measuring tools are relatively simple. Following studies will use more assessment methods to make further confirmation. Results of this study need to be interpreted with caution. Second, this was a single-arm trial without a control group. To confirm the effects and provide conclusive evidence, a multi-center fully powered randomized controlled trial (RCT) is needed to compare the effects of this modified procedure with those of the current surgical procedure.

Conclusions

In this study, we found that duo-nerve-guided SND had a significant and positive effect on postoperative QOL in patients with NSCLC at 3 months after surgery. A future RCT with a larger sample size is needed to further confirm

the effects of this procedure in improving patients' QOL and its correlation with neuroprotection.

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Footnote

Reporting Checklist: The authors have completed the TREND reporting checklist. Available at <https://dx.doi.org/10.21037/atm-21-5820>

Data Sharing Statement: Available at <https://dx.doi.org/10.21037/atm-21-5820>

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://dx.doi.org/10.21037/atm-21-5820>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee and Institutional Review Board of Guangdong Association Study of Thoracic Oncology (No. A2018-006) and informed consent was taken from all the patients.

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Appendix 1 Functional Assessment of Cancer Therapy-Lung (FACT-L) questionnaire (simplified Chinese version)

FACT-L（第四版）生活质量评分量表

附录IV

下面罗列了大多数和您相同疾病的病人认为是重要的陈述。请选择最近 7 天来最能描述你的状况的数字。

		一点也不	有一点	有几分	颇有一些	非常多
日常活动						
GP1	我缺乏精力	0	1	2	3	4
GP2	我有呕吐	0	1	2	3	4
GP3	我不能胜任家庭的日常生活	0	1	2	3	4
GP4	我有疼痛	0	1	2	3	4
GP5	我被因治疗引起毒性反应所困扰	0	1	2	3	4
GP6	通常我很虚弱	0	1	2	3	4
GP7	我不得不卧床	0	1	2	3	4
社交/家庭生活						
GS1	我得到了朋友的亲近	0	1	2	3	4
GS2	我从家庭中得到精神支持	0	1	2	3	4
GS3	我得到了朋友的支持	0	1	2	3	4
GS4	我的家庭接受我的疾病	0	1	2	3	4
GS5	我对和家庭间关于病情的交流感到满意	0	1	2	3	4
GS6	我觉得和我的伴侣很亲近(或是我认为最重要的人)....	0	1	2	3	4
Q1	撇开您现在的性欲活动, 请您回答下面的问题。如果你不愿意回答, 请在这儿做个标记, <input type="checkbox"/> 回答下一个环节。					
GS7	我满意我的性生活	0	1	2	3	4

FACT-L（第四版）生活质量评分量表

请根据过去的7天您的情况，在每一行陈述中圈明最符合您的数字。

情绪		一点也不	有一点	有几分	颇有一些	非常多
GE1	我很悲伤	0	1	2	3	4
GE2	我很自豪我能面对疾病	0	1	2	3	4
GE3	在与疾病斗争中,我感到失望	0	1	2	3	4
GE4	我感到很紧张	0	1	2	3	4
GE5	我害怕死亡	0	1	2	3	4
GE6	我担心我的情况会变的更坏	0	1	2	3	4

活动能力		一点也不	有一点	有几分	颇有一些	非常多
GF1	我能工作（包括在家里进行的工作）	0	1	2	3	4
GF2	我工作得很充实（包括在家里工作）	0	1	2	3	4
GF3	我此时此刻还十分享受生活	0	1	2	3	4
GF4	我能接受我的疾病	0	1	2	3	4
GF5	我睡眠好	0	1	2	3	4
GF6	我进行以前的休闲活动	0	1	2	3	4
GF7	我目前很关心我的生活质量	0	1	2	3	4

FACT-L（第四版）生活质量评分量表

请根据过去的7天您的情况，在每一行陈述中圈明最符合您的数字。

其他因素		一点 也不	有一点	有几 分	颇有 一些	非常 多
B1	我感到气短	0	1	2	3	4
C2	我的体重在下降	0	1	2	3	4
L1	我思维清晰	0	1	2	3	4
L2	我有咳嗽	0	1	2	3	4
B5	我为脱发而烦恼	0	1	2	3	4
C6	我的食欲很好	0	1	2	3	4
L3	我感到胸闷	0	1	2	3	4
L4	我呼吸通畅	0	1	2	3	4
Q3	你曾吸烟吗 不 ___ 是 ___ 如果是请回答:					
L5	我对吸烟感觉后悔	0	1	2	3	4