Longitudinal Transition Patterns of Symptom Clusters and Health Outcomes in Patients with Lung Cancer Surgery

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

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Introduction: Lung cancer is the most prevalent cancers worldwide. The survival rate of lung cancer is gradually increasing to lung resection surgery. Despite surgery, patients suffer from various symptoms and symptom clusters (SxCls), highlighting the importance of identifying these changes over time. Further, these symptoms and SxCls negatively impact health outcomes in patients with lung cancer. Therefore, this study aimed to identify postoperative symptoms, the types of SxCls, and their transition patterns over time, and to investigate their impact on health outcomes at 12 weeks after surgery in patients with early-stage lung cancer who underwent lung resection.

Methods: This was a prospective longitudinal study conducted at the first outpatient clinic visit after discharge (T1), 4 weeks after surgery (T2), 8 weeks after surgery (T3), and 12

weeks after surgery (T4). At T1, data were collected through face-to-face self-reported surveys at the hospital, while from T2 to T4, data were collected using online surveys accessible via mobile phones. Inclusion criteria were age ≥ 19 years, with lung cancer diagnosed pathologically and underwent lung resection at a tertiary hospital in Seoul, South Korea. Symptoms were measured using the MD Anderson Symptom Inventory-Lung Cancer, which comprised of 16 symptoms, with higher scores indicating more severe symptoms. The health outcomes included quality of life (QOL) and return to care (RTC). QOL was measured using the Functional Assessment of Cancer Therapy-General, consisting of 27 items, with higher scores indicating a higher QOL. RTC included unplanned outpatient clinic visits, emergency department visits, and readmissions, as identified through the electronic medical records. Latent profile analysis was conducted to identify potential SxCls at each time point. Latent transition analysis was conducted to identify transition patterns of SxCls between T1 and T4. Linear and logistic regression analyses were conducted to identify factors associated with health outcomes. All data were analyzed using SPSS Statistics version 26, Mplus version 8.8, and R version 4.3.2.

Results: Of the 177 participants enrolled in this study, 163 at T1, 138 at T2, 120 at T3, and 101 at T4 were included in the data analysis. Participants had a mean age of 61.99 ± 9.61 years; 60.1% were women. The top five symptoms with high severity at T1 were fatigue, coughing, pain, shortness of breath, and drowsy. Among the 16 symptoms, fatigue had the highest severity at all four time points. Three types of SxCls were categorized according to the symptom severity scores at each time point: low SxCl, medium SxCl, and high SxCl.

Most participants were categorized in the low SxCl at all time points. Participants belonging to low and medium SxCls at T1 were likely to belong to the same type at T4. However, those with high SxCl at T1 were likely to belong to medium or high SxCls at T4. The transition patterns of SxCls between T1 and T4 were classified as stayers (50.5%), worsened movers (29.7%), and improved movers (19.8%). Participants' QOL score at T4 was a mean of 74.31 ± 17.15 out of 108. RTC occurred in 13 cases (8.4%) until T4; among them, unplanned outpatient clinic visits occurred the most. Lower QOL was significantly associated with the medium (B = –17.00, p < .001) and high SxCls (B = –26.85, p < .001). Worsened mover was significantly associated with lower QOL (B = –12.03, p < .001); improved mover was significantly associated with higher QOL (B = 11.58, p = .012). However, no significant factors were associated with the occurrence of RTC.

Conclusion: This longitudinal study was conducted by taking a person-centered approach to identify SxCls until 12 weeks after surgery in patients with early-stage lung cancer who underwent lung resection expected to have relatively mild symptoms. Some patients still experienced high-severity symptoms and worsening symptoms over time. In addition, SxCls and transition patterns significantly influenced the QOL. Therefore, early screening of high-risk symptom groups and provision of intervention may contribute to alleviating symptoms and ultimately improving QOL.

Key words: lung cancer, lung resection, symptoms, symptom clusters, transition patterns, quality of life, return to care, postoperative recovery, latent transition analysis

I. INTRODUCTION

1.1. Background

Lung cancer is one of the most prevalent cancers worldwide, with the highest reported mortality rate compared to other types of cancers (Sung et al., 2021). In Korea, lung cancer was ranked as the second most frequently diagnosed cancer, accounting for 11.68% of the total cancer diagnoses in 2020 (Korean Statistical Information Service [KOSIS], 2023a). The 5-year relative survival rate for lung cancer in Korea has progressively increased over the past two decades, reaching 36.8% from 2016 to 2020 (KOSIS, 2023b) and identified 76.7% for cases where lung cancer staging indicated localization (Ministry of Health and Welfare, 2022). Lung resection for treating early-stage non-small cell lung cancer is considered a pivotal therapeutic modality (Latimer & Mott, 2015; Sun et al., 2016). However, lung resection can elicit anatomical and physiological changes in patients, leading to respiratory complications such as atelectasis, persistent air leakage, pneumonia, and acute respiratory distress syndrome (Bedat et al., 2019; Cho & Choi, 2014), as well as other complications, including atrial fibrillation, pneumothorax, hemothorax, and bronchial fistula (Bedat et al., 2019).

Even after undergoing surgery for lung cancer treatment, patients often continue to experience various symptoms. A previous study revealed that, at the time of discharge following surgery, patients reported several symptoms, including cough, pain, sleep

disturbances, shortness of breath, and fatigue, with more than half reporting severe symptoms (Liao et al., 2022). Upon returning home after discharge, patients still encountered symptoms and treatment-related burdens, indicating a need for continued support (Kyte et al., 2019). Compared to pre-surgery, the number and severity of symptoms increased 1 month after surgery, with more than 80% of patients reporting symptom experiences (Oksholm, Miaskowski, et al., 2015). Fagundes et al. (2015) reported the recovery of patients' symptom to pre-surgery levels at 3 months after surgery, whereas other studies indicated the persistence of certain symptoms at 4 months (Sarna et al., 2008) and 5 months (Oksholm, Rustoen, et al., 2015) after surgery. Although patients with lung cancer continued to experience symptoms after surgery, there remain inconsistencies in the types of symptoms and the timing of recovery, indicating the need for a comprehensive longitudinal approach to these aspects.

The various symptoms experienced by patients can be understood from the perspective of symptom clusters. The approach to symptom clusters can be broadly classified into two types: one that determines the number and types of symptom clusters based on the symptoms themselves and another that classifies participants as subgroups within the symptom clusters (Miaskowski, 2016). In the symptom-centered approach, symptom clusters are defined as the composition of two or more related and concurrently occurring symptoms (Kim et al., 2005). Previous studies have sought to identify symptom clusters in patients diagnosed with lung cancer (Gift et al., 2003; Wang et al., 2008) and in those with lung cancer who have undergone lung resection (Lin et al., 2013). However,

symptom-centered studies on symptom clusters, predominantly those employing exploratory factor analysis methods (Cheville et al., 2011a; Gift et al., 2004; Wang et al., 2008), have faced limitations in identifying changes in symptoms over time and understanding individual trajectories of symptoms, as noted in previous research (Jeon et al., 2019).

Due to these limitations, some research has employed a participant-centered perspective by using latent class or latent profile analysis (Miaskowski, 2016). In such studies, participants with similar characteristics are classified into the same subgroups of symptom clusters based on the patterns of their responses to symptoms. This analysis is considered a novel approach among patients with cancer (Jeon et al., 2019; Kim et al., 2013; Miaskowski, 2016). Although some studies using this approach have included some patients with lung cancer alongside those with other types of cancer (Miaskowski et al., 2014; Miaskowski et al., 2015; Wallstrom et al., 2022), another study on patients with advanced lung cancer categorized latent groups based on perceived symptom importance (Krueger et al., 2021). Therefore, there is a lack of research on participant-centered symptom clusters experienced by patients with lung cancer.

These analyses face limitations in identifying changes over time, which has prompted the application of latent transition analysis using longitudinal data. Latent transition analysis can be used to discern the transition probability of latent groups to which a participant belongs between different time points and the transition pattern of latent groups over time (Collins & Lanza, 2009). While research related to symptom clusters in patients

with cancer has gradually gained attention recently (Dirksen et al., 2016), only one such study has been conducted on patients with lung cancer receiving chemotherapy (Li et al., 2020).

Symptoms experienced by patients with cancer have been shown to have a negative impact on health outcomes (Cheville et al., 2011b; Dodd, Miaskowski, et al., 2001). In addition, symptom clusters have been found to exacerbate overall health outcomes due to the worsening of disease status and increased emotional distress (Kim et al., 2005). Specifically, in patients with lung cancer, postoperative symptoms (Lowery et al., 2014) and symptom clusters after surgery (Lin et al., 2013) have been found to negatively impact quality of life. In addition, the symptoms of patients with cancer during the treatment process have been associated with unplanned outpatient clinic visits (Aprile et al., 2013; McKenzie et al., 2011). Indeed, various symptoms have been reported as significant factors in emergency department visits after thoracic surgery (Hazewinkel et al., 2021; Shaffer et al., 2018). Moreover, the symptoms experienced by patients with cancer have been identified as factors contributing to increased readmission rates (Nipp et al., 2017). However, studies regarding the postoperative symptom clusters and health outcomes in patients with lung cancer remain scarce.

In patients with cancer, symptom clusters change according to the progression of cancer and its treatment process; therefore, it is crucial to identify changes over time through longitudinal studies (Chen et al., 2011). However, most longitudinal studies conducted on patients with postoperative lung cancer have primarily focused on

postoperative symptoms rather than symptom clusters, or have adopted a symptom-centered approach using exploratory factor analysis to examine symptom clusters. Therefore, this study aimed to identify the types of symptom cluster, and their transition patterns over time, and their impact on health outcomes in patients with lung cancer who underwent lung resection. These findings may contribute to the development of nursing interventions to enhance symptom management and postoperative health outcomes for discharged patients.

1.2. Purpose

This study aimed to identify the postoperative symptoms, types of symptom cluster, and transition patterns of symptom clusters in patients with early-stage lung cancer who underwent lung resection from the first outpatient clinic visit after discharge to 12 weeks after surgery and to determine their impact on health outcomes 12 weeks after surgery. The specific purposes were as follows:

To identify the participants' general, health and illness-related, and environmental characteristics.

To identify the participants' postoperative symptoms and health outcomes at the first outpatient clinic visit after discharge, and at 4, 8, and 12 weeks after surgery.

To identify the types of symptom cluster classified at the first outpatient clinic visit after discharge, and at 4, 8, and 12 weeks after surgery, and determine the characteristics

of each symptom cluster.

To identify the transition patterns of symptom cluster between the first outpatient clinic visit after discharge and 12 weeks after surgery and the associated factors.

To identify differences in health outcomes at 12 weeks after surgery according to the participant characteristics, types of symptom cluster, and transition patterns of symptom cluster.

To identify factors associated with health outcomes at 12 weeks after surgery.

1.3. Definitions

1.3.1. Patients with lung cancer who underwent surgery

1) Theoretical definition: Patients with lung cancer who underwent surgery refers to patients who have undergone surgery to remove part or all of the lung, with the intention to completely remove the cancer, depending on the extent and location of the cancer lesion, for the treatment of non-small cell lung cancer (Korean Association for the Study of Lung Cancer, 2011).

2) Operational definition: Patients with lung cancer who underwent surgery were defined as those who have been diagnosed with non-small cell lung cancer, have undergone lung resection, including bilobectomy, lobectomy, and segmentectomy, and have had their first outpatient clinic visit after discharge from the hospital.

1.3.2. Symptom cluster

1) Theoretical definition: A symptom cluster refers to the classification of patients into latent groups that are identified and classified with similar characteristics based on the patient's response pattern to various symptoms (Miaskowski, 2016). For example, the type of symptom cluster can be divided into those who responded that the overall severity of their symptoms was low, medium, and high.

2) Operational definition: In this study, the symptom cluster was defined as a type categorized according to the severity of symptoms by conducting a latent profile analysis of 16 symptoms measured by the Korean version of the MD Anderson Symptom Inventory - Lung Cancer (Mendoza et al., 2011).

1.3.3. Transition patterns of symptom cluster

1) Theoretical definition: The transition patterns of symptom cluster are defined as the stability and transition of the type of latent group estimated by the transition probability of the latent group to which the patient belongs at two consecutive time points using latent transition analysis (Collins & Lanza, 2009; Kim et al., 2013).

2) Operational definition: In this study, latent transition analysis was conducted to identify the transition patterns of symptom cluster categorized by the severity of 16 symptoms measured by the Korean version of the MD Anderson Symptom Inventory - Lung Cancer (Mendoza et al., 2011). Among the transition patterns, a stayer with stability

is defined as a participant belonging to the same type of symptom cluster at one time point and the next. Conversely, a mover with a transition is defined as a participant whose symptom cluster type changes from one time point to the next.

1.3.4. Health outcomes

1) Theoretical definition: Health outcomes refer to symptom status, functional status, emotional status, quality of life, self-care, health care costs, morbidity and comorbidities, and mortality, all of which can be derived from the symptom experience (Dodd, Janson, et al., 2001).

2) Operational definition: In this study, health outcomes included quality of life, as measured by the Korean version of the Functional Assessment of Cancer Therapy – General (Cella et al., 1993), and return to care, including unplanned outpatient clinic visits, emergency department visits, and readmissions, as identified in the electronic medical records review (Aprile et al., 2013; Shaffer et al., 2018).

II. LITERATURE REVIEW

A literature review was conducted to comprehend the postoperative symptoms and symptom clusters in patients with lung cancer based on previous research, as well as to explore symptom-related studies using latent transition analysis of patients with cancer, and examine studies related to the health outcomes of patients with lung cancer.

2.1. Symptoms and symptom clusters in patients with lung cancer

The diverse symptoms experienced by patients with lung cancer persist from the time of diagnosis to post-treatment, posing health issues that warrant attention because of their potential negative impact on the patients' well-being and health. Walling et al. (2015) investigated symptoms in patients with newly diagnosed cancer and reported that more than 98% of the 2,411 patients with lung cancer experienced symptoms regardless of the cancer stage. Among these symptoms, coughing (81.5%), shortness of breath (81.2%), depression (79.5%), fatigue (74.4%), and pain (58.4%) were the most prevalent. Female patients, those aged 70 years or older, those with lower economic status, those with two or more comorbidities, and those undergoing chemotherapy or surgery were more likely to experience symptoms (Walling et al., 2015).

Symptoms remain a significant health concern for patients with lung cancer who have undergone lung resection. A previous qualitative study explored the perceptions of

symptoms 1 day before discharge in 39 patients who underwent lung resection, and revealed the experience of symptoms such as pain (100%), cough (94.9%), mobility impairment (92.3%), shortness of breath (89.7%), and sleep disturbances (87.2%) (Wei et al., 2022). Furthermore, a study conducted across six Chinese hospitals involving 366 postoperative lung resection patients, where symptoms at the time of discharge were measured using the MD Anderson Symptom Inventory - Lung Cancer, indicated that patients commonly reported cough, pain, shortness of breath, fatigue, and sleep disturbances as major symptoms (Liao et al., 2022). More than half of the patients experienced symptoms of moderate to severe intensity (Liao et al., 2022). Additionally, a qualitative study conducted on patients within 3 weeks of discharge after lung resection found that they encountered difficulties in daily activities due to various symptoms, which negatively impacted various aspects of their lives compared to during the preoperative period (Kyte et al., 2019).

This literature review identified longitudinal studies that have aimed to investigate the transition patterns of symptoms experienced by patients with lung cancer who underwent lung resection, as these individuals continue to experience symptoms even after discharge. Although many studies have assessed symptoms from the preoperative phase (Dai et al., 2022; Fagundes et al., 2015; Hugoy et al., 2019; Khullar et al., 2017; Oksholm, Miaskowski, et al., 2015; Oksholm, Rustoen, et al., 2015; Shi et al., 2016), some studies have started assessing symptoms from 2 to 4 weeks after surgery (Sarna et al., 2008; Shin et al., 2022). When investigating the symptoms experienced by patients, the duration of the follow-up

period ranged from 1 month after surgery (Oksholm, Miaskowski, et al., 2015) to 1 year after surgery (Shin et al., 2022). The measurement intervals for symptom assessment were mainly conducted every 4 weeks, although some studies measured symptoms weekly (Dai et al., 2022; Fagundes et al., 2015; Shi et al., 2016). To measure symptoms, researchers predominantly used tools that assessed multiple symptoms, such as the MD Anderson Symptom Inventory (Cleeland et al., 2000), Memorial Symptom Assessment Scale (Portenoy et al., 1994), and Lung Cancer Symptom Scale (Hollen et al., 1993). Additionally, to measure different symptoms, some studies used tools focusing on single symptoms, such as pain, shortness of breath, and fatigue.

In a study on 60 patients with lung cancer patients who underwent lung resection, Fagundes et al. (2015) measured symptoms before surgery, 3 and 5 days after surgery, and weekly from 1 week to 3 months after discharge. The most severe symptoms after surgery were pain, fatigue, drowsiness, shortness of breath, and sleep disturbances, with fatigue being the most severe 5 days after surgery and the other four symptoms being the most severe 3 days after surgery (Fagundes et al., 2015). Four weeks after surgery, fatigue and pain remained severe, whereas the other symptoms had recovered to pre-surgery severity levels (Fagundes et al., 2015). Another study, involving 228 patients with lung resection, reported an increase in the occurrence and severity of symptoms 1 month after surgery compared to preoperatively, with more than 80% of patients experiencing shortness of breath, lack of energy, pain, and drowsiness (Oksholm, Miaskowski, et al., 2015). While some studies reported symptom recovery to pre-surgery levels at 3 months after surgery

(Fagundes et al., 2015), other studies indicated persistent symptoms at 4 months (Sarna et al., 2008) and 5 months (Oksholm, Rustoen, et al., 2015) after surgery. Previous studies have revealed that patients with lung cancer who have undergone lung resection continue to experience symptoms. Although some recovery occurs over time, there is inconsistency in the types of symptoms experienced and the timing of symptom recovery after surgery. Consequently, longitudinal investigations are necessary to understand the trajectory of symptom recovery and transition patterns after lung resection.

Patients often experience symptoms with similar characteristics simultaneously, especially in patients with cancer who experience distress and undergo various symptoms due to the disease and treatment process. Understanding the symptom clusters of such patients plays a crucial role not only in cancer treatment but also in nursing care provision (Barsevick et al., 2006). Miaskowski (2016) differentiated approaches to symptom clusters into symptom- and participant-centered methods. First, the symptom-centered approach was defined as two or more related and concurrent symptoms (Kim et al., 2005), primarily employing factor analysis to determine the number and types of symptom clusters (Miaskowski, 2016). When examining studies related to symptom clusters in patients with lung cancer, many have focused on those receiving chemotherapy (N. Li et al., 2021; Russell et al., 2019; Wang & Fu, 2014; Wong et al., 2017; Zhang et al., 2022), whereas studies on patients undergoing lung resection are limited. Lin et al. (2013) studied 145 patients who had undergone lung resection and reported a symptom cluster composed of pain, fatigue, sleep disturbance, and distress. Another study involving 217 patients who had

undergone lung resection identified four symptom clusters (lung cancer-specific, psychological, sleep disturbance, neurological) upon admission, six clusters (nutritional, gastrointestinal, sleep disturbance, psychological, lung cancer-specific, neurological) at 2 –4 days after surgery, and five clusters (nutritional, lung cancer-specific, respiratory, sleep disturbance, neurological) at 1 month after surgery (J. J. Li et al., 2021). However, there are limitations to understanding the changing patterns of symptom clusters over time and identifying individual symptom trajectories (Jeon et al., 2019).

Next, from a participant-centered perspective on symptom clusters, latent class analysis or latent profile analysis was employed to categorize patients into subgroups based on their symptom clusters (Miaskowski, 2016). This method uses patterns of participant responses to symptoms, classifying participants with similar characteristics into subgroups. Considered as a novel approach for studies on symptom clusters in patients with cancer (Jeon et al., 2019; Kim et al., 2013; Miaskowski, 2016), this perspective allows for the identification of patient characteristics based on the severity or burden of symptoms, with the advantage of identifying high-risk populations for symptoms, thereby enabling prioritization of nursing interventions (Miaskowski, 2016). Previous studies, including those on patients with lung cancer, classified types of symptom clusters based on the severity of symptoms (Miaskowski et al., 2014; Miaskowski et al., 2015; Wallstrom et al., 2022). A previous study focused solely on patients with advanced lung cancer categorized based on the perceived importance of symptoms rather than the symptoms experienced (Krueger et al., 2021). This suggests a knowledge gap in participant-centered research on

symptom clusters in patients with lung cancer who have undergone lung resection, indicating the need for further studies.

2.2. Latent transition analysis applied to symptoms in patients with cancer

The symptoms of patients with cancer vary depending on the patient's condition and stage of treatment, indicating dynamic change patterns over time (Chen et al., 2011). Consequently, conducting longitudinal studies, as opposed to cross-sectional studies, enables a broader understanding of symptoms. The latent transition analysis method allows the classification of types of symptom clusters and the identification of transition patterns in symptom clusters over time (Collins & Lanza, 2009). In nursing research, understanding changes over time is crucial because it provides information about the changes themselves, allows prediction and understanding of behaviors in response to changes, and facilitates the exploration of relationships between changes and their outcomes (Roberts & Ward, 2011). Roberts and Ward (2011) emphasized the need for latent transition analysis of nursing research to understand changes over time, stating that this participant-centered approach, which classifies participants into subgroups based on patterns of responses, is an appropriate method in nursing research. Furthermore, longitudinal study designs are essential for generating evidence relating to the directionality and causality of symptoms. Applying latent transition analysis of such designs confirms transition patterns in symptom

cluster types between two time points (Kim et al., 2013).

Thus, the necessity of applying latent transition analysis to understand the changes in symptom clusters over time has been identified. However, to date, relatively few studies have applied latent transition analysis to symptoms in patients with cancer, with research gradually emerging since a study conducted in 2016 on patients with prostate (Dirksen et al., 2016). Subsequently, studies encompassing various types of patients with cancer were conducted in 2017 (Miaskowski et al., 2017; Zhu et al., 2017) and 2019 (Jeon et al., 2019). One study focusing on patients with lung cancer investigated the severity of symptoms in patients undergoing chemotherapy (Li et al., 2020). Types of symptom cluster were classified at three time points, including 2 weeks before anticancer treatment, one cycle after, and three cycles after, revealing categories of “mild” and “moderate-severe” (Li et al., 2020). However, few studies have conducted latent transition analysis and examined the association between symptom clusters and health outcomes. Studies exploring the relationship between symptom clusters and quality of life found that higher severity symptom clusters were associated with lower quality of life (Dirksen et al., 2016; Miaskowski et al., 2017). The results of the literature review indicate a lack of longitudinal studies specifically investigating the type of symptom cluster and transition patterns in patients with lung cancer, particularly those who have undergone surgery.

2.3. Health outcomes related to symptoms in patients with lung cancer

The symptoms and symptom clusters experienced by patients with lung cancer have been shown to have an overall negative impact on health outcomes such as quality of life, physical activity, employment status, and mortality (Cheville et al., 2011b). Several previous studies examining the health outcomes of patients with lung cancer have primarily focused on symptoms and their association with quality of life and hospital utilization. First, a study conducted on lung cancer survivors reported a significant association between fatigue and shortness of breath symptoms and reduced quality of life (Cheville et al., 2011b). In a study on patients with advanced non-small cell lung cancer, symptoms such as loss of appetite, cough, pain, and shortness of breath were identified as predictive factors for quality of life (Iyer et al., 2014). Research conducted on patients with lung cancer scheduled for chemotherapy revealed that symptoms, including insomnia, diarrhea, and shortness of breath, significantly impact quality of life (Silvoniemi et al., 2016). For patients with lung cancer undergoing chemotherapy, fatigue has been reported as a predictive factor for mental quality of life (Shallwani et al., 2016). In a study involving patients with lung cancer who underwent surgery, an increase in symptom burden was associated with a decrease in physical quality of life, while the simultaneous occurrence of three or more symptoms resulted in a decrease in mental quality of life (Lowery et al., 2014). Moreover, the number of symptoms experienced by patients with lung cancer postoperatively was inversely related to their quality of life, with distress, sleep disturbances, and fatigue identified as major influencing factors (Lin et al., 2013).

In a study examining the relationship between symptom clusters and quality of life in patients with lung cancer, Choi and Ryu (2018) demonstrated that depression- and lung cancer-related symptom clusters are significant factors influencing quality of life. Another study involving patients with lung cancer receiving chemotherapy revealed a negative correlation between gastrointestinal-, emotional-, and fatigue-related symptom clusters and quality of life (Wang & Fu, 2014). These findings confirmed that the various symptoms and symptom clusters experienced by patients with lung cancer have a detrimental impact on their quality of life.

Research on symptom-associated healthcare utilization primarily encompasses unplanned outpatient clinic visits, emergency department visits, and readmissions, representing health outcomes that can be considered from a cost perspective. First, concerning unplanned outpatient clinic visits, various symptoms, such as nausea and vomiting, pain, dyspnea, fatigue, diarrhea, anxiety, and depression, have been reported as the main reasons for outpatient visits in patients with cancer including lung cancer receiving chemotherapy (McKenzie et al., 2011). Aprile et al. (2013) indicated that symptoms such as pain, fatigue, dyspnea, nausea and vomiting, and diarrhea led to unplanned outpatient clinic visits among patients with cancer, including those with lung cancer. Second, regarding emergency department visits, patients diagnosed with lung cancer were more likely to visit the emergency department (Dufton et al., 2019). Additionally, among patients with lung cancer who underwent thoracotomy, 6.3% visited the emergency department, with surgical complications, including pain and various

symptoms, reported as the primary causes (Shaffer et al., 2018). Hazewinkel et al. (2021) reported that 27.4% of patients who underwent chest surgery visited the emergency department within 6 months of discharge, reporting reasons such as postoperative pain, dyspnea, and fatigue. Finally, in the case of readmissions of patients with cancer, physical symptoms and anxiety were identified as factors contributing to increased readmissions (Nipp et al., 2017). Among patients who underwent lung cancer surgery, 11% were readmitted within 30 days of discharge, with symptoms such as shortness of breath and pain reported as reasons for readmission (King et al., 2019). Despite establishing the relevance between symptoms and health outcomes in patients with lung cancer, there remains a lack of integrated research on the postoperative symptoms, symptom clusters, and health outcomes of patients with lung cancer.

The literature review of previous studies confirmed the need for additional research to identify the types and transition patterns of symptom clusters in patients with lung cancer following surgery, as well as the need to examine the corresponding health outcomes. Specifically, it was established that these patients continue to experience symptoms and symptom-related distress even several months after surgery, emphasizing the ongoing need for attention and monitoring. Furthermore, approaching symptom clusters from a participant-centered perspective to classify the types of symptom clusters can help identify groups with high symptom burdens or those at risk of experiencing future symptoms, enabling targeted and intensive management. Additionally, recognizing the evolving symptoms over time, a comprehensive longitudinal approach to understanding symptoms

at various time points and classifying them into types can facilitate the identification of transition patterns within symptom clusters. Finally, it is crucial to investigate the relationship between health outcomes, including quality of life and return to care, along with symptoms and symptom clusters.

III. CONCEPTUAL FRAMEWORK

3.1. Theoretical framework

This study was based on Dodd's symptom management model (Figure 1). This model, which was developed and revised by the faculty at the University of California, San Francisco School of Nursing, is structured on the premise that effective management of symptoms or symptom clusters requires consideration of three dimensions, including symptom experience, components of symptom management strategies, and outcomes (Dodd, Janson, et al., 2001).

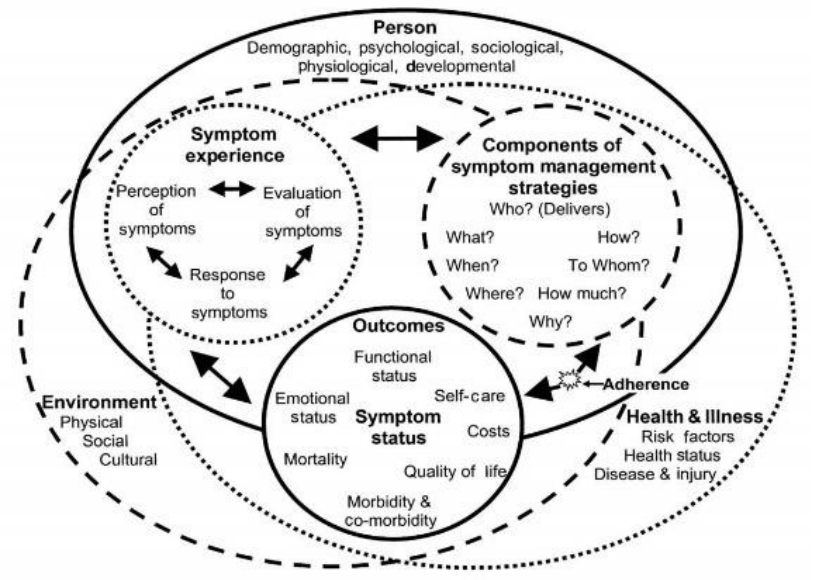

Figure 1 Symptom management model by Dodd et al. (2001)

The symptom management model is structured around three dimensions, including personal, health and illness-related, and environmental domains, and can be seen as a contextual variable influencing the dimensions of the model—symptom experience, components of symptom management strategies, and outcomes (Dodd, Janson, et al., 2001). First, in the personal domain, individual variables such as demographic, psychological, social, and physiological factors address the perspective from which an individual views and responds to symptoms. Second, the health and illness-related domain comprises variables related to an individual's health or disease status, including risk factors, symptoms associated with environmental factors, side effects of treatments, and risks of sequelae from persistent symptoms due to illness. Third, the environmental domain signifies the conditions or situations in which symptoms occur; the physical environment includes home, workplace, and hospital settings; the social environment involves an individual's social support network or interpersonal relationships. The personal, health and illness-related, and environmental domains are interrelated components of the symptom management model, which directly and indirectly influence and modify the structure of the dimensions.

The symptom experience, which is a core component of the symptom management model, encompasses an individual's perception of symptoms, evaluation of symptoms, and response to symptoms (Dodd, Janson, et al., 2001). Symptom perception indicates whether an individual recognizes changes in their usual feelings and behaviors and the ability to self-report by reacting to symptom perception. Symptom evaluation involves judgments

about the severity, intensity, location, temporal characteristics, frequency, and emotional impact of the symptom experience. Responses to symptoms encompass physiological, psychological, sociocultural, and behavioral components, in which more than one reaction may occur per symptom. Understanding the interaction among the components of symptom experience is essential for effective symptom management.

Furthermore, symptom management aims to avoid or delay negative outcomes through expert assistance and self-management. Symptom management strategies comprise components such as what (characteristics of the approach), when, where, why, how much (amount of intervention), for whom (beneficiary of the intervention), and how (delivery) (Dodd, Janson, et al., 2001).

Finally, the outcomes derived from the symptom experience and symptom management strategies in the model emphasize eight factors, including symptom status, functional status, emotional status, quality of life, self-care, costs, comorbidity, and mortality (Dodd, Janson, et al., 2001).

3.2. Conceptual framework of this study

In this study, a conceptual framework based on Dodd's symptom management model was established to explore health outcomes according to postoperative symptom clusters and transition patterns until 12 weeks after surgery in patients with lung cancer who underwent lung resection. This framework incorporates participant characteristics, symptom experience, and outcomes (Figure 2).

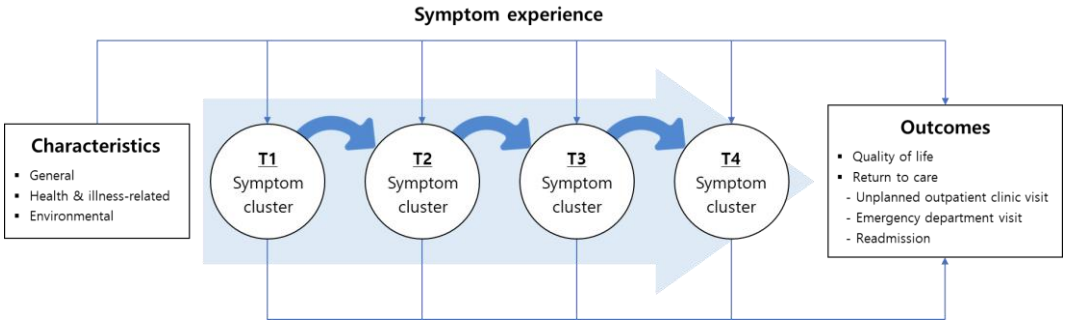

Figure 2 Conceptual framework of this study

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery.

The participant characteristics influencing symptom experience and outcomes, which are components of the symptom management model, were configured. To comprehend the participant characteristics, general characteristics were constructed using age, gender, religion, marital status, employment status, education level, income level, and economic status. Within the health and illness-related characteristics, health-related characteristics encompassed body mass index, smoking status, drinking status, comorbidities, preoperative pulmonary function test results, and weight changes. Cancer-related characteristics included postoperative pathologic cancer stage, cancer histology, and preoperative treatment. Surgery-related characteristics included surgical approach, direction of surgery, number of surgical sites, location of surgery, extent of surgery, operation time, estimated blood loss, number of chest tubes, duration of chest tubes, intensive care unit admission after surgery, hospital length of stay, and postoperative complications. In the environmental characteristics, the physical environment was

delineated by the discharge location, whereas the social environment included living status, primary caregiver, and social support.

Symptom experience, a core component of the symptom management model, was defined by patients' perception and evaluation of symptoms following lung resection. This conceptualization included symptoms, types of symptom clusters, and transition patterns. After discharge from the surgery, symptoms were assessed at four time points: the first outpatient clinic visit after discharge, and 4, 8, and 12 weeks after surgery. Participants were classified into symptom clusters based on the symptom severity reported at each time point. In addition, the transition patterns of symptom clusters were identified by examining changes in participants belonging to symptom clusters over time.

Finally, the outcomes based on the symptom management model consist of the health outcomes of patients with lung cancer who underwent lung resection. These outcomes encompass participants' self-reported quality of life and return to care, including unplanned outpatient clinic visits, emergency department visits, and readmissions, as identified through a review of the participants' electronic medical records.

Building upon the conceptual framework developed in this study, it is assumed that participants' general, health and illness-related, and environmental characteristics will influence the symptoms, types of symptom clusters, and transition patterns identified at each time point, as well as the associated health outcomes. Furthermore, it is assumed that the symptom experiences constructed from the symptoms, types of symptom clusters, and transition patterns at each time point will impact the participants' health outcomes.

IV. METHODS

4.1. Study design

This study has a prospective longitudinal research design, with the aim to identify the postoperative symptoms, types of symptom clusters, and transition patterns of symptom clusters experienced by patients with early-stage lung cancer who underwent lung resection from the first outpatient clinic visit after discharge to 12 weeks after surgery, as well as to explore the impact of these on health outcomes at 12 weeks after surgery.

4.2. Study participants

The study participants were patients who visited the thoracic surgery department for their first outpatient clinic visit after being discharged following lung resection for lung cancer from a tertiary hospital in Seoul.

4.2.1. Inclusion criteria

The specific participant selection criteria were as follows: 1) adults aged ≥19 years; 2) those diagnosed with pathologically non-small cell lung cancer; 3) those who underwent lung resection, including bilobectomy, lobectomy, and segmentectomy; and 4) those who visited the first outpatient clinic after discharge following lung resection.

4.2.2. Exclusion criteria

The exclusion criteria were as follows: 1) patients who underwent lung resection due to metastasis of other cancers; 2) those scheduled for additional chemotherapy or radiation therapy after lung resection; 3) those diagnosed with other cancer within 5 years; 4) those who visited the emergency department or were readmitted before their first outpatient clinic visit after discharge following lung resection; and 5) those who were unaware of their cancer diagnosis.

4.2.3. Sample size

In this study, latent profile and latent transition analyses were conducted to categorize the latent groups according to the symptoms experienced by the participants. Although there is a lack of clear evidence on the required sample size for these methods (Nylund-Gibson et al., 2023), as the relevant analysis methods are based on structural equation modeling, previous research has reported that the appropriate sample size is at least ten times the variable to be estimated (Bentler & Chou, 1987). In this study, the number of symptoms measured by participants was 16, and the minimum sample size was 160. However, longitudinal studies conducted over a 3-month periods on patients who underwent lung resection for lung cancer reported a dropout rate of 8.3% (Fagundes et al., 2015). Considering a dropout rate of 10%, the total number of participants required for this 12-week study was 177.

4.3. Measurements

4.3.1. Symptoms and types of symptom cluster

Symptoms were measured using the MD Anderson Symptom Inventory - Lung Cancer (MDASI-LC), which consists of symptom severity and symptom interference experienced in the past 24 hours (Mendoza et al., 2011). A Korean translation version of the MDASI-LC was provided after approval from the Symptom Research Department at the MD Anderson Cancer Center. The symptom severity consists of 13 core symptoms, including pain, fatigue (tiredness), nausea, disturbed sleep, distressed (upset), shortness of breath, remembering things, lack of appetite, drowsy (sleep), dry mouth, sad, vomiting, and numbness or tingling, and three lung cancer-specific symptoms including coughing, constipation, and sore throat. Symptom interference consists of the extent to which symptoms interfere with six areas of daily life, including general activity, mood, work, relations with other people, walking, and enjoyment of life. Each symptom severity item used an 11-point Likert scale ranging from 0 (not present) to 10 (as bad as you can imagine), with higher scores indicating more severe symptoms. This tool was validated for content and concurrent validity during development, and the reliability of the symptom severity has a Cronbach's α of 0.86–0.90 (Mendoza et al., 2011). In a study conducted among patients with lung cancer in Korea, the Cronbach's α was 0.87 (Chae & Park, 2017), while in this study, the Cronbach's α was 0.92.

The types of symptom cluster refer to a potential group of participants classified according to the 16 symptoms measured by the MDASI-LC by performing latent profile analysis.

4.3.2. Quality of life

Quality of life was measured using the Functional Assessment of Cancer Therapy - General (FACT-G) version 4, which was developed to measure the health-related quality of life in patients with cancer (Cella et al., 1993). The Korean-translated version of this tool was provided after approval from the FACIT group. The FACT-G comprises 27 items with four subscales as follows: physical well-being (seven items), social and family well-being (seven items), emotional well-being (six items), and functional well-being (seven items). Each item was measured on a 5-point Likert scale ranging from 0 (not at all) to 4 (very much) for the past 7 days. The total score ranged from 0 to 108, with a higher total score indicating a greater quality of life. The validity of the Korean translation of this tool has been verified in patients with cancer, including those with lung cancer (Kim et al., 2003). In terms of the reliability, the developed tool had a Cronbach's α of 0.89 (Cella et al., 1993), that of the Korean translation was 0.87 (Kim et al., 2003), and that of this study was 0.88.

4.3.3. Return to care

Return to care consisted of unplanned outpatient clinic visits, emergency department visits, and readmissions based on previous studies (Aprile et al., 2013; Shaffer et al., 2018).

Unplanned outpatient clinic visits. Unplanned outpatient clinic visits during data collection were identified by reviewing the patients' electronic medical records. When unplanned outpatient clinic visits occurred, the reasons for the visits were assessed.

Emergency department visits. Emergency department visits during the data collection period were identified by reviewing the patients' electronic medical records. When emergency department visits occurred, the reasons for the visits were assessed.

Readmissions. Readmissions during the data collection period were identified by reviewing the patients' electronic medical records. When readmissions occurred, the reasons for them were assessed.

4.3.4. Patients' characteristics

General characteristics. The postoperative day at enrollment, age, gender, religion, marital status, employment status, education, monthly household income, and perceived economic status were investigated.

Health and illness-related characteristics. Among Health and illness-related characteristics, health-related characteristics included body mass index, smoking status, drinking status, comorbidities, preoperative pulmonary function test results, and weight change before and after surgery. Cancer-related characteristics included postoperative pathologic cancer stage, cancer histology, and preoperative treatment. Surgery-related characteristics included surgical approach, direction of surgery, number of surgical sites, location of surgery, extent of surgery, operation time, estimated blood loss, number of chest

tubes, duration of chest tubes, intensive care unit admission after surgery, hospital length of stay, and postoperative complications. These characteristics were identified by a survey and review of electronic medical records.

Environmental characteristics. Environmental characteristics included living status, primary caregiver, discharge location, and social support. Social support was measured using the Multidimensional Scale of Perceived Social Support (MSPSS) developed by Zimet et al. (1988) and translated into Korean by Park et al. (2012). Before using this tool, permission was obtained from the original author and the translating author. The MSPSS consisted of 12 items with three subscales as follows: family (four items), friends (four items), and significant other (four items). Referring to a previous study (Lee & Jeong, 2019), the support of significant others was evaluated as that of healthcare providers, including doctors and nurses, which was approved by the original author. Each item in the MSPSS was measured on a 7-point Likert scale ranging from 1 (very strongly disagree) to 7 (very strongly agree). The score was calculated as the total of each item, ranging from 12 to 84, with higher scores indicating greater social support. The validity of this tool has been verified for patients with cancer (Calderon et al., 2021), and the reliability at the time of development showed a Cronbach's α of 0.88. (Zimet et al., 1988). The tool translated into Korean had a Cronbach's α of 0.90 (Park et al., 2012), while that used in this study had a Cronbach's α of 0.91.

4.4. Data collection

Before data collection, this study was approved by the Institutional Review Board of the Yonsei University Health System (No. 4-2023-0227) and the thoracic surgery department of a tertiary hospital in Seoul. When patients who underwent lung resection visited the thoracic surgery outpatient clinic approximately 2 weeks after discharge, those who met the selection criteria of this study were approached. Informed consent was obtained from patients who voluntarily agreed to participate in the study after explaining the study's purpose, procedures, duration, and confidentiality at an independent outpatient clinic location.

Data collection was conducted four times as follows: first outpatient clinic visit after discharge (time point 1, T1), 4 weeks after surgery (time point 2, T2), 8 weeks after surgery (time point 3, T3), and 12 weeks after surgery (time point 4, T4). At T1, the participants' characteristics, symptoms, and quality of life were assessed using a self-reported survey and a review of the patients' electronic medical records. At T2 and T3, symptoms and quality of life were assessed using a self-reported online survey accessible via mobile phone because there was no outpatient clinic visit for participants. At T4, symptoms and quality of life were assessed using a self-reported online survey accessible via mobile phone or direct self-reported survey, depending on whether the patients visited the outpatient clinic. At each data collection point, the participants were sent a text message with a URL to access the online survey on their mobile phones. When enrolling for the study, the participants were taught in advance how to access the URL and participate in the

online survey. If the participants did not respond to the online survey, reminder text messages or phone calls were provided within a week. Return to care, including unplanned outpatient clinic visits, emergency department visits, and readmissions, was examined through electronic medical record review at each time point (Table 1).

Table 1 Time points and types of data collection according to the variables

Variables	Type of data collection	Time point			
		T1	T2	T3	T4
Characteristics	Self-report survey and EMR review	O			
Symptoms	Self-report survey	O	O	O	O
Health outcomes					
Quality of life	Self-report survey	O	O	O	O
Return to care					
Unplanned outpatient clinic visit	EMR review		O	O	O
Emergency department visit	EMR review		O	O	O
Readmission	EMR review		O	O	O

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery, EMR: Electronic medical records.

4.5. Data analysis

All data were analyzed using IBM SPSS Statistics version 26, Mplus version 8.8, and R version 4.3.2. The statistical significance level was set at α 0.05, and the detailed analysis methods were as follows:

First, participant characteristics, symptoms, quality of life, and return to care were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations.

Second, latent profile analysis was conducted to identify potential symptom clusters based on the 16 symptoms from the MDASI-LC at each time point. Latent profile analysis is a person-centered mixed-modeling method that classifies latent group types based on latent variables measured by continuous indicators in cross-sectional studies (Williams & Kibowski, 2015). To determine the appropriate number of symptom clusters, the information index, quality of classification, comparative validation of the model, and interpretability are considered. Information indices include the Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-size adjusted BIC (SABIC), with lower values indicating a better model fit (Collins & Lanza, 2009). Entropy, which indicates the quality of classification, ranges from 0 to 1, with values closer to 1 indicating a better model fit (Williams & Kibowski, 2015). The adjusted Lo–Mendell–Rubin likelihood ratio test (LMR-LRT) (Lo et al., 2001) and the parametric bootstrapped likelihood ratio test (BLRT) (McLachlan & Peel, 2000) were used for comparative validation of the models. If the *P*-value of each test is significant, k groups can be selected;

if not, k-1 groups can be selected. Considering these criteria and the possibility of interpreting classified groups, the appropriate number of symptom clusters for each time point was determined.

Third, latent transition analysis was conducted to identify changes in the pattern of symptom clusters over time. Considering previous research that indicated the recovery of symptoms in patients undergoing lung resection surgery to preoperative levels at 3 months after surgery (Fagundes et al., 2015), transition patterns were identified between the first outpatient clinic visit (T1) and 12 weeks after surgery (T4). This analysis is a longitudinal extension of latent profile analysis that classifies latent groups at one point in time, which can identify the prevalence of latent status and estimate the transition probability (Collins & Lanza, 2009). Latent status prevalence refers to the proportion of each classified symptom cluster type, and transition probability refers to the probability that a participant who belongs to one type of symptom cluster at one point will belong to that type the next time. A latent transition model was estimated using a three-step method, that considers classification errors that occur while classifying latent groups (Nylund-Gibson et al., 2014). In addition, the mover–stayer model was applied to determine the transition patterns of symptom clusters as stability (stayer) and transition (mover) (Nylund, 2007). For example, participants belonging to the same type of symptom clusters over time were stable and classified as stayers. Conversely, when participants transition to a different type of symptom cluster than the one they already belonged to over time, they are classified as movers (Figure 3). The flow of participants belonging to each symptom cluster over time

was presented using a Sankey diagram.

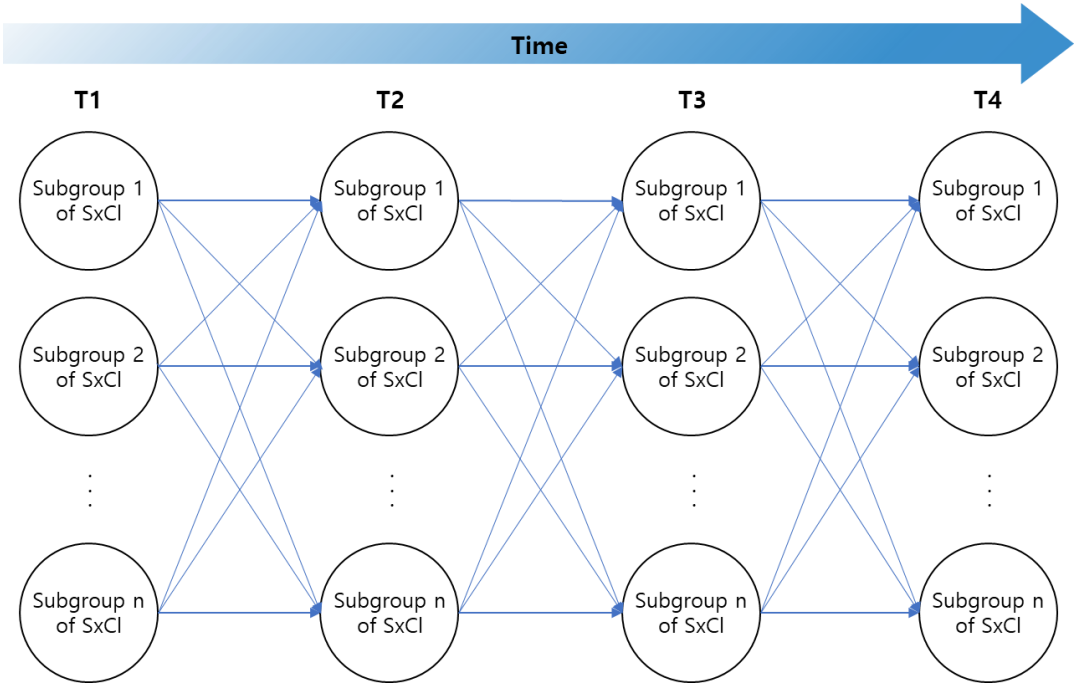

Figure 3 Example of transition patterns of symptom cluster over time

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery, SxCl: Symptom cluster.

Fourth, multinomial logistic regression analysis was conducted to identify factors associated with the transition pattern of symptom clusters.

Fifth, an independent t-test, one-way ANOVA, and Pearson's correlation were conducted to identify differences in quality of life according to participant characteristics and transition patterns of symptom cluster types between T1 and T4. When post hoc analysis was necessary, the Bonferroni method was used.

Sixth, χ^2 test or Fisher's exact test was conducted to identify differences in return to care, including unplanned outpatient clinic visits, emergency department visits, and readmission, according to participant characteristics and transition patterns of symptom cluster types.

Seventh, among the three-stage approaches, the Bolck, Croon, and Hagenaars (BCH) approach was used to identify differences in quality of life and return to care, including unplanned outpatient clinic visits, emergency department visits, and readmission according to the types of symptom cluster at T1 (Asparouhov & Muthén, 2014). The BCH method has the advantage that the classification of the latent group does not change even if the outcome variable is added during the analysis (Bakk & Vermunt, 2016). This method presented the values of Wald chi-squared tests to verify the equality of the predictive values of outcome variables between symptom clusters (Bakk & Vermunt, 2016).

Eighth, multiple linear regression analysis was performed to identify factors associated with participants' quality of life, and logistic regression analysis was performed to identify factors associated with return to care.

V. RESULTS

5.1. Participants' characteristics

A flow diagram of the participant selection process is shown in Figure 4. A total of 593 patients were screened from May to December 2023, of whom 263 met the selection criteria. Among the eligible patients, 177 were enrolled in the study, and 163 were included in the T1 data collection. At T2, nine participants did not reach the timeline for data collection, two did not wish to participate in the study, and 14 did not respond to the survey, resulting in data being collected from 138 participants. At T3, 30 participants did not reach the timeline for data collection, two did not wish to participate in the study, and 11 did not respond to the survey, resulting in data being collected from 120 participants. At T4, 47 participants did not reach the timeline for data collection, one did not wish to participate in the study, and 14 did not respond to the survey, resulting in data being collected from 101 participants.

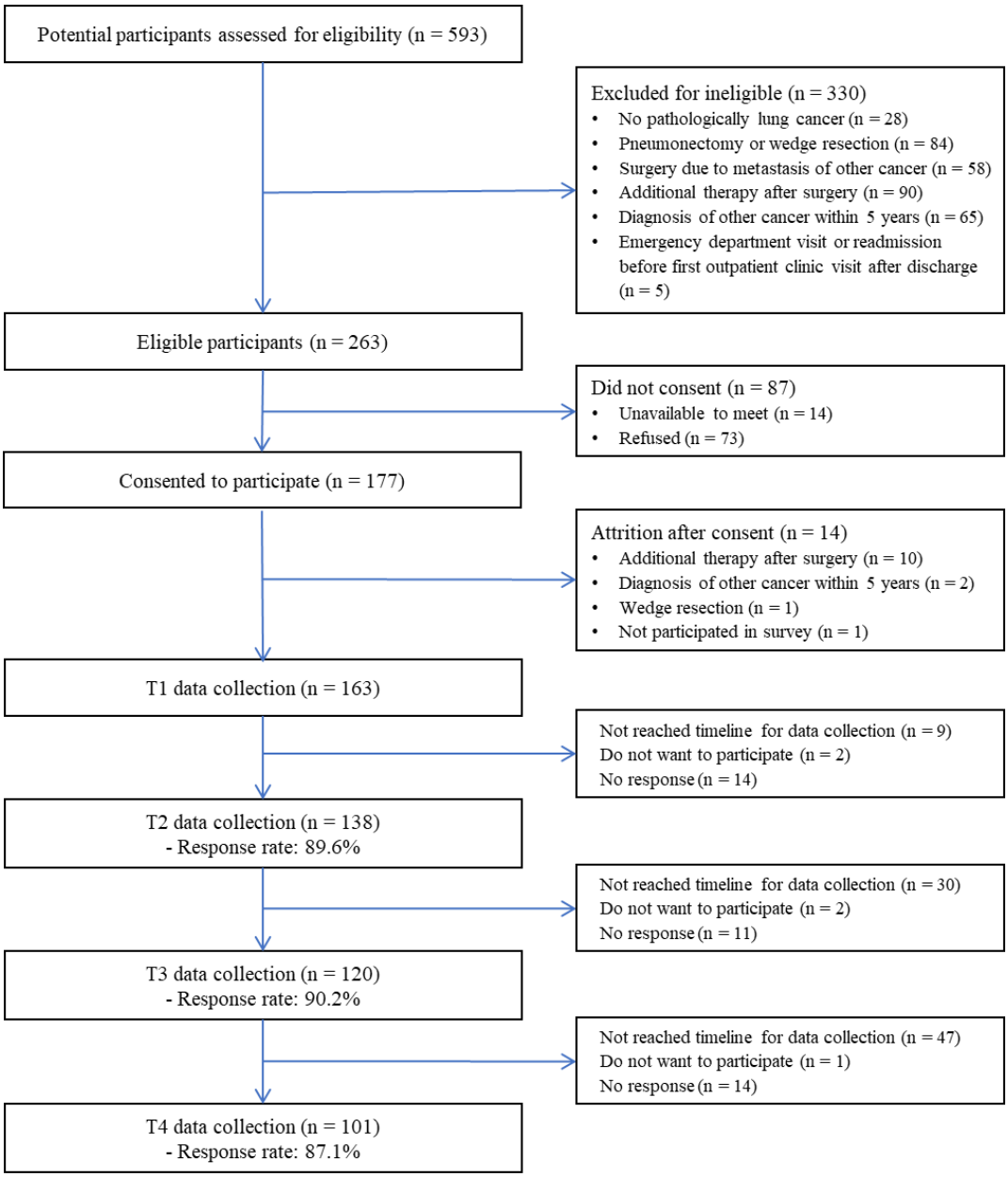

Figure 4 Flow diagram of the participant selection

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery.

The participants' general characteristics, health and illness-related characteristics, and environmental characteristics are presented in Table 2. Among the 163 participants, the average postoperative day at enrollment was 14.91 ± 3.09 days. The average age of the participants was 61.99 ± 9.61 years, with women accounting for 60.1%. Approximately 80% of the participants were married (79.8%), and more than half were currently unemployed (55.8%). The majority of participants perceived their economic status to be middle-class (57.7%).

The average body mass index of the participants was 23.37 kg/m^2, 60.1% of the participants were never-smokers, and 58.9% were ex-drinkers. Regarding the comorbidities calculated using the Charlson comorbidity index, 31.9% of the participants had additional comorbidities besides lung cancer. The results of the preoperative pulmonary function test were abnormal, including obstructive and restrictive patterns, in 64.4% of the participants, and approximately half of the participants lost weight before and after surgery (50.3%). The postoperative pathologic cancer stage was identified as stage 1A1 in 39.3% of the participants. Most participants had adenocarcinoma (95.7%), did not receive preoperative chemotherapy or radiation therapy (95.7%), underwent video-assisted thoracoscopic surgery (99.4%), and had only one surgery site (92.0%). The extent of surgery was lobectomy in 38.7% and segmentectomy in 61.3%. The average operation time was 103.96 ± 48.09 min, and the estimated blood loss during surgery was < 50 ml in 68.7% of the participants. No participants were admitted to the intensive care unit after surgery, the average length of hospital stay was 6.33 ± 2.00 days, and 15.3% had complications after

surgery.

Most participants lived with their families (89.0%), received care from their spouses (66.3%), and were discharged home (91.4%). The overall social support averaged 5.90 out of 7, and the highest-ranked subscales of social support were family (6.41), healthcare providers (5.65), and friends (5.62).

Table 2 Characteristics of the study participants (n = 163)

Characteristics	Categories	n (%) or M ± SD
General characteristics		
Postoperative day at enrollment (days)		14.91 ± 3.09
Age (years)		61.99 ± 9.61
	≤ 59	59 (36.2)
	60–69	68 (41.7)
	≥ 70	36 (22.1)
Gender	Men	65 (39.9)
	Women	98 (60.1)
Religion	Yes	98 (60.1)
	No	65 (39.9)
Marital status	Married	130 (79.8)
	Single/Bereaved/divorced/separated	33 (20.2)
Employment status	Yes	72 (44.2)
	No	91 (55.8)
Education	≤ Middle school	26 (16.0)
	High school	64 (39.3)
	≥ College	73 (44.8)
Monthly household income (10,000 KRW)		500.43 ± 425.43
	≤ 299	48 (31.4)
	300–599	55 (35.9)
	≥ 600	50 (32.7)
Perceived economic status	Low	29 (17.8)
	Middle	94 (57.7)
	High	40 (24.5)
Health and illness related characteristics		
Body mass index (kg/m^2)		23.37 ± 2.72
	< 25	111 (68.1)
	≥ 25	52 (31.9)
Smoking status	Never-smoker	98 (60.1)
	Ex-smoker	65 (39.9)
Drinking status	Never-drinker	51 (31.3)
	Ex-drinker	96 (58.9)
	Current drinker	16 (9.8)

Characteristics	Categories	n (%) or M ± SD
Comorbidity by CCI score	2	111 (68.1)
	≥ 3	52 (31.9)
Preoperative PFT†	Normal	57 (35.6)
	Obstructive pattern	98 (61.3)
	Restrictive pattern	5 (3.1)
Weight change before/after surgery	Increased	31 (19.0)
	Maintained	50 (30.7)
	Decreased	82 (50.3)
Postoperative pathologic cancer stage	1A1	64 (39.3)
	1A2	60 (36.8)
	1A3	22 (13.5)
	1B	17 (10.4)
Cancer histology	Adenocarcinoma	156 (95.7)
	Others	7 (4.3)
Preoperative treatment	Yes	7 (4.3)
	No	156 (95.7)
Surgical approach	VATS	162 (99.4)
	Thoracotomy	1 (0.6)
Direction of surgery	Right	96 (58.9)
	Left	67 (41.1)
Number of surgery sites	1	150 (92.0)
	2	13 (8.0)
Location of surgery	Upper lobe	89 (56.0)
	Middle lobe	10 (6.3)
	Lower lobe	60 (37.7)
Extent of surgery	Lobectomy	63 (38.7)
	Segmentectomy	100 (61.3)
Operation time (min)		103.96 ± 48.09
	≤ 90	62 (38.0)
	> 90	101 (62.0)
Estimated blood loss (ml)	< 50	112 (68.7)
	≥ 50	51 (31.3)
Number of chest tube	1	133 (81.6)
	2	30 (18.4)
Duration of chest tube (days)		4.15 ± 1.77

Characteristics	Categories	n (%) or M ± SD
ICU admission after surgery		0 (0.0)
Hospital length of stay (days)		6.33 ± 2.00
	≤ 6	109 (66.9)
	≥ 7	54 (33.1)
Postoperative complication	Yes	25 (15.3)
	No	138 (84.7)
Environmental characteristics		
Living status	Living alone	18 (11.0)
	Living with family	145 (89.0)
Primary caregiver	Spouse	108 (66.3)
	Children	40 (24.5)
	Others	15 (9.2)
Discharge location	Home	149 (91.4)
	Hospital	14 (8.6)
Social support	Healthcare providers	5.65 ± 1.15
	Family	6.41 ± 1.01
	Friends	5.62 ± 1.48
	Total	5.90 ± 1.02

Note. M: Mean, SD: Standard deviation, CCI: Charlson comorbidity index, PFT: Pulmonary function test, VATS: Video assisted thoracoscopic surgery, ICU: Intensive care unit.

†Missing data, n = 150.

5.2. Participants' symptoms at each time point

The scores and rankings for symptom severity and interference reported by the participants at each time point are presented in Table 3 and Figure 5. Among the 16 symptoms at T1, when 163 participants responded, the top five symptoms with the highest severity were fatigue (tiredness), coughing, pain, shortness of breath, and drowsy (sleep). Among the six symptom interferences, the top three items were enjoyment of life, work, and general activity. At T2, when 138 participants responded, the top five symptoms with the highest severity were fatigue (tiredness), coughing, pain, lack of appetite, and shortness of breath, whereas the top three symptom interferences were work, general activity, and enjoyment of life. At T3, when 120 participants responded, the top five symptoms with the highest severity were fatigue (tiredness), coughing, shortness of breath, lack of appetite, and disturbed sleep, whereas the top three symptom interferences were enjoyment of life, work, and general activity. At T4, when 101 participants responded, the top five symptoms with the highest severity were fatigue (tiredness), coughing, drowsy (sleep), shortness of breath, and disturbed sleep, whereas the top three symptom interferences were enjoyment of life, mood, and general activity.

Next, the trends in change in symptom severity over time were identified. Among the 16 symptoms, the severity of 13 symptoms, excluding problem with remembering things, dry mouth, and feeling sad, increased more at T2 than at T1 and then gradually decreased at T3 and T4. Problem with remembering things and feeling sad gradually increased in severity from T1 to T3 but showed a decrease in severity at T4. In contrast, dry mouth

gradually decreased in severity from T1 to T4.

Among the 16 symptoms, fatigue (tiredness) had the highest severity at all four time points, indicating that fatigue was the symptom that participants found most distressing. Coughing was reported to have the second highest severity from T1 to T4. Pain was reported as the third most severe symptom in T1 and T2 but decreased in severity ranking in T3 (8^{th}) and T4 (11^{th}), indicating an improvement in participants' perceived severity of pain over time. Shortness of breath increased in severity in T3 (3^{rd}) and T4 (4^{th}) compared to that in T1 (4^{th}) and T2 (5^{th}), indicating a relative worsening over time.

Table 3 Characteristics of the participants' symptoms at each time point

Category	T1 (n = 163)			T2 (n = 138)			T3 (n = 120)			T4 (n = 101)		
	M	SD	Rank	M	SD	Rank	M	SD	Rank	M	SD	Rank
Severity												
Pain	3.75	2.71	3	4.13	2.41	3	2.90	2.47	8	2.17	1.98	11
Fatigue (tiredness)	4.15	2.81	1	4.75	2.30	1	3.98	2.30	1	3.34	2.39	1
Nausea	1.55	2.56	14	2.07	2.72	13	1.37	2.15	15	1.03	1.76	15
Disturbed sleep	2.63	2.95	10	3.52	2.87	7	3.33	2.81	5	2.68	2.47	5
Distressed (upset)	3.02	3.09	8	3.42	2.61	8	2.99	2.52	7	2.27	2.23	9
Shortness of breath	3.65	2.86	4	3.88	2.38	5	3.44	2.39	3	2.76	2.25	4
Problem with remembering things	1.76	2.38	13	2.01	2.15	14	2.33	2.24	13	2.26	2.26	10
Lack of appetite	3.09	3.15	7	4.07	2.92	4	3.40	2.74	4	2.49	2.29	6
Drowsy (sleep)	3.55	2.75	5	3.75	2.34	6	3.23	2.25	6	2.79	2.22	3
Dry mouth	3.02	2.95	8	2.90	2.41	11	2.57	2.26	10	2.32	2.41	8
Feeling sad	2.31	2.84	12	2.62	2.68	12	2.68	2.62	9	2.33	2.59	7
Vomiting	0.88	1.97	16	1.22	2.11	16	0.88	1.59	16	0.61	1.41	16
Numbness or tingling	2.43	2.76	11	3.07	2.60	10	2.56	2.36	11	2.06	2.15	12
Coughing	3.84	3.20	2	4.30	2.63	2	3.73	2.79	2	3.05	2.77	2
Constipation	3.17	3.45	6	3.30	2.98	9	2.48	2.66	12	1.74	2.30	13
Sore throat	1.40	2.32	15	1.75	2.18	15	1.73	2.17	14	1.43	2.01	14
Interference												
General activity	3.06	2.77	3	3.61	2.39	2	2.47	2.17	3	2.05	1.90	3
Mood	2.99	2.73	4	3.02	2.37	4	2.41	2.13	4	2.18	2.20	2
Work	3.24	2.94	2	4.01	2.64	1	2.67	2.38	2	1.88	2.01	4
Relations with people	2.67	2.93	5	2.86	2.80	5	2.01	2.29	5	1.67	1.83	5

Category	T1 (n = 163)			T2 (n = 138)			T3 (n = 120)			T4 (n = 101)		
	M	SD	Rank	M	SD	Rank	M	SD	Rank	M	SD	Rank
Walking	2.26	2.62	6	2.47	2.43	6	1.81	2.15	6	1.18	1.72	6
Enjoyment of life	3.36	3.03	1	3.38	2.53	3	2.79	2.43	1	2.20	2.13	1

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery, M: Mean, SD: Standard deviation.

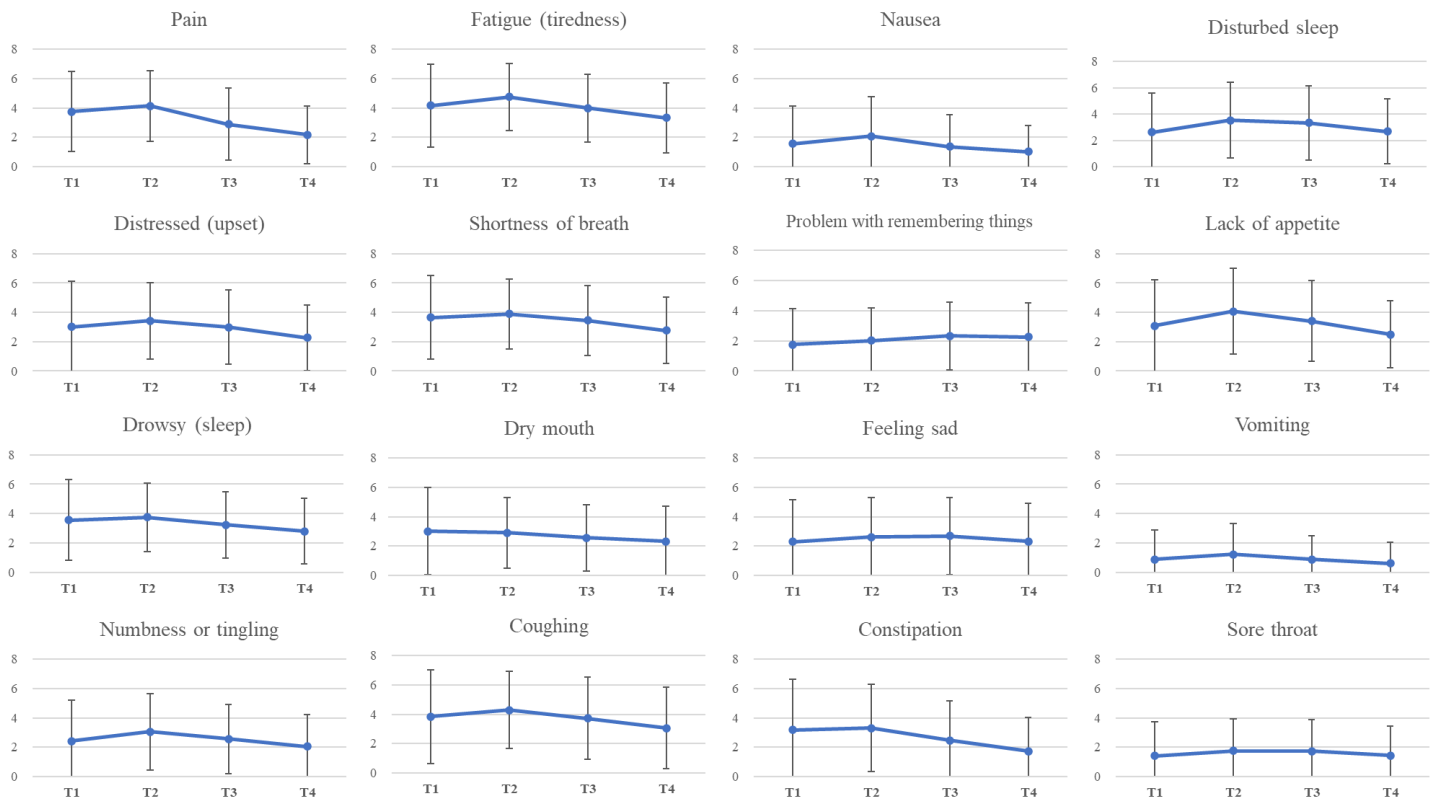

Figure 5 Mean scores of each symptom by time point

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery.

5.3. Participants' health outcomes over time

Participants' health outcomes comprise quality of life and return to care. The scores and trends for the subscales and total quality of life by time points are presented in Table 4 and Figure 6. The physical quality of life, which ranged from 0 to 28 points, decreased at T2 compared to that at T1, before gradually increasing. The social and family quality of life, which ranged from 0 to 28 points, gradually decreased from T1 to T4. The emotional quality of life, which ranged from 0 to 24 points, gradually increased from T1 to T4. The functional quality of life, which ranged from 0 to 28 points, decreased at T2 compared to that at T1, before gradually increasing. The total quality of life, which ranged from 0 to 108 points, decreased at T2 compared to that at T1, before gradually increasing.

Table 4 Participants' quality of life at each time point

Category	T1 (n = 163)		T2 (n = 138)		T3 (n = 120)		T4 (n = 101)	
	M	SD	M	SD	M	SD	M	SD
Physical QOL	19.40	5.85	19.07	5.53	21.39	4.67	22.65	4.67
Social/family QOL	18.86	6.43	17.80	5.98	17.34	5.75	16.66	6.32
Emotional QOL	17.96	4.63	18.05	4.56	18.05	4.32	18.31	4.33
Functional QOL	16.37	6.51	14.91	5.72	16.03	5.48	16.70	6.08
Total QOL	72.59	15.60	69.83	16.39	72.82	15.44	74.31	17.15

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery, M: Mean, SD: Standard deviation, QOL: Quality of life.

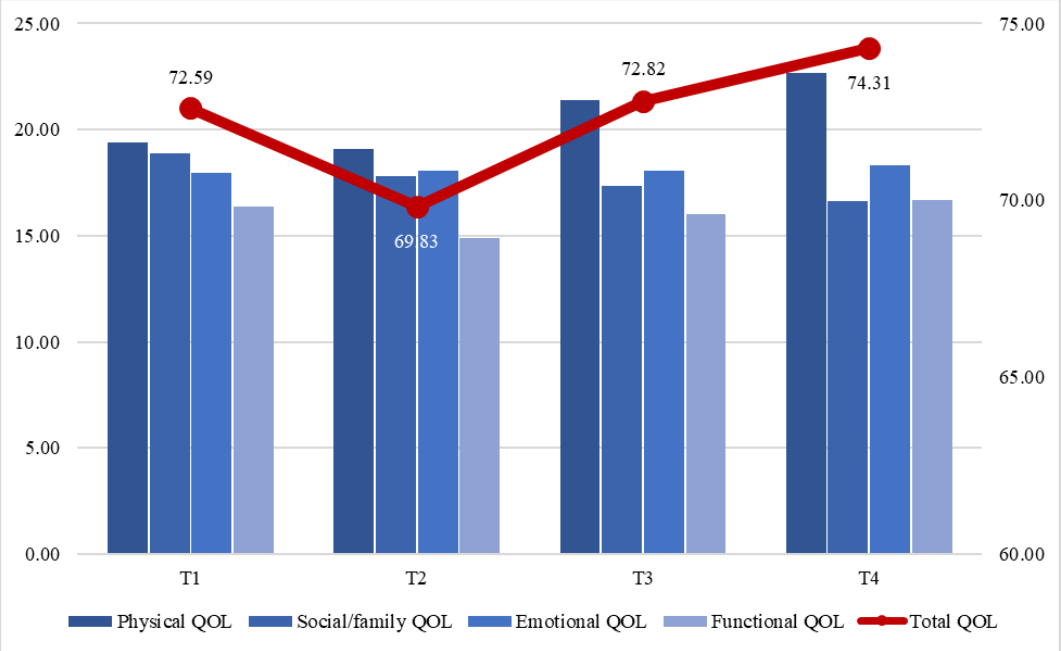

Figure 6 Mean scores of quality of life at each time point

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery, QOL: Quality of life.

Table 5 shows the frequency and percentage of return to care by time point. First, there were two (1.3%) unplanned outpatient clinic visits between T1 and T2, eight (6.0%) between T2 and T3, and one (0.9%) between T3 and T4. Emergency department visits occurred in three cases (1.9%) between T1 and T2 and one case (0.8%) between T2 and T3. Readmission occurred only once (0.8%) between T2 and T3.

During the entire data collection period, unplanned outpatient clinic visits occurred the most, with nine cases (5.8%), followed by emergency department visits, with four cases (2.6%), and readmission, with one case (0.6%). Total return to care occurred in five cases (3.2%) between T1 and T2, in ten cases (7.5%) between T2 and T3, and in one case (0.9%) between T3 and T4. In summary, the frequency of return to care was highest between T2 and T3.

In this study, participants' uncontrolled symptoms were the main cause of return to care. Participants with unplanned outpatient clinic visits primarily complained of pain (n = 6), respiratory symptoms such as cough and sputum (n = 4), and pyrosis (n = 2). Participants who visited the emergency department complained of pain (n = 1), dyspnea (n = 1), chills (n = 1), and fever and headache with vomiting (n = 1). Readmitted participants were admitted for PCD insertion due to pleural effusion (n = 1).

Table 5 Participants' return to care at each time point

Category	T1–T2 (n = 154)		T2–T3 (n = 133)		T3–T4 (n = 116)		Total (n = 154)	
	n	%	n	%	n	%	n	%
Unplanned outpatient clinic visit	2	1.3	8	6.0	1	0.9	9	5.8
Emergency department visit	3	1.9	1	0.8	0	0.0	4	2.6
Readmission	0	0.0	1	0.8	0	0.0	1	0.6
Total return to care	5	3.2	10	7.5	1	0.9	13	8.4

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery.

5.4. Types of symptom clusters at each time point

5.4.1. Identification of the optimal number of symptom clusters

The results of the model fit indices used to determine the appropriate number of symptom clusters for each time point through latent profile analysis are presented in Table 6. At T1, the AIC and SABIC of the information indices were the lowest in five groups, the BIC was the lowest in four groups, and the elbow points of the indicators were identified in three groups (Figure 7). Entropy, which indicates the quality of classification, was greater than 0.9 in all groups, indicating that the overall quality of classification was good. In the case of comparative verification of models, the *p*-value of LMR-LRT was > 0.05 in four groups, so three groups were significant and considered the appropriate number of groups. The *p*-value of BLRT was significant in 2–5 groups ($p < .001$).

At T2, the AIC, BIC, and SABIC of the information indices were the lowest in five groups, while the elbow points of the indicators were identified in three groups (Figure 8). Entropy was greater than 0.9 in all groups, indicating that the overall quality of classification was good. In the case of comparative verification of models, the *p*-value of LMR-LRT was > 0.05 in three groups, so two groups were significant and considered the appropriate number of groups. The *p*-value of BLRT was significant in 2–5 groups ($p < .001$).

At T3, the AIC, BIC, and SABIC of the information indices were the lowest in five groups, while the elbow points of the indicators were identified in three groups (Figure 9). Entropy was greater than 0.9 in all groups, indicating that the overall quality of classification was good. In the case of comparative verification of models, the *p*-value of LMR-LRT was > 0.05 in three groups, so two groups were significant and considered the appropriate number of groups. The p-value of BLRT was significant in 2–5 groups ($p < .001$).

At T4, the AIC and SABIC of the information indices were the lowest in five groups, the BIC was the lowest in four groups, while the elbow points of the indicators were identified in three groups (Figure 10). Entropy was greater than 0.9 in all groups, indicating that the overall quality of classification was good. In the case of comparative verification of models, the *p*-value of LMR-LRT was > 0.05 in three groups, so two groups were significant and considered the appropriate number of groups. The p-value of BLRT was significant in 2–5 groups ($p < .001$).

Considering several indices for the type of symptom cluster at each time point and the possibility of interpreting the symptom cluster itself, three symptom clusters were finally classified at each of the four time points.

Table 6 Model fit indices for symptom clusters at each time point

Time point	No of group	AIC	BIC	SABIC	Entropy	LMR-LRT (*p*-value)	BLRT (*p*-value)
T1	2	11942.049	12093.643	11938.516	.941	.024	< .001
	3	11662.798	11866.985	11658.039	.944	.038	< .001
	4	11483.813	11740.595	11477.828	.951	.419	< .001
	5	11459.873	11769.248	11452.662	.938	.565	< .001
T2	2	9650.157	9793.593	9638.573	.962	< .001	< .001
	3	9425.559	9618.758	9409.956	.931	.121	< .001
	4	9301.557	9544.520	9281.935	.945	.283	< .001
	5	9232.562	9525.287	9208.921	.945	.396	< .001
T3	2	7920.578	8056.342	7901.440	.963	.029	< .001
	3	7715.754	7898.620	7689.977	.958	.214	< .001
	4	7640.464	7870.431	7608.048	.926	.253	< .001
	5	7535.398	7812.467	7496.342	.946	.241	< .001
T4	2	6627.448	6755.589	6600.825	.974	.017	< .001
	3	6435.538	6608.136	6399.679	.941	.310	< .001
	4	6363.659	6580.714	6318.563	.954	.759	< .001
	5	6334.279	6595.791	6279.947	.967	.448	< .001

Note. No: Number, AIC: Akaike information criterion, BIC: Bayesian information criterion, SABIC: Sample-size adjusted bayesian information criterion, LMR-LRT: Lo–Mendell–Rubin likelihood ratio test, BLRT: Bootstrapped likelihood ratio test, T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery.

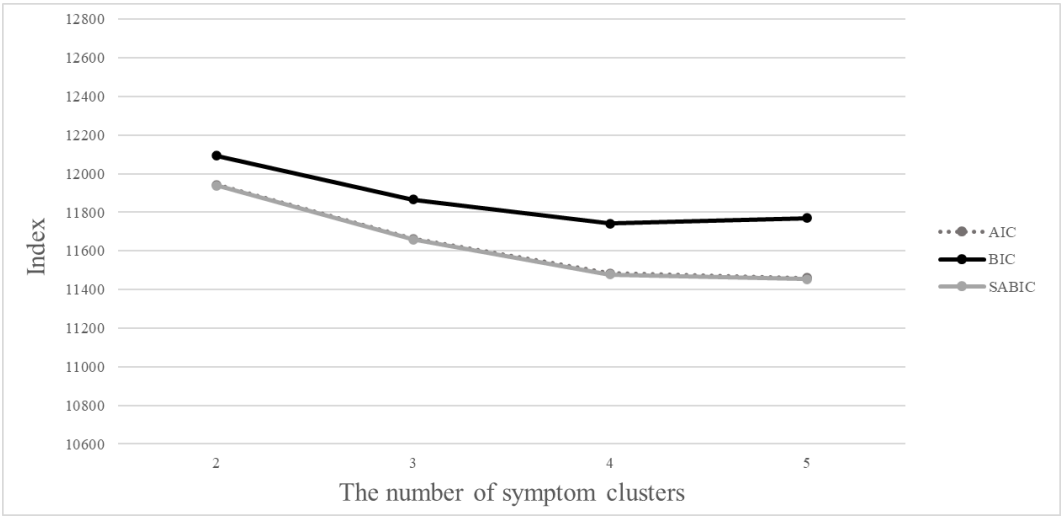

Figure 7 Model fit indices at time point 1

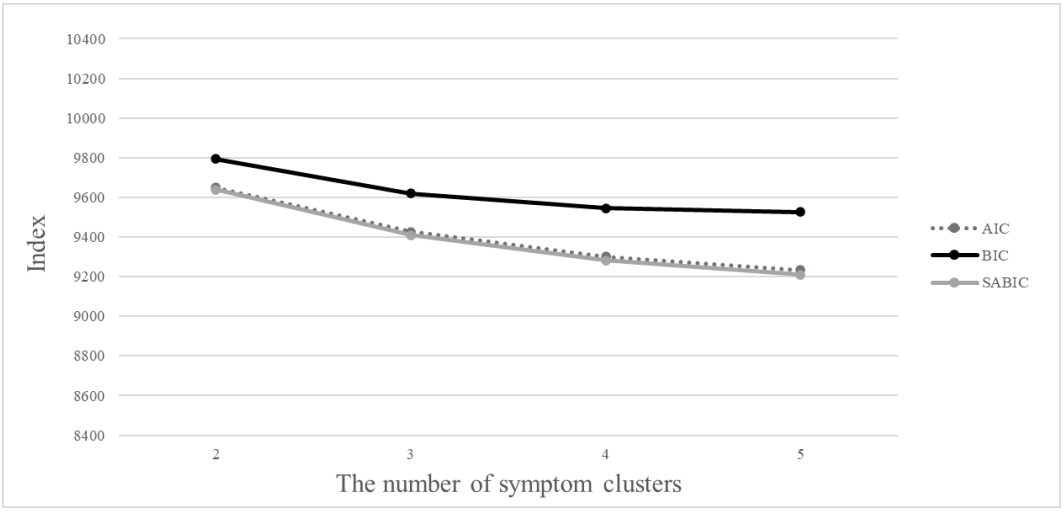

Figure 8 Model fit indices at time point 2

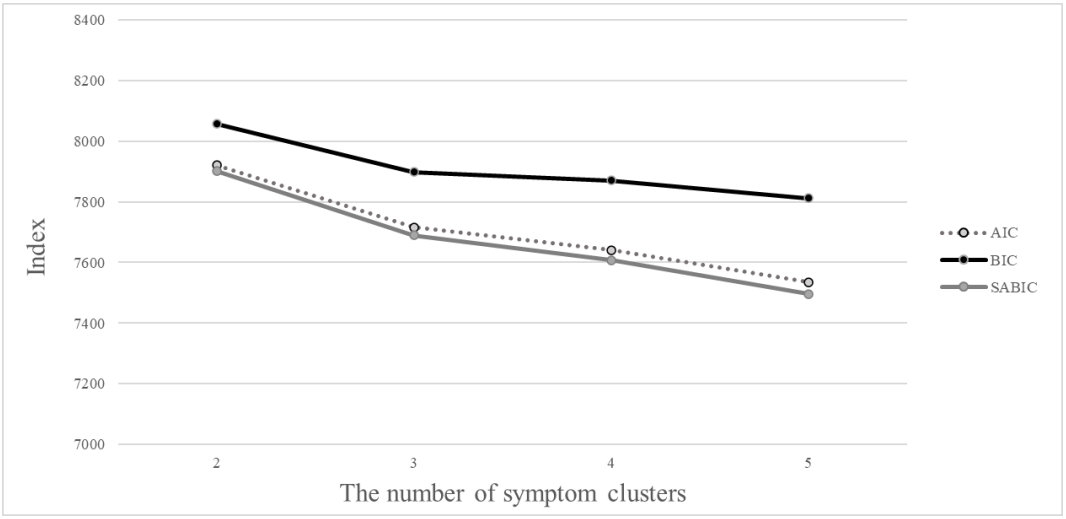

Figure 9 Model fit indices at time point 3

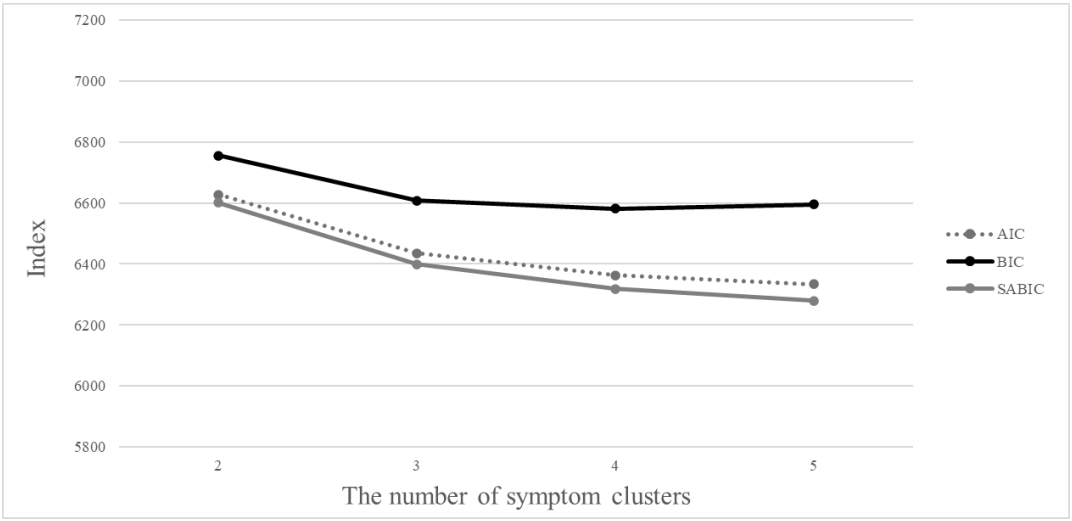

Figure 10 Model fit indices at time point 4

5.4.2. Types of symptom cluster

The proportion of participants belonging to each type of symptom cluster and the estimated mean severity of 16 symptoms from T1 to T4 using latent profile analysis are presented in Table 7. In this study, three types of symptom cluster were categorized based on the symptom severity scores reported by participants as follows: 1) low symptom cluster, 2) medium symptom cluster, and 3) high symptom cluster.

At T1, the first type of symptom cluster was the low symptom cluster, which accounted for the largest proportion of all participants at 44.2%, in which the average symptom severity ranged from 0.16 to 2.01 out of 10, representing low overall symptom severity; the second type was the medium symptom cluster, accounting for 39.3% of participants, in which the average symptom severity ranged from 0.63 to 5.34 out of 10, indicating medium overall symptom severity; and the third type was the high symptom cluster, accounting for 17.6% of participants, in which the average symptom severity ranged from 3.41 to 7.47 out of 10, showing high overall symptom severity (Figure 11).

At T2, the low symptom cluster accounted for 41.3% of participants, in which the average symptom severity ranged from 0.32 to 2.80 out of 10, representing low overall symptom severity; the medium symptom cluster accounted for 41.3% of participants, in which the average symptom severity ranged from 1.01 to 5.58 out of 10, indicating medium overall symptom severity; and the high symptom cluster accounted for 17.4% of participants, in which the average symptom severity ranged from 3.78 to 7.30 out of 10, showing high overall symptom severity (Figure 12).

At T3, the low symptom cluster accounted for the largest proportion of all participants at 59.3%, in which the average symptom severity ranged from 0.24 to 2.76 out of 10, presenting low overall symptom severity; the medium symptom cluster accounted for 28.8% of the total participants, in which the average symptom severity ranged from 0.74 to 5.27 out of 10, indicating medium overall symptom severity; and the high symptom cluster accounted for 11.9% of participants, in which the average symptom severity ranged from 4.00 to 7.09 out of 10, showing high overall symptom severity (Figure 13).

At T4, the low symptom cluster accounted for the largest proportion of all participants at 46.5%, in which the average symptom severity ranged from 0.07 to 1.84 out of 10, presenting low overall symptom severity; the medium symptom cluster accounted for 41.6% of the total participants, in which the average symptom severity ranged from 0.70 to 4.26 out of 10, indicating medium overall symptom severity; and the high symptom cluster accounted for 11.9% of the participants, in which the average symptom severity ranged from 2.42 to 7.33 out of 10, showing high overall symptom severity (Figure 14).

Table 7 Number, proportion, and mean symptom severity of different symptom clusters at each time point

Category	T1 (n = 163)			T2 (n = 138)			T3 (n = 120)			T4 (n = 101)		
	L	M	H	L	M	H	L	M	H	L	M	H
n (%)	72 (44.2)	64 (39.3)	27 (17.6)	57 (41.3)	57 (41.3)	24 (17.4)	70 (59.3)	34 (28.8)	14 (11.9)	47 (46.5)	42 (41.6)	12 (11.9)
Pain	0.88	3.62	7.24	1.46	4.01	6.59	1.45	4.76	5.80	0.81	2.77	6.17
Fatigue (tiredness)	1.47	4.66	6.95	2.08	4.52	6.58	2.14	4.80	6.09	1.31	3.40	6.17
Nausea	0.44	2.36	3.82	0.86	2.07	4.58	1.08	3.68	4.79	0.94	2.68	5.92
Disturbed sleep	0.83	4.23	6.35	1.85	5.01	7.00	2.00	4.64	6.81	0.90	3.30	5.75
Distressed (upset)	1.48	4.73	6.17	2.15	4.33	6.14	1.99	4.55	5.93	1.45	3.48	5.59
Shortness of breath	1.15	3.32	7.25	1.08	3.41	5.93	1.15	3.88	5.94	0.85	2.68	6.75
Problem with remembering things	0.89	2.31	6.04	0.94	2.63	6.46	1.13	4.24	6.08	0.68	2.94	6.58
Lack of appetite	0.16	0.63	3.41	0.32	1.01	3.78	0.24	0.74	4.15	0.07	0.70	2.42
Drowsy (sleep)	0.88	3.62	7.24	1.46	4.01	6.59	1.45	4.76	5.80	0.81	2.77	6.17
Dry mouth	1.47	4.66	6.95	2.08	4.52	6.58	2.14	4.80	6.09	1.31	3.40	6.17
Feeling sad	0.44	2.36	3.82	0.86	2.07	4.58	1.08	3.68	4.79	0.94	2.68	5.92
Vomiting	0.83	4.23	6.35	1.85	5.01	7.00	2.00	4.64	6.81	0.90	3.30	5.75

Category	T1 (n = 163)			T2 (n = 138)			T3 (n = 120)			T4 (n = 101)		
	L	M	H	L	M	H	L	M	H	L	M	H
Numbness or tingling	0.99	2.63	5.77	1.25	3.48	6.31	1.38	3.63	5.29	0.75	2.79	4.58
Coughing	2.01	4.37	7.42	2.75	4.71	6.91	2.48	5.27	6.16	1.13	4.26	6.25
Constipation	1.74	3.76	5.51	1.92	3.57	5.91	1.41	2.73	7.09	0.95	1.65	5.17
Sore throat	0.38	1.19	4.64	0.81	1.63	4.18	1.00	2.01	4.00	0.33	1.93	3.92

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery, L: Low symptom cluster, M: Medium symptom cluster, H: High symptom cluster.

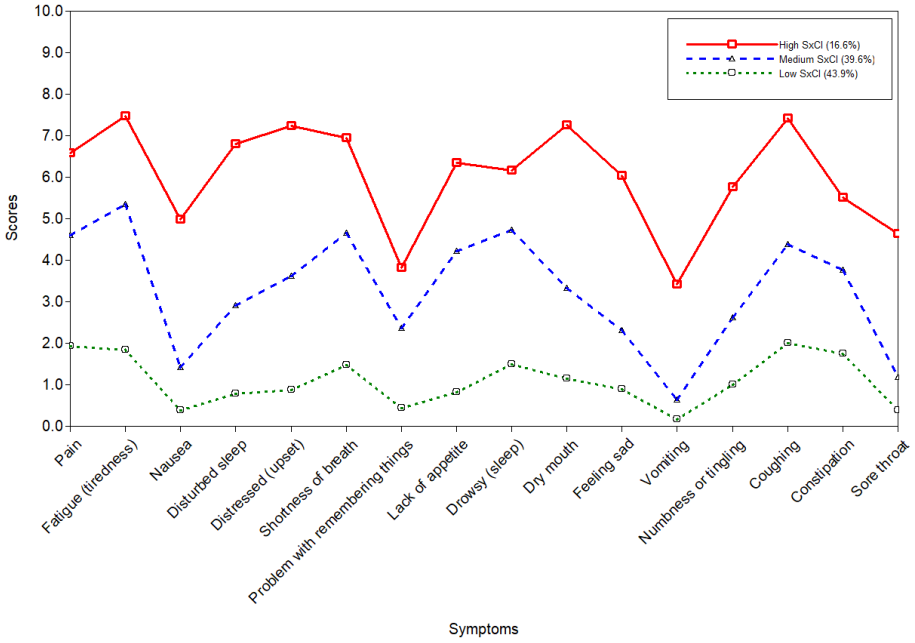

Figure 11 Types of symptom cluster at time point 1

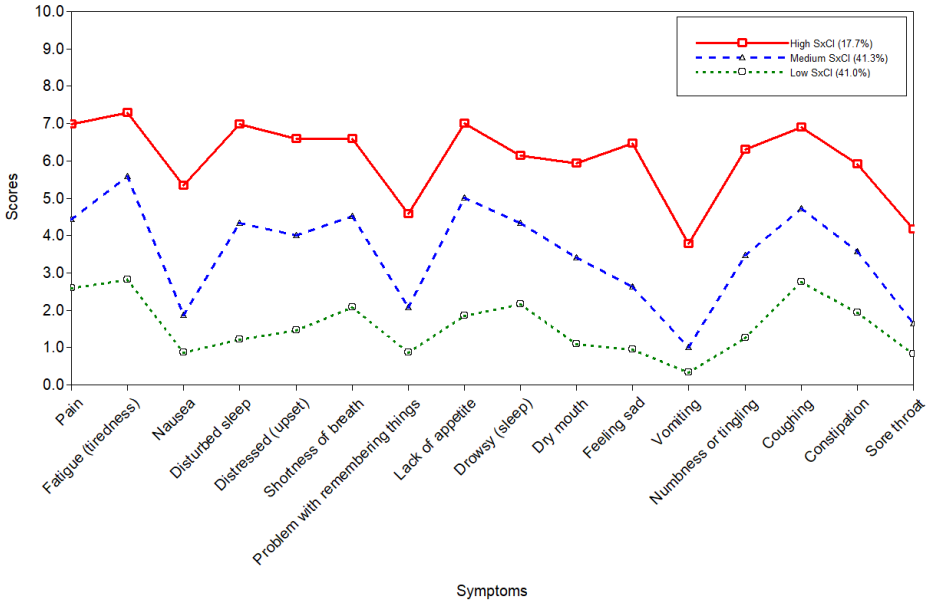

Figure 12 Types of symptom cluster at time point 2

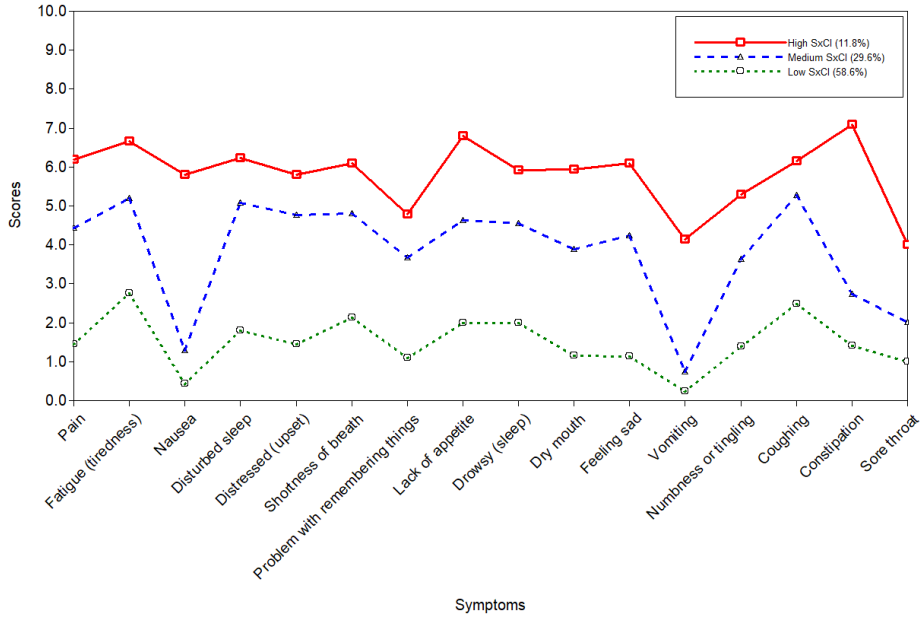

Figure 13 Types of symptom cluster at time point 3

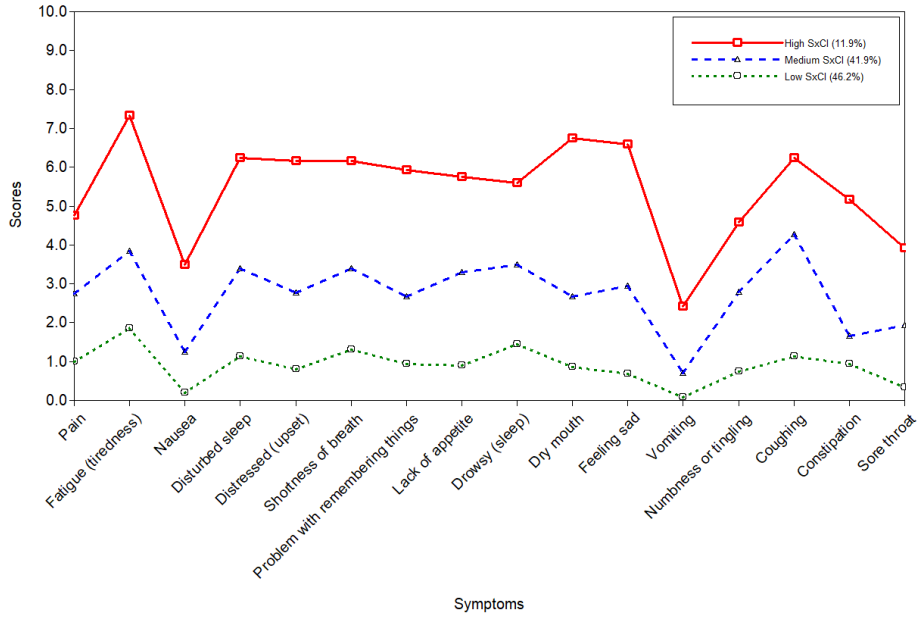

Figure 14 Types of symptom cluster at time point 4

Figure 15 shows the probability of participants belonging to each symptom cluster at each time point. At all time points, many participants (41.3%–59.3%) were likely to belong to the low symptom cluster, with an increase at T3 (59.3%) and then a decrease at T4 (46.5%). The probability of participants belonging to the medium symptom cluster was the second highest at all time points (28.8%–41.6%), with a decrease at T3 (28.8%) and then an increase at T4 (41.6%). The probability of participants belonging to the high symptom cluster was the lowest at all time points (11.9%–17.6%), with a decreasing trend over time.

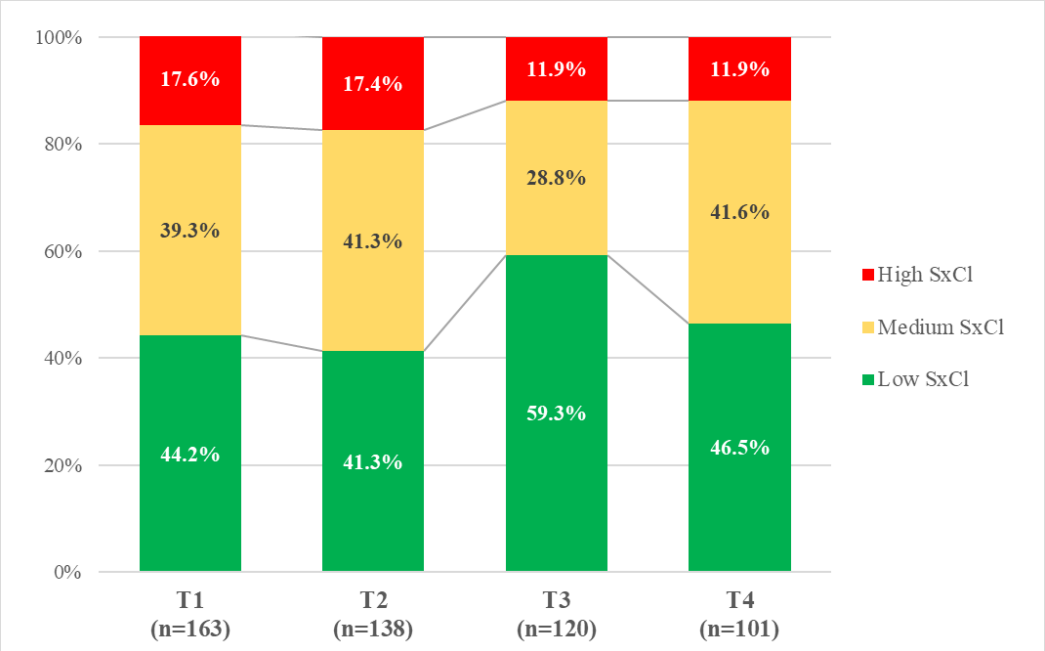

Figure 15 Probabilities of symptom clusters at each time point

Note. T1: First outpatient clinic visit after surgery (enroll date), T2: 4 weeks after surgery, T3: 8 weeks after surgery, T4: 12 weeks after surgery, SxCl: Symptom cluster.

5.5. Transition patterns of symptom clusters

5.5.1. Latent transition analysis of symptom clusters

Table 8 and Figure 16 show the results of latent transition analysis between T1 and T4, which was conducted to identify the transition pattern of the symptom cluster to which the participants belonged. First, participants that belonged to the low symptom cluster at T1 were highly likely to belong to the same type at T4 (61.7%). In contrast, 34.9% of these participants belonged to the medium symptom cluster at T4, and 3.5% belonged to the high symptom cluster at T4, resulting in worsening symptoms. Second, participants that belonged to the medium symptom cluster at T1 were also likely to belong to the same type at T4 (43.3%). Among these participants, 33.9% belonged to the low symptom cluster at T4, indicating that their symptoms improved, while 22.8% belonged to the high symptom cluster at T4, indicating that their symptoms worsened. Finally, participants that belonged to the high symptom cluster at T1 were highly likely to belong to the other symptom clusters at T4. Only 14.3% still belonged to the same high symptom cluster at T4, whereas 85.7% belonged to the medium symptom cluster at T4, indicating improved symptoms.

Table 8 Latent transition probabilities of symptom clusters between time points 1 and 4

	T4		
T1	Low SxCl (n = 47, 46.5%)	Medium SxCl (n = 42, 41.6%)	High SxCl (n = 12, 11.9%)
Low SxCl (n = 54, 53.5%)	.617	.349	.035
Medium SxCl (n = 40, 39.6%)	.339	.433	.228
High SxCl (n = 7, 6.9%)	.000	.857	.143

Note. T1: First outpatient clinic visit after surgery (enroll date), T4: 12 weeks after surgery, SxCl: Symptom cluster.

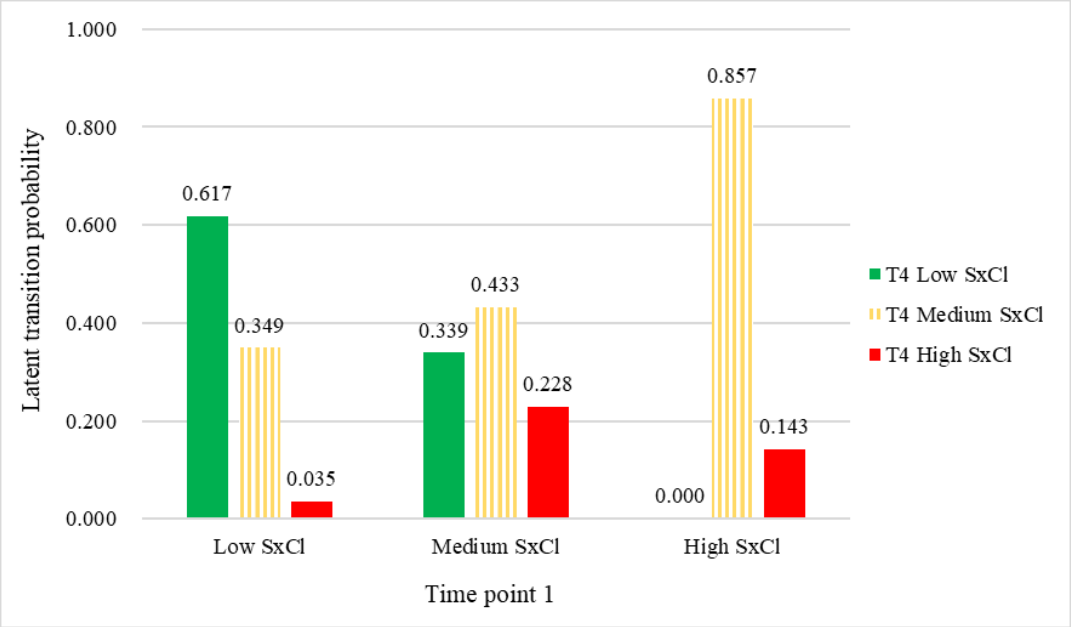

Figure 16 Latent transition probabilities of symptom clusters between time points 1 and 4

Note. T4: 12 weeks after surgery, SxCl: Symptom cluster.

5.5.2. Transition patterns of symptom clusters

The classification, frequencies, and percentages according to the transition patterns of symptom clusters between T1 and T4 are shown in Figure 17 and Table 9. Three types of symptom clusters, including low, medium, and high symptom clusters, were identified at each time point. Between T1 and T4, nine transition patterns were classified and categorized into three transition patterns based on symptom severity characteristics: stayer, worsened mover, and improved mover (Table 9).

Stayer refers to a participant with the same type of symptom clusters at T1 and T4, from low to low, medium to medium, or high to high. Approximately half of the participants were classified as stayers (50.5%), among whom, those in the low symptom cluster at both time points accounted for the largest proportion (64.7%).

Worsened mover refers to a participant whose symptom cluster at T4 worsened compared to that at T1, including those who moved from low to medium, low to high, or medium to high symptom clusters. Worsened movers accounted for 29.7% of all participants, with those who moved from low to medium symptom clusters being the most common (63.3%).

Improved mover refers to a participant whose symptom cluster at T4 was alleviated compared to that at T1, including those who moved from medium to low, high to low, or high to medium symptom clusters. Improved movers accounted for 19.8% of the participants, with moving from medium to low symptom clusters being the most common (70.0%). Conversely, there was no movement from high to low symptom clusters.

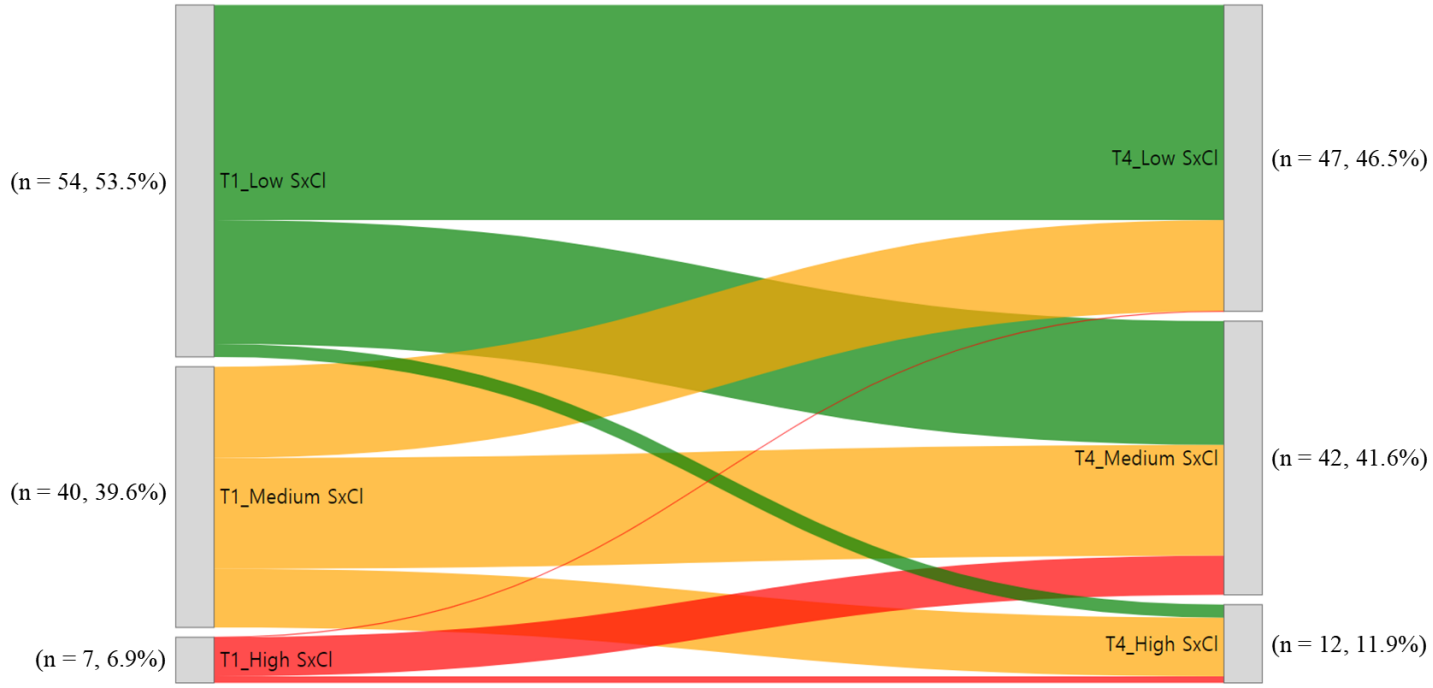

Figure 17 Transition patterns of symptom cluster between time points 1 and 4

Note. T1: First outpatient clinic visit after surgery (enroll date), T4: 12 weeks after surgery, SxCl: Symptom cluster.

Table 9 Frequency and percentage of each transition pattern of symptom cluster between time points 1 and 4

Transition pattern	T1	T4	n	% within transition patterns	% of total sample
Stayer	Low SxCl	Low SxCl	33	64.7	32.7
(n = 51, 50.5%)	Medium SxCl	Medium SxCl	17	33.3	16.8
	High SxCl	High SxCl	1	2.0	1.0
Worsened mover	Low SxCl	Medium SxCl	19	63.3	18.8
(n = 30, 29.7%)	Low SxCl	High SxCl	2	6.7	2.0
	Medium SxCl	High SxCl	9	30.0	8.9
Improved mover	Medium SxCl	Low SxCl	14	70.0	13.9
(n = 20, 19.8%)	High SxCl	Low SxCl	0	0.0	0.0
	High SxCl	Medium SxCl	6	30.0	5.9

Note. T1: First outpatient clinic visit after surgery (enroll date), T4: 12 weeks after surgery, SxCl: Symptom cluster.

5.5.3. Factors associated with the transition patterns of symptom clusters

Table 10 shows the factors associated with the transition pattern of symptom clusters between T1 and T4, as classified by latent transition analysis using multinomial logistic regression. The results are presented for worsened and improved movers, with the reference group set to stayers.

Among general characteristics, there were no significant factors associated with the transition pattern of symptom clusters.

Among health and illness-related characteristics, body mass index and location of surgery were identified as significant factors. Participants with a higher body mass index were less likely to be worsened movers than stayers (p = .031), while those who underwent surgery on the middle lobe compared to the lower lobe were more likely to be worsened movers than stayers (p = .013).

Among environmental characteristics, there were no significant factors associated with the transition pattern of symptom clusters.

Table 10 Factors associated with the transition patterns of symptom clusters between time points 1 and 4

Variable	Worsened mover			Improved mover		
	B	SE	*p*-value	*B*	SE	*p*-value
General characteristics						
Age	−0.026	0.034	.447	0.011	0.042	.799
Gender (ref: men)	−0.659	0.600	.272	1.021	0.828	.218
Religion (ref: yes)	−0.773	0.589	.190	0.771	0.671	.251
Marital status (ref: non-married)	−0.539	0.617	.382	−0.493	0.742	.506
Employment status (ref: yes)	0.906	0.563	.108	1.238	0.739	.094
Education (ref: ≥ college)						
Middle school	0.441	0.854	.606	0.777	0.997	.436
High school	1.217	0.625	.052	0.797	0.746	.285
Monthly household income (10,000 KRW)	0.000	0.001	.973	0.001	0.001	.143
Perceived economic status (ref: low)						
High	0.335	0.917	.715	0.500	1.107	.651
Middle	0.436	0.706	.537	0.451	0.908	.620
Health and illness-related characteristics						
Body mass index (kg/m^2)	−0.235	0.109	.031*	−0.186	0.123	.129
Smoking status (ref: ex-smoker)	0.052	0.575	.928	0.489	0.681	.472
Drinking status (ref: current drinker)						
Never drinker	−0.868	0.966	.369	0.432	1.318	.743
Ex-drinker	−1.271	0.857	.138	−0.101	1.245	.935
Comorbidity by CCI score	0.172	0.380	.652	−0.454	0.579	.434
Preoperative PFT (ref: abnormal)	0.195	0.501	.698	−0.872	0.624	.163
Weight change before/after surgery (ref: decreased)						
Increased	−0.765	0.714	.284	−0.381	0.761	.616
Maintained	−0.182	0.572	.751	−0.494	0.672	.462
Postoperative pathologic cancer stage	0.263	0.267	.324	0.086	0.304	.777

Variable	Worsened mover			Improved mover		
	B	SE	*p*-value	*B*	SE	*p*-value
Preoperative treatment (ref: yes)	−0.724	1.354	.593	−1.192	1.206	.323
Direction of surgery (ref: left)	−0.262	0.532	.622	−0.519	0.564	.357
Number of surgery sites	0.638	0.972	.512	0.998	1.099	.364
Location of surgery (ref: lower lobe)						
Upper lobe	0.315	0.568	.579	0.310	0.580	.593
Middle lobe	3.351	1.355	.013*	1.145	1.593	.473
Extent of surgery (ref: segmentectomy)	−1.024	0.641	.110	0.106	0.639	.869
Operation time	0.000	0.005	.927	−0.006	0.010	.538
Estimated blood loss (ml) (ref: ≥ 50)	0.413	0.581	.476	0.232	0.601	.700
Hospital length of stay	0.146	0.175	.402	0.136	0.209	.517
Postoperative complication (ref: yes)	−1.113	0.776	.152	1.572	1.344	.242
Environmental characteristics						
Primary caregiver (ref: other)						
Spouse	0.539	0.864	.533	0.028	0.884	.975
Children	0.874	0.945	.355	0.587	0.968	.544
Social support	−0.110	0.236	.642	−0.156	0.268	.560

Note. ref: Reference category = stayer, SE: Standard error, CCI: Charlson comorbidity index, PFT: Pulmonary function test.

* $p < .05$, ** $p < .001$

5.6. Health outcomes and associated factors

5.6.1. Differences in health outcomes according to the participants' characteristics

The differences in quality of life at 12 weeks after surgery according to the participants' general characteristics, health and illness-related characteristics, and environmental characteristics are presented in Table 11. Among the general characteristics, there were differences in quality of life according to monthly household income and perceived economic status. The higher the participant's monthly household income, the higher the quality of life (r = .263, p = .008). Participants with high, medium, and low perceived economic status had quality of life scores of 78.74, 75.73, and 63.93, respectively, with significant differences observed among the three groups (F = 4.578, p = .013). Among the health and illness-related characteristics, quality of life was associated with operation time, in that the quality of life decreased with increasing operation time (r = −.253, p = .011). Among the environmental characteristics, the quality of life differed according to the discharge location and social support. The quality of life of participants discharged home (75.35) was higher than that of participants discharged to the hospital (60.43) (t = 2.322, p = .026). Additionally, higher social support from healthcare providers (r = .220, p = .027), social support from family (r = .312, p = .001), and total social support (r = .285, p = .004) were associated with higher quality of life.

Table 11 Differences in quality of life at time point 4 according to the participants' characteristics (n = 101)

Characteristics	n	Total QOL	T or F or r (*p*)
General characteristics			
Age (years)		NA	−0.148 (.140)
≤ 59	36	76.36 ± 18.48	0.508 (.603)
60–69	42	73.94 ± 17.27	
≥ 70	23	71.80 ± 14.96	
Gender			
Men	35	74.96 ± 13.74	3.102 (.784)
Women	66	73.97 ± 18.80	
Religion			
Yes	63	73.93 ± 17.13	0.033 (.772)
No	38	74.96 ± 17.40	
Marital status			
Married	79	75.73 ± 17.05	0.248 (.116)
Single/Bereaved/divorced/separated	22	69.22 ± 16.91	
Employment status			
Yes	47	75.73 ± 16.25	0.467 (.441)
No	54	73.08 ± 17.96	
Education			
≤ Middle school	18	70.06 ± 15.83	0.832 (.438)
High school	37	74.05 ± 17.66	
≥ College	46	76.19 ± 17.28	
Monthly household income (10,000 KRW)			
≤ 299	31	70.46 ± 15.16	2.599 (.079)
300–599	38	72.88 ± 18.10	
≥ 600	32	79.74 ± 16.95	
Perceived economic status			
Low	18	63.93 ± 18.39	4.578 (.013)*
Middle	60	75.73 ± 15.85	
High	23	78.74 ± 16.96	
Health and illness-related characteristics			
Body mass index (kg/m^2)		NA	−0.025 (.803)
< 25	72	74.94 ± 15.87	0.574 (.567)
≥ 25	29	72.76 ± 20.21	

Characteristics	n	Total QOL	T or F or r (*p*)
Smoking status			
Never-smoker	64	72.98 ± 19.05	0.178 (.837)
Ex-smoker	37	74.88 ± 13.47	
Drinking status			
Never-drinker	35	71.99 ± 20.62	0.491 (.614)
Ex-drinker	57	75.49 ± 15.49	
Current drinker	9	75.93 ± 12.40	
Comorbidity by CCI score		NA	−0.022 (.824)
2	70	73.77 ± 17.42	0.004 (.635)
≥ 3	31	75.54 ± 16.73	
Preoperative PFT			
Normal	40	72.34 ± 17.14	0.096 (.351)
Abnormal	61	75.61 ± 17.17	
Weight change before/after surgery			
Increased	21	70.71 ± 17.51	0.725 (.487)
Maintained	25	76.43 ± 17.61	
Decreased	45	74.35 ± 16.73	
Postoperative pathologic cancer stage			
1A1	37	73.21 ± 17.83	1.109 (.349)
1A2	35	78.28 ± 14.06	
1A3	18	69.93 ± 19.90	
1B	11	72.58 ± 18.83	
Cancer histology			
Adenocarcinoma	98	74.24 ± 17.30	0.553 (.811)
Others	3	76.67 ± 13.20	
Preoperative treatment			
Yes	5	75.13 ± 14.82	0.280 (.913)
No	96	74.27 ± 17.33	
Direction of surgery			
Right	59	73.29 ± 16.53	0.147 (.478)
Left	42	75.76 ± 18.09	
Number of surgery sites			
1	92	74.62 ± 17.32	0.236 (.574)
2	9	71.22 ± 15.86	

Characteristics	n	Total QOL	T or F or r (*p*)
Location of surgery			
Upper lobe	58	75.61 ± 16.94	0.416 (.661)
Middle lobe	6	70.19 ± 17.14	
Lower lobe	36	73.12 ± 17.95	
Extent of surgery			
Lobectomy	45	73.94 ± 19.00	1.116 (.847)
Segmentectomy	56	74.61 ± 15.68	
Operation time (minutes)		NA	−0.253 (.011)*
≤ 90	31	77.70 ± 13.98	3.095 (.188)
> 90	70	72.81 ± 18.27	
Estimated blood loss (ml)			
< 50	68	75.38 ± 16.22	0.808 (.374)
≥ 50	33	72.12 ± 19.00	
Number of chest tube			
1	79	74.42 ± 16.10	1.731 (.905)
2	22	73.92 ± 20.92	
Duration of chest tube (days)		NA	−0.184 (.066)
Hospital length of stay (days)		NA	−0.184 (.065)
≤ 6	66	74.99 ± 16.32	0.743 (.587)
≥ 7	35	73.03 ± 18.80	
Postoperative complication			
Yes	16	67.04 ± 15.56	0.118 (.064)
No	85	75.68 ± 17.17	
Environmental characteristics			
Living status			
Living alone	12	69.70 ± 15.93	0.008 (.324)
Living with family	89	74.93 ± 17.30	
Primary caregiver			
Spouse	67	75.11 ± 18.00	0.223 (.800)
Children	24	73.04 ± 15.03	
Others	10	72.03 ± 17.29	
Discharge location			
Home	94	75.35 ± 16.40	2.322 (.026)*
Hospital	7	60.43 ± 22.16	

Characteristics	n	Total QOL	T or F or r (*p*)
Social support			
Healthcare providers		NA	.220 (.027)*
Family		NA	.312 (.001)*
Friends		NA	.183 (.066)
Total		NA	.285 (.004)*

Note. QOL: Quality of life, NA: Not applicable, CCI: Charlson comorbidity index, PFT: Pulmonary function test.

* $p < .05$, ** $p < .001$

Table 12 shows the differences in the occurrence of return to care depending on the participant's general characteristics, health and illness-related characteristics, and environmental characteristics. At each time point, the participant's electronic medical record was reviewed to determine whether there was more than one return to care, including unplanned outpatient clinic visits, emergency department visits, and readmission. Among all participant's characteristics, there were no significant variables that differed in the occurrence of return to care.

Table 12 Differences in return to care until time point 4 according to the participants' characteristics

Variables	Return to care				*p*-value†
	Yes		No		
	n	%	n	%	
General characteristics					
Age (years)					
≤ 59	3	5.5	52	94.5	.348
60–69	5	7.8	59	92.2	
≥ 70	5	14.3	30	85.7	
Gender					
Men	6	10.2	53	89.8	.563
Women	7	7.4	88	92.6	
Religion					
Yes	8	8.4	87	91.6	> .999
No	5	8.5	54	91.5	
Marital status					
Married	11	9.1	110	90.9	.736
Single/Bereaved/divorced/separated	2	6.1	31	93.9	
Employment status					
Yes	4	6.0	63	94.0	.393
No	9	10.3	78	89.7	
Education					
≤ Middle school	1	4.2	23	95.8	.582
High school	7	11.3	55	88.7	
≥ College	5	7.4	63	92.6	
Monthly household income (10,000 KRW)					
≤ 299	3	6.4	44	93.6	.769
300–599	6	10.5	51	89.5	
≥ 600	4	8.0	46	92.0	
Perceived economic status					
Low	3	11.1	24	88.9	.557
Middle	6	6.7	84	93.3	
High	4	10.8	33	89.2	

Variables	Return to care				*p*-value†
	Yes		No		
	n	%	n	%	
Health and illness-related characteristics					
Body mass index (kg/m^2)					
< 25	7	6.8	96	93.2	.358
≥ 25	6	11.8	45	88.2	
Smoking status					
Never-smoker	9	9.7	84	90.3	.567
Ex-smoker	4	6.6	57	93.4	
Drinking status					
Never-drinker	3	6.1	46	93.9	.828
Ex-drinker	9	10.1	80	89.9	
Current drinker	1	6.3	15	93.8	
Comorbidity by CCI score					
2	9	8.5	97	91.5	> .999
≥ 3	4	8.3	44	91.7	
Preoperative PFT					
Normal	6	11.3	47	88.7	.372
Abnormal	7	6.9	94	93.1	
Weight change before/after surgery					
Increased	3	10.3	26	89.7	.144
Maintained	1	2.1	46	97.9	
Decreased	9	11.5	69	88.5	
Postoperative pathologic cancer stage					
1A1	7	11.9	52	88.1	.774
1A2	4	7.1	52	92.9	
1A3	1	4.5	21	95.5	
1B	1	5.9	16	94.1	
Cancer histology					
Adenocarcinoma	12	8.2	135	91.8	.468
Others	1	14.3	6	85.7	
Preoperative treatment					
Yes	1	14.3	6	85.7	.468
No	12	8.2	135	91.8	

Variables	Return to care				*p*-value†
	Yes		No		
	n	%	n	%	
Direction of surgery					
Right	8	9.0	81	91.0	> .999
Left	5	7.7	60	92.3	
Number of surgery sites					
1	13	9.2	128	90.8	.604
2	0	0.0	13	100.0	
Location of surgery					
Upper lobe	6	7.0	80	93.0	.547
Middle lobe	1	11.1	8	88.9	
Lower lobe	6	10.9	49	89.1	
Extent of surgery					
Lobectomy	5	8.1	57	91.9	.568
Segmentectomy	8	8.7	84	91.3	
Operation time (minutes)					
≤ 90	5	9.1	50	90.9	> .999
> 90	8	8.1	91	91.9	
Estimated blood loss (ml)					
< 50	7	6.5	101	93.5	.210
≥ 50	6	13.0	40	87.0	
Number of chest tube					
1	11	8.9	113	91.1	> .999
2	2	6.7	28	93.3	
Hospital length of stay (days)					
≤ 6	8	7.9	93	92.1	.766
≥ 7	5	9.4	48	90.6	
Postoperative complication					
Yes	2	8.0	23	92.0	> .999
No	11	8.5	118	91.5	
Environmental characteristics					
Living status					
Living alone	1	5.6	17	94.4	> .999
Living with family	12	8.8	124	91.2	

Variables	Return to care				*p*-value†
	Yes		No		
	n	%	n	%	
Primary caregiver					
Spouse	10	9.9	91	90.1	.813
Children	2	5.3	36	94.7	
Others	1	6.7	14	93.3	
Discharge location					
Home	13	9.3	127	90.7	.610
Hospital	0	0.0	14	100.0	

Note. CCI: Charlson comorbidity index, PFT: Pulmonary function test.

†Fisher's exact test.

* $p < .05$, ** $p < .001$

5.6.2. Differences in health outcomes according to the types of symptom cluster

Table 13 shows the differences in quality of life at T4 according to the types of symptom cluster at T1 classified by latent profile analysis. The results revealed a significant difference in physical quality of life depending on the types of symptom cluster ($\chi^2 = 19.51$, $p < .001$). Post hoc comparisons showed that participants in the low symptom cluster (24.29) and medium symptom cluster (23.31) had a higher physical quality of life than those in the high symptom cluster (18.65).

Additionally, there was a significant difference in the emotional quality of life based on the types of symptom cluster ($\chi^2 = 9.13$, $p = .010$). In the post-hoc comparison, the emotional quality of life of participants in the low symptom cluster (19.50) and medium symptom cluster (18.61) was higher than that of participants in the high symptom cluster (15.68).

The results also revealed a significant difference in the functional quality of life based on the types of symptom cluster ($\chi^2 = 6.84$, $p = .033$). In the post-hoc comparison, the functional quality of life of participants in the low symptom cluster (18.20) and medium symptom cluster (17.05) was higher than that of participants in the high symptom cluster (13.46).

Additionally, there was a significant difference in the total quality of life based on the types of symptom cluster ($\chi^2 = 7.95$, $p = .019$). In the post-hoc comparison, the total quality of life of participants in the low symptom cluster (78.04) and medium symptom cluster

(76.82) was higher than that of participants in the high symptom cluster (63.64).

However, social/family quality of life did not differ significantly by types of symptom cluster.

Table 13 Differences in quality of life at time point 4 according to the types of symptom cluster at time point 1

Category	Low SxCl[a]		Medium SxCl[b]		High SxCl[c]		χ^2
	M	SE	M	SE	M	SE	(*p*-value)
Physical QOL	24.29	0.63	23.31	0.42	18.65	1.24	16.51 (< .001)** a, b > c
Social/family QOL	16.06	1.01	17.85	0.94	15.85	1.46	2.10 (.349)
Emotional QOL	19.50	0.55	18.61	0.62	15.68	1.14	9.13 (.010)* a, b > c
Functional QOL	18.20	0.92	17.05	0.74	13.46	1.56	6.84 (.033)* a, b > c
Total QOL	78.04	2.34	76.82	2.12	63.64	4.66	7.95 (.019)* a, b > c

Note. SxCl: Symptom cluster, M: Mean, SE: Standard error, QOL: Quality of life.
* $p < .05$, ** $p < .001$

Table 14 indicates the differences in the occurrence of return to care from T1 to T4 according to the types of symptom cluster at T1 classified by latent profile analysis. As a result, there was no significant difference in the probability of unplanned outpatient clinic visits, emergency department visits, readmission, and total return to care according to the types of symptom cluster ($p > .05$).

Table 14 Differences in return to care until time point 4 according to the types of symptom cluster at time point 1

Category	Low SxCl		Medium SxCl		High SxCl		χ^2
	P	SE	P	SE	P	SE	(p-value)
Unplanned outpatient clinic visit	.029	0.021	.067	0.033	.111	0.061	2.17 (.337)
Emergency department visit	.014	0.015	.034	0.024	.037	0.037	0.64 (.727)
Readmission	.015	0.015	.000	0.000	.000	0.000	1.02 (.602)
Total return to care	.059	0.030	.101	0.040	.111	0.061	1.02 (.600)

Note. SxCl: Symptom cluster, P: Probability, SE: Standard error.

5.6.3. Differences in health outcomes according to the transition patterns of symptom cluster

Table 15 presents the differences in quality of life at T4 according to the transition patterns of symptom cluster between T1 and T4 classified by latent transition analysis. The results revealed a significant difference in physical quality of life based on the transition patterns of symptom cluster ($F = 12.67$, $p < .001$). Post hoc tests showed that the quality of life of stayers (24.20) and improved movers (23.53) was higher than that of worsened movers (19.43). Moreover, the emotional quality of life was significantly different according to the transition patterns of symptom cluster ($F = 4.96$, $p = .009$). In the post hoc test, the stayers' quality of life (19.14) was higher than the worsened movers' quality of life (16.30). Additionally, there was a significant difference in the total quality of life based on the transition patterns of symptom cluster ($F = 4.74$, $p = .011$). In the post-hoc comparison, the quality of life of stayers (77.12) and improved movers (78.53) was higher than that of worsened movers (66.56).

In contrast, social/family and functional quality of life did not significantly differ by transition patterns of symptom cluster.

Table 15 Differences in quality of life at time point 4 according to the transition patterns of symptom cluster at time points 1–4

	Stayer[a]		Worsened mover[b]		Improved mover[c]		F (*p*-value)
	M	SD	M	SD	M	SD	
Physical QOL	24.20	3.30	19.43	5.93	23.53	2.95	12.67 (< .001)** a, c > b
Social/family QOL	16.42	6.86	16.19	5.57	17.95	6.04	0.53 (.589)
Emotional QOL	19.14	4.34	16.30	4.48	19.20	3.05	4.96 (.009)* a > b
Functional QOL	17.47	6.44	14.63	5.40	17.85	5.56	2.58 (.081)
Total QOL	77.23	17.73	66.56	16.10	78.53	13.75	4.74 (.011)* a, c > b

Note. M: Mean, SD: Standard deviation, QOL: Quality of life.

* $p < .05$, ** $p < .001$

Table 16 shows the differences in the occurrence of return to care from T1 to T4 according to the transition patterns of symptom cluster between T1 and T4 classified by latent transition analysis. The results revealed no significant difference in the probability of unplanned outpatient clinic visits, emergency department visits, readmission, and total return to care according to the transition patterns of symptom cluster ($p > .05$).

Table 16 Differences in return to care until time point 4 according to the transition patterns of symptom cluster at time points 1–4

	Stayer		Worsened mover		Improved mover		*p*-value†
	n	%	n	%	n	%	
Unplanned outpatient clinic visit							
Yes	3	5.9	2	6.7	1	5.0	> .999
No	48	94.1	28	93.3	19	95.0	
Emergency department visit							
Yes	2	3.9	1	3.3	1	5.0	> .999
No	49	96.1	29	96.7	19	95.0	
Readmission							
Yes	0	0.0	1	3.3	0	0.0	.495
No	51	100.0	29	96.7	20	100.0	
Total return to care							
Yes	4	7.8	4	13.3	2	10.0	.752
No	47	92.2	26	86.7	18	90.0	

†Fisher's exact test.

5.6.4. Factors associated with health outcomes

Table 17 illustrates the results of the multiple linear regression analysis to identify factors associated with quality of life at T4. In this study, the regression model was statistically significant ($F = 7.88$, $p < .001$) and explained 40.8% of the variance in quality of life 12 weeks after surgery for patients who underwent lung resection ($R^2 = .467$, $_{adj}R^2 = .408$). The variance inflation factors (VIFs) of the variables entered into the regression model were < 10, indicating that there were no multicollinearity issues.

Discharge location, social support, types of symptom cluster, and transition patterns of symptom cluster were identified as factors that had a significant impact on participants' quality of life. Specifically, those who went home after discharge had a significantly higher quality of life than those who went to hospital ($B = 16.052$, $p = .003$). A higher quality of life was significantly associated with high social support ($B = 3.518$, $p = .017$). Lower quality of life was significantly associated with the medium symptom cluster ($B = -17.00$, $p < .001$) and the high symptom cluster ($B = -26.849$, $p < .001$). Among the transition patterns of symptom cluster, worsened mover was significantly associated with lower quality of life ($B = -12.031$, $p < .001$), whereas improved mover was significantly associated with higher quality of life ($B = 11.579$, $p = .012$).

Table 17 Factors associated with quality of life at time point 4

Variables	*B*	SE	*β*	t	*p*-value
Age	−0.018	0.166	−0.010	−0.107	.915
Gender (ref: men)					
Women	4.957	3.232	0.138	1.534	.129
Monthly household income	0.006	0.004	0.144	1.619	.109
Operation time	−0.036	0.024	−0.122	−1.486	.141
Discharge location (ref: hospital)					
Home	16.052	5.307	0.239	3.025	.003*
Social support	3.518	1.441	0.202	2.441	.017*
Types of SxCl at T1 (ref: low)					
Medium	−17.000	3.509	−0.487	−4.845	< .001**
High	−26.849	6.820	−0.400	−3.937	< .001**
Transition patterns of SxCl at T1−T4 (ref: stayer)					
Worsened mover	−12.031	3.088	−0.322	−3.896	< .001**
Improved mover	11.579	4.518	0.270	2.563	.012*
$F = 7.88$ ($p < .001$), $R^2 = .467$, Adjusted $R^2 = .408$					

Note. SE: Standard error, SxCl: Symptom cluster, T1: First outpatient clinic visit after surgery (enroll date), T4: 12 weeks after surgery.

* $p < .05$, ** $p < .001$

Table 18 displays the results of logistic regression analysis to identify factors associated with return to care from T1 to T4. This logistic regression model was statistically significant (Hosmer & Lemeshow $\chi^2 = 3.784$, $p = .876$). As a result, the logistic regression analysis revealed that no factors significantly influenced the occurrence of return to care ($p > .05$).

Table 18 Factors associated with return to care until time point 4

Variables	*B*	SE	OR	95% CI	*p*-value
Age	0.031	0.035	1.032	0.963–1.106	.377
Gender (ref: men)					
Women	−0.808	0.683	0.446	0.117–1.698	.236
Body mass index	−0.081	0.114	0.922	0.738–1.153	.479
Operation time	−0.007	0.012	0.993	0.970–1.016	.542
Hospital length of stay	−0.058	0.151	0.944	0.702–1.270	.704
Types of SxCl at T1 (ref: low)					
Medium	1.336	0.790	3.805	0.809–17.901	.091
High	−18.029	15064.947	0.000	0.000	.999
Transition patterns of SxCl at T1−T4 (ref: stayer)					
Worsened mover	0.511	0.700	1.667	0.423–6.569	.465
Improved mover	−0.107	1.026	0.898	0.120–6.714	.917
Hosmer & Lemeshow test: $\chi^2 = 3.784$ ($p = .876$)					

Note. SE: Standard error, OR: Odds ratio, CI: Confidence interval, SxCl: Symptom cluster, T1: First outpatient clinic visit after surgery (enroll date), T4: 12 weeks after surgery.

* $p < .05$, ** $p < .001$

VI. DISCUSSION

In this prospective, longitudinal study of patients after lung cancer surgery, postoperative symptoms and health outcomes, including quality of life and return to care, until 12 weeks after surgery were assessed. Latent profile and latent transition analyses were performed on postoperative symptoms to identify symptom clusters and transition patterns, providing a comprehensive understanding of participants' symptoms. In addition, the association between patients' quality of life and postoperative symptoms was identified, which suggests the need for symptom management to improve quality of life in future studies. This study concluded by discussing the significance of nursing theory, research, practice, and limitations, and by offering suggestions for future research.

In this study, participants diagnosed with non-small cell lung cancer who underwent lung resection without additional treatment had an average age of 61.99 years. This aligns with the average age reported in previous studies conducted on patients undergoing lung resection (Shin et al., 2022; Yu et al., 2022). In this research, participants aged > 70 years accounted for more than one-fifth of the total, reflecting a higher prevalence of lung cancer in older adults, consistent with prior findings (Siegel et al., 2023). With a global trend of aging society, the incidence of cancer in older adults is increasing and is expected to continue rising (Pilleron et al., 2019). Attention should be given to the higher incidence of lung cancer in older adults based on previous research, particularly by considering their diverse health problems (Barta et al., 2017).

6.1. Symptoms and types of symptom cluster of patients who underwent lung cancer surgery

In the current study, the symptoms of patients after early lung cancer surgery (expected to be relatively mild) were identified longitudinally. Specifically, the severity of 16 symptoms was assessed using the MDASI-LC at four time points: the first outpatient clinic visit after discharge, and 4, 8, and 12 weeks after surgery. Overall, symptoms showed an improvement over time, but fatigue consistently emerged as the most severe symptom at all four time points. At 4 weeks after surgery, the highest severity was 4.75 out of 10; although it gradually decreased, the severity remained at 3.34 even 12 weeks after surgery. Similar findings were presented by Fagundes et al. (2015), indicating that fatigue is most severe in patients who underwent lung resection. Cancer-related fatigue is a common and distressing symptom among patients with cancer, persisting even after treatment completion (Bower, 2014). Even in patients with lung cancer, cancer-related fatigue has been identified as a prevalent symptom throughout the entire treatment process (Carnio et al., 2016). Fatigue has a negative impact on the overall quality of life and may be considered a risk factor for reduced survival, emphasizing the need for effective management of this symptom (Bower, 2014).

The findings of this study revealed that, in addition to fatigue, symptoms such as cough, pain, lack of appetite, shortness of breath, and drowsiness were consistently reported to have high severity during the postoperative recovery period from discharge to 12 weeks after surgery. These results are consistent with previous studies that reported

persistent symptoms in patients with lung cancer even 3–4 months after surgery (Fagundes et al., 2015; Sarna et al., 2008). Uncontrolled symptoms with high severity were found to be associated with the unmet needs of patients with lung cancer, including health system and information needs, psychological needs, and physical and daily living care needs (Liao et al., 2011). The impact of symptoms on patients' unmet needs is significant, and these symptoms are considered to require attention and management by healthcare providers. In other words, it is crucial for healthcare providers to provide care for symptoms that patients report as being severe, rather than relying on predictions or assumptions from healthcare providers. In the current medical situation, as the focus is on postoperative follow-up and recurrence of cancer, symptom management that can relieve patients' physical and psychological distress may be insufficient to fulfill their unmet needs (Liao et al., 2011). This may affect the unexpected increase in return to care, including outpatient treatment; thus, active attention to the patient's postoperative symptoms is necessary.

In this study, by conducting latent profile analysis, participants were classified into three symptom clusters at each time point as follows: low, medium, and high symptom clusters. These findings were similar to those of a study on patients with lung cancer receiving chemotherapy, which classified mild and moderate-severe symptoms despite differences in the number of clusters (Li et al., 2020). In other previous studies, patients with cancer receiving chemotherapy were classified into low, moderate, and high symptom clusters based on 32 symptoms measured by the Memorial Symptom Assessment Scale (MSAS), which was consistent with the results of this study (Miaskowski et al., 2017;

Miaskowski et al., 2014). Consistent with previous studies (Miaskowski et al., 2017; Miaskowski et al., 2014), in this study, the types of symptom cluster were classified by focusing on multiple overall symptom severity patterns rather than specific symptoms. In other words, participants were not categorized based on the relative severity of specific symptoms, but instead on the overall severity level of all 16 symptoms.

In this study, the types of symptom cluster persisted not only at the first outpatient clinic visit after discharge but also at 4, 8, and 12 weeks after surgery. These results show that the low symptom cluster accounts for the largest proportion at all four time points. However, when comparing the proportion of symptom cluster types at 8 and 12 weeks after surgery, the proportion of low symptom clusters decreased from 59.3% to 46.5%, while that of medium symptom clusters increased from 28.8% to 41.6%. Contrary to the expectation that symptoms would alleviate over time, an increase in the proportion of the medium symptom cluster at 12 weeks after surgery compared to 8 weeks after surgery was noted, which required further investigation. Additionally, there remained patients who experienced a relatively high symptom burden even after the recovery period after surgery. Therefore, these findings highlight the need to select distressed patients with high symptom severity and provide tailored interventions rather than providing the same interventions to patients during the postoperative recovery period.

In this study, latent transition analysis was conducted to identify longitudinal transition patterns of symptom cluster between the first outpatient clinic visit after discharge and 12 weeks after surgery. The identified transition patterns were classified into

stayers, who remained in the same cluster over time; worsened movers, who experienced exacerbated symptoms; and improved movers, who exhibited enhanced symptoms. A similar result was reported by Jun et al. (2023) in a study on the symptoms of patients with chronic obstructive pulmonary disease using latent transition analysis, aligning with the results of this study. The findings of this study indicated that the transition probability that participants classified in the low symptom cluster at the first outpatient clinic visit after discharge remained in the same type, designated as stayers, at 12 weeks after surgery was more than 60%. However, the transition probabilities of worsened movers, who moved from low to medium or high, and those who moved from medium to high, were 38.4% and 22.8%, respectively. This suggests that despite the common belief that recovery after surgery will progress over time, the severity of symptoms perceived by patients may worsen. In contrast, among improved movers whose symptoms were alleviated over time, the transition probability of moving from high to low was 0, showing that there is little possibility of extreme improvement in symptoms.

According to this study, approximately half of all participants were identified as stayers, approximately one-third were identified as worsened movers, and 19.8% were identified as improved movers during the 12 weeks after surgery. This finding suggests that some patients may experience a worsening severity of symptoms over time despite the passage of time during the 12-week recovery period following surgery. Additionally, some participants' characteristics, including body mass index and location of surgery, were identified as associated factors for worsened movers. Although these are not modifiable,

they can be identified in advance at discharge, facilitating the provision of active intervention during the follow-up period, especially for patients who are likely to become worsened movers.

6.2. Health outcomes of patients who underwent lung cancer surgery

In this study, participants' quality of life, as measured by FACT-G, from the first outpatient clinic visit after discharge to 12 weeks after surgery ranged from an average of 69.83 to 74.31 out of 108. This was higher than that of patients with advanced lung cancer (mean: 63.8) reported by Choi and Ryu (2018) and lower than that of survivors 1 month after lung cancer surgery (mean: 86.15) reported by Lin and Rong (2022). The findings of the current study indicate a slight decrease in the participants' quality of life at 4 weeks after surgery compared to the first outpatient clinic visit after discharge, followed by a gradual increase at 8 and 12 weeks after surgery. This phenomenon, which occurred between first outpatient clinic visit after discharge and 4 weeks after surgery, may be due to systematic error among measurement errors (Groves et al., 2009). This phenomenon has several possible explanations. First, changes in the mode of data collection, including the shift from researcher-supervised self-reporting in an outpatient setting at the first outpatient clinic visit after discharge to self-reporting at home from 4 weeks after surgery, may be the cause of the systematic error responsible for the decreased quality of life score (Lyberg & Kasprzyk, 2004). Second, this may result from the transition from care received in a

hospital to care provided at home, indicating that the effect of the medicine prescribed by the hospital disappears during this period. Finally, the participants' responses to the questionnaire may have been overestimated because the participants felt hopeful after hearing from their doctor that the surgical results were favorable and that no further treatment was needed at the first outpatient clinic visit. Therefore, careful interpretation of the research results is necessary, and future studies should investigate trends in responses from the preoperative period to gain a comprehensive understanding.

The results of this study identified symptom-related variables as important factors associated with quality of life at 12 weeks after lung cancer surgery. The participants' quality of life was significantly lower when the types of symptom cluster was medium or high compared to low. Additionally, the quality of life of worsened movers was lower than that of stayers, while the quality of life of improved movers was higher than that of stayers over time. Studies conducted on patients with cancer undergoing chemotherapy (Miaskowski et al., 2017) and those with prostate cancer undergoing radiation therapy (Dirksen et al., 2016) have reported that a more severe symptom cluster is associated with lower quality of life. Considering the significant impact of the types of symptom cluster and transition patterns, as opposed to individual symptoms, on the quality of life, periodic and longitudinal screening and management of symptoms are required during the postoperative recovery period to enhance patients' quality of life.

We found that 9% of participants experienced a total return to care, including unplanned outpatient clinic visits, emergency department visits, and readmissions, until 12

weeks after surgery. While the absolute occurrence frequency of return to care was relatively low, participants who visited unplanned outpatient clinics were the most numerous, comprising nine (6.2%), followed by those who visited the emergency department with four (2.8%), and those who were readmitted with one (0.7%). This finding was relatively low frequency compared to previous studies (Hazewinkel et al., 2021; Shaffer et al., 2018), which may be because the participants in the present study were limited to patients whose treatment was terminated by surgery without postoperative chemotherapy or radiation therapy.

The participants in this study can be considered to be relatively unlikely to suffer from symptoms that are not controlled by additional treatment. However, these participants also had uncontrolled symptoms such as pain, cough, sputum, and pyrosis, which resulted in them making unplanned outpatient clinic visits between regular follow-up intervals. Studies related to outpatient clinic visits in patients with cancer, including lung cancer (Aprile et al., 2013; McKenzie et al., 2011), have reported that these patients visited outpatient clinics due to their symptoms, which is consistent with the findings of the current study. In other words, these findings demonstrate that despite the postoperative recovery period, patients still have considerable unmet needs related to their symptoms, suggesting a need to improve the continuity of treatment to address these problems (McKenzie et al., 2011).

In contrast to previous studies (King et al., 2019; Nipp et al., 2017; Shaffer et al., 2018), the results of logistic regression analysis showed no significant factors associated

with return to care up to 12 weeks after surgery. These results could be interpreted as a result of the low frequency of return to care itself. Despite the lack of statistical significance, a difference in return to care occurrence based on the types of symptom cluster or transition pattern was noted. Return to care, including unplanned outpatient clinic visits, emergency department visits, and readmissions, not only negatively impacts a patient's recovery process after surgery but also drives up healthcare costs from a macro perspective. Therefore, efforts are required from healthcare providers to reduce the return to care by actively providing care for participants' symptom clusters and transition patterns, aiding their recovery, and improving the quality of treatment (Shaffer et al., 2018).

6.3. Significance of the study

6.3.1. Nursing theory

In this study, Dodd's symptom management model was applied to identify postoperative symptoms, types of symptom cluster, and transition patterns in patients with lung cancer, with the aim to examine their association with health outcomes. These results provide scientific evidence for postoperative symptoms in patients with lung cancer based on the symptom management model. Furthermore, these findings contribute to validating the symptom management model for postoperative patients with lung cancer, confirming the clinical applicability and usability of the theory, and accumulating empirical evidence

to advance nursing knowledge. Applying this theory may assist in the development of interventions for postoperative symptom management in patients with lung cancer.

6.3.2. Nursing research

In this study, a longitudinal approach was conducted to gain a comprehensive understanding of symptoms, symptom clusters, transition patterns, and health outcomes over time during the postoperative recovery process of patients with lung cancer. Data were collected at four time points from the first outpatient clinic visit after discharge to 12 weeks after surgery, which expands the understanding of patients with lung cancer who still suffer from various symptoms during the recovery period after lung resection. Moreover, by performing latent transition analysis, it was possible to classify participants into symptom clusters where multiple symptoms occur simultaneously rather than individual symptoms, allowing for an individual-centered approach. Additionally, this study supports the need to provide interventions related to symptom clusters to enhance quality of life by investigating the impact of symptom clusters and transition patterns on quality of life.

6.3.3. Nursing practice

In this study, symptoms, symptom clusters, and transition patterns of symptom clusters were identified longitudinally over 12 weeks in patients with lung cancer who were

discharged from the hospital and were recovering at home after undergoing lung resection. These findings provide a deeper understanding of the symptoms experienced by patients during the postoperative recovery period. In the current clinical practice setting, care is provided for physical issues, including the most prominent symptoms, and cancer follow-up through routine outpatient clinic visits after surgery. However, it can be challenging to identify symptoms, including patients' postoperative unmet needs, and provide appropriate management at each stage. Therefore, early screening of symptom-related high-risk groups in practice, as well as the provision of intervention can contribute to alleviating symptoms and ultimately improve the patients' quality of life by identifying postoperative symptoms, types of symptom cluster, and transition patterns.

6.4. Limitations

This study has several limitations that warrant discussion. First, patients whose treatment ended up with surgery for lung cancer without subsequent chemotherapy and radiation therapy were included in this study. This constrains the generalizability of the findings, as the symptoms or health conditions may be relatively mild compared to all patients who underwent lung resection. Nevertheless, it is noteworthy that participants reported symptomatic distress persisting up to 12 weeks after surgery.

Second, preoperative symptoms or quality of life were not measured, primarily due to the feasibility of participant recruitment. While the primary focus was identifying the

symptom cluster and health outcomes during the postoperative recovery period, the lack of information on baseline status before surgery poses a challenge for comparing pre- and post-surgery data. Furthermore, data collection occurred four times over 12 weeks after surgery, indicating a relatively narrow follow-up interval, which may present challenges in identifying extreme changes or long-term trends.

Third, four data collections up to 12 weeks after surgery were conducted in this study; however, unlike the first data collection, where the paper-based surveys were conducted in person, subsequent data collection was conducted in an e-patient reported outcome format, allowing participants to respond to surveys using mobile phones without hospital visits. These variations in data collection mode and settings may have influenced the symptoms and quality of life reported by the participants, resulting in systematic measurement errors. Despite the potential risk of measurement errors, taking into account the feasibility of data collection, data was collected up to 3 months after surgery longitudinally. By collecting data without additional visits, even when patients did not visit the hospital, their symptoms and quality of life could be identified while reducing restrictions on time and place, which ultimately provides a comprehensive understanding of the patients' postoperative recovery process. Additionally, despite efforts to encourage participation through text messages and phone calls, the survey response rate was 87.1%–90.2%. This incomplete response rate may lead to an insufficient understanding of the postoperative recovery related to the symptom cluster in patients who underwent lung resection.

Lastly, among those who responded to this study's first data collection, some participants had not yet reached the point of completing the response for the final data collection. Consequently, there is a possibility that the phenomena related to symptoms and quality of life at the 12 weeks after surgery for patients with lung cancer who underwent lung resection may be incompletely explained.

6.5. Suggestions for future studies

In this study, we aimed to longitudinally identify the types of symptom cluster and transition pattern in patients with lung cancer who underwent lung resection from the first outpatient clinic visit after discharge to 12 weeks after surgery and explore their impact on health outcomes. Several suggestions for future research can be made. First, considering the continuity of care for patients diagnosed with cancer, we recommend conducting a longitudinal study that includes preoperative assessments and extends to long-term follow-up points beyond the 12-week postoperative period. The findings of this study affirm the presence of patients experiencing high severity of symptom clusters even at 12 weeks after surgery, underscoring the importance of investigating health issues from a long-term perspective.

Second, efforts should be made to enhance response rates in studies that use mobile phones for data collection. The average age of postoperative patients with lung cancer in this study was approximately 62 years old, with over one-fifth of participants aged > 70

years. We observed challenges in survey completion, which were attributed to factors such as poor eyesight and limited digital literacy. In several cases, assistance from caregivers, including family members or children, was required to facilitate survey participation. Consequently, future data collection endeavors should be meticulously planned, considering these challenges, and should incorporate strategies to improve overall response rates.

Lastly, even as time elapsed during the postoperative recovery period, patients continued to experience symptom distress, negatively impacting their quality of life. It is crucial to regularly monitor postoperative symptoms, particularly those that are severe, and identify high-risk groups by considering not only individual symptoms but also symptom clusters and transition patterns. Developing and providing interventions tailored to alleviate high-severity symptoms and unmet needs in this population is essential for improving health outcomes.

VII. CONCLUSION

In this study, we aimed to assess the symptoms, types of symptom cluster, and transition patterns in patients diagnosed with lung cancer with lung resection up to 12 weeks postoperatively, as well as to examine their impact on quality of life and return to care. These findings reveal that patients who underwent lung resection for lung cancer can be classified into three symptom clusters based on symptom severity: low, medium, and high symptom clusters. Additionally, over time, many patients remained in the same symptom clusters as stayers, while others experienced improvement or worsening of symptoms as movers. The types of symptom cluster and transition pattern significantly influenced the quality of life of patients who underwent lung resection 12 weeks after surgery, emphasizing the importance of symptom management in the postoperative recovery period. We conducted symptom and quality of life assessments through mobile phones without requiring additional hospital visits, providing valuable insights into postoperative recovery for patients who underwent lung resection. Furthermore, the longitudinal collection of relatively underexplored postoperative symptoms offers a new perspective by identifying symptom clusters through an individual-centered approach. Future research should focus on identifying high-risk groups via symptom monitoring, including symptom cluster and transition pattern, and developing and providing symptom management interventions to improve the quality of life of patients who have undergone lung resection.

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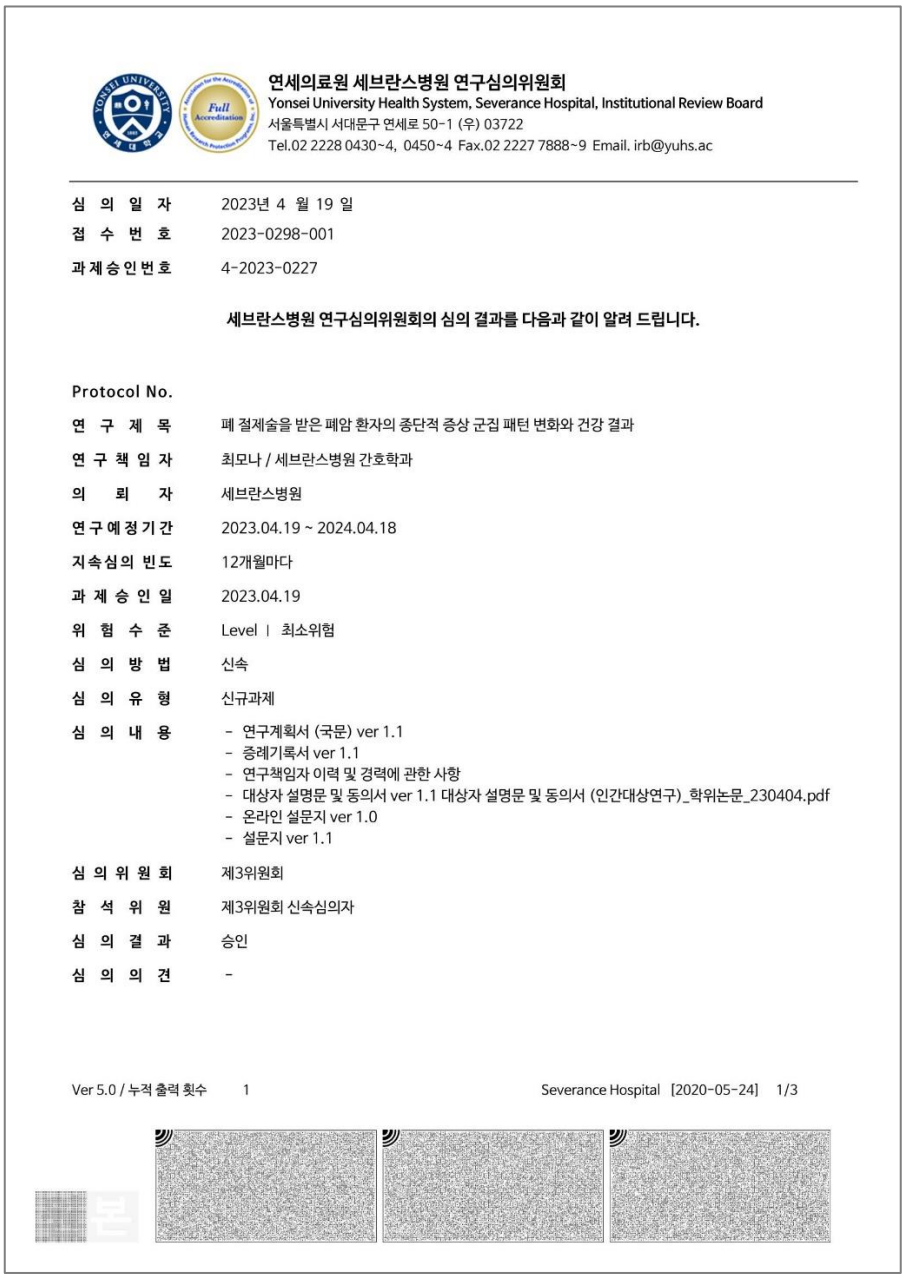
APPENDICES

Appendix 1 Approval from the Institutional Review Board



연세의료원 세브란스병원 연구심의위원회
Yonsei University Health System, Severance Hospital, Institutional Review Board
서울특별시 서대문구 연세로 50-1 (우) 03722
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심 의 일 자	2023년 4 월 19 일
접 수 번 호	2023-0298-001
과제승인번호	4-2023-0227

세브란스병원 연구심의위원회의 심의 결과를 다음과 같이 알려 드립니다.

Protocol No.	
연 구 제 목	폐 절제술을 받은 폐암 환자의 종단적 증상 군집 패턴 변화와 건강 결과
연 구 책 임 자	최모나 / 세브란스병원 간호학과
의 뢰 자	세브란스병원
연구예정기간	2023.04.19 ~ 2024.04.18
지속심의 빈도	12개월마다
과 제 승 인 일	2023.04.19
위 험 수 준	Level I 최소위험
심 의 방 법	신속
심 의 유 형	신규과제
심 의 내 용	- 연구계획서 (국문) ver 1.1 - 증례기록서 ver 1.1 - 연구책임자 이력 및 경력에 관한 사항 - 대상자 설명문 및 동의서 ver 1.1 대상자 설명문 및 동의서 (인간대상연구)_학위논문_230404.pdf - 온라인 설문지 ver 1.0 - 설문지 ver 1.1
심 의 위 원 회	제3위원회
참 석 위 원	제3위원회 신속심의자
심 의 결 과	승인
심 의 의 견	-

Ver 5.0 / 누적 출력 횟수 1 Severance Hospital [2020-05-24] 1/3

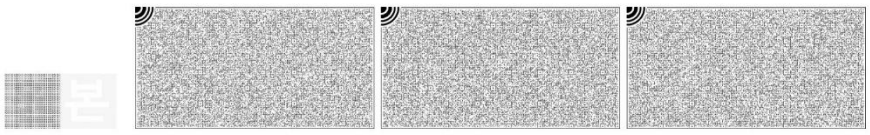
Appendix 1 Approval from the Institutional Review Board (continued)

※ 본 통보서에 기재된 사항은 세브란스병원 연구심의위원회의 기록된 내용과 일치함을 증명합니다.
※ 세브란스병원 연구심의위원회는 국제 임상시험 통일안(ICH-GCP), 임상시험 관리기준(KGCP), 생명윤리 및 안전에 관한 법률을 준수합니다.
※ 연구책임자 및 연구담당자가 IRB위원인 경우, 해당 위원은 위 연구의 심의과정에 참여하지 않았습니다.

연세의료원 세브란스병원

연구심의위원회 위원장

Ver 5.0 / 누적 출력 횟수 1 Severance Hospital [2020-05-24] 2/3



Appendix 2 Survey questionnaire

설문 일시	2023. .
설문지 번호	

설 문 지

안녕하십니까?

본 설문지는 폐 절제술을 받은 폐암 환자분을 대상으로 시간의 흐름에 따른 수술 후 증상, 증상 군집의 유형 및 전환 패턴을 파악하고, 이에 대한 건강 결과의 차이를 확인하기 위한 목적으로 작성되었습니다.

설문지 작성은 약 15-20분 정도 시간이 소요될 것으로 예상됩니다. 귀하께서 응답해주신 내용들은 폐 절제술을 받은 폐암 환자들의 퇴원 후 증상을 관리하고 수술 후 건강 결과를 향상시키기 위한 중재 개발에 도움이 될 것입니다.

본 설문에 귀하께서 응답해주신 내용들은 무기명으로 처리되고, 비밀 보장을 유지하며, 설문의 결과는 연구 목적 이외에 다른 목적으로 절대 사용되지 않을 것입니다.

설문 중 언제든지 중단할 수 있으며, 이로 인해 귀하에게 어떠한 불이익도 없을 것입니다. 응답해주신 내용들은 본 연구에서 귀중한 자료가 되니, 설문을 잘 읽으신 후 빠짐없이 솔직하게 답변해 주시기를 부탁드립니다.

바쁘신 가운데 귀한 시간 내어 설문에 응해 주셔서 진심으로 감사드립니다.

2023 년 월

연구담당자: 연세대학교 간호대학 박사과정 김예솔
연 락 처: 010-****-****
이 메 일: ********@yuhs.ac

- 1 -

Appendix 2 Survey questionnaire (continued)

Ⅰ. 증상

◆ **귀하의 증상은 얼마나 심합니까?**

지난 24시간 동안 아래의 증상들을 어떻게 느꼈는지 그 정도를 표현해 주십시오. 각 항목에 대하여 0 (증상이 없음)부터 10 (상상할 수 없을 정도로 심한 증상)까지 아래의 숫자를 선택해 주십시오.

	항 목	증상이 없음										상상할 수 없을 정도로 심함
1	가장 심했을 때의 통증	0	1	2	3	4	5	6	7	8	9	10
2	가장 심했을 때의 피로 (피로감)	0	1	2	3	4	5	6	7	8	9	10
3	가장 심했을 때의 메스꺼움	0	1	2	3	4	5	6	7	8	9	10
4	가장 심했을 때의 수면장애	0	1	2	3	4	5	6	7	8	9	10
5	가장 심했을 때의 괴로움 (속상함)	0	1	2	3	4	5	6	7	8	9	10
6	가장 심했을 때의 숨가쁨	0	1	2	3	4	5	6	7	8	9	10
7	가장 심했을 때의 건망증	0	1	2	3	4	5	6	7	8	9	10
8	가장 심했을 때의 식욕부진	0	1	2	3	4	5	6	7	8	9	10
9	가장 심했을 때의 졸음 (나른함)	0	1	2	3	4	5	6	7	8	9	10
10	가장 심했을 때의 입이 마른 느낌	0	1	2	3	4	5	6	7	8	9	10
11	가장 심했을 때의 슬픔	0	1	2	3	4	5	6	7	8	9	10
12	가장 심했을 때의 구토	0	1	2	3	4	5	6	7	8	9	10
13	가장 심했을 때의 무감각하거나 저린 느낌	0	1	2	3	4	5	6	7	8	9	10
14	가장 심했을 때의 기침	0	1	2	3	4	5	6	7	8	9	10
15	가장 심했을 때의 변비	0	1	2	3	4	5	6	7	8	9	10
16	가장 심했을 때의 목 따가움	0	1	2	3	4	5	6	7	8	9	10

- 2 -

Appendix 2 Survey questionnaire (continued)

◆ **귀하의 증상들이 삶에 얼마나 지장을 주고 있습니까?**

증상들은 흔히 우리의 기분이나 일상생활에 여러 가지로 지장을 줍니다.

지난 24시간 동안 귀하의 증상들이 아래 항목에 얼마나 많이 지장을 주었습니까?

각 항목에 대하여 0 (지장이 없음)부터 10 (완전히 지장을 받음)까지 아래의 숫자를 선택해 주십시오.

	항 목	지장이 없음										완전히 지장을 받음
1	일반적인 활동	0	1	2	3	4	5	6	7	8	9	10
2	기분	0	1	2	3	4	5	6	7	8	9	10
3	일 (집안일 포함)	0	1	2	3	4	5	6	7	8	9	10
4	대인 관계	0	1	2	3	4	5	6	7	8	9	10
5	보행 능력	0	1	2	3	4	5	6	7	8	9	10
6	생활의 즐거움 / 삶의 향유	0	1	2	3	4	5	6	7	8	9	10

Appendix 2 Survey questionnaire (continued)

Ⅱ. 삶의 질

◆ 다음은 귀하와 동일한 병을 앓고 계신 분들이 중요하다고 한 내용입니다.
지난 7일 동안에 해당되는 귀하의 응답을 각 줄에 하나씩 숫자에 동그라미를 하거나 표시하여 나타내십시오.

1) 신체 상태

	항 목	전혀 그렇지 않다	조금 그렇다	보통 이다	꽤 그렇다	매우 그렇다
1	기운이 없다	0	1	2	3	4
2	속이 메슥거린다	0	1	2	3	4
3	몸 상태 때문에 가족의 요구를 들어 주는 데 어려움이 있다	0	1	2	3	4
4	통증이 있다	0	1	2	3	4
5	치료의 부작용 때문에 괴롭다	0	1	2	3	4
6	몸이 아픈 느낌이다	0	1	2	3	4
7	자리(침대)에 누워 있어야만 한다	0	1	2	3	4

2) 사회/가족 상태

	항 목	전혀 그렇지 않다	조금 그렇다	보통 이다	꽤 그렇다	매우 그렇다
1	친구들과 가깝게 느껴진다	0	1	2	3	4
2	정서적으로 가족의 따뜻한 보살핌을 받는다	0	1	2	3	4
3	친구들로부터 도움을 받는다	0	1	2	3	4
4	내 가족들은 내 병을 받아들였다	0	1	2	3	4
5	내 병에 대한 가족과의 대화에 만족한다	0	1	2	3	4
6	배우자와 가깝게 느낀다 (배우자가 없는 경우는 나에게 가장 많은 도움을 주는 사람)	0	1	2	3	4

Appendix 2 Survey questionnaire (continued)

	현재 귀하의 성생활 정도와 상관없이 (성생활을 하고 있든, 하고 있지 않든 간에), 아래 질문에 답해 주십시오. 만약 답하고 싶지 않으면 이 네모 칸에 □ 체크 표시하고 3) 정서 상태로 가십시오.					
7	성생활에 만족한다	0	1	2	3	4

3) 정서 상태

	항 목	전혀 그렇지 않다	조금 그렇다	보통 이다	꽤 그렇다	매우 그렇다
1	슬프다	0	1	2	3	4
2	내가 병에 대처해 나가는 방법에 만족한다	0	1	2	3	4
3	병과의 싸움에서 희망을 잃고 있다	0	1	2	3	4
4	불안하고 초조하다	0	1	2	3	4
5	죽음에 대해 걱정이 된다	0	1	2	3	4
6	내 상태가 더 나빠질까 봐 걱정이다	0	1	2	3	4

4) 기능 상태

	항 목	전혀 그렇지 않다	조금 그렇다	보통 이다	꽤 그렇다	매우 그렇다
1	일을 할 수 있다 (집안일 포함)	0	1	2	3	4
2	나의 하는 일에서 성취감을 느낀다 (집안일 포함)	0	1	2	3	4
3	삶을 즐길 수 있다	0	1	2	3	4
4	내 병을 받아들였다	0	1	2	3	4
5	잠을 잘 잔다	0	1	2	3	4
6	평소에 재미로 하는 일들을 즐겁게 한다	0	1	2	3	4
7	지금의 삶의 질에 만족하고 있다	0	1	2	3	4

Appendix 2 Survey questionnaire (continued)

Ⅲ. 사회적 지지

◆ 다음의 문항은 여러분이 받는 사회적 지지에 관한 문항입니다.
1) 의료진(의사, 간호사), 2) 가족들(자식, 부모님, 형제, 자매 등) 그리고
3) 친구들로부터 받는 도움의 정도에 대해 표시해 주십시오.

	항 목	항상 그렇지 않다			보통 이다			항상 그렇다
1	나는 언제든지 의료진(의사, 간호사)에게 도움을 청할 수 있다	1	2	3	4	5	6	7
2	나는 의료진(의사, 간호사)과 진정으로 기쁨과 슬픔을 같이 나눌 수 있다	1	2	3	4	5	6	7
3	나의 가족은 진심으로 나를 도우려고 한다	1	2	3	4	5	6	7
4	나는 가족으로부터 정서적인 지지와 도움을 받고 있다	1	2	3	4	5	6	7
5	나의 의료진(의사, 간호사)은 나를 진정으로 편안하게 해 준다	1	2	3	4	5	6	7
6	내 친구들은 진심으로 나를 도우려 한다	1	2	3	4	5	6	7
7	일이 잘못되었을 때 나는 내 친구들에게 의지할 수 있다	1	2	3	4	5	6	7
8	나는 가족과 내 문제점에 대해 상의할 수 있다	1	2	3	4	5	6	7
9	나는 기쁨과 슬픔을 나눌 수 있는 친구가 있다	1	2	3	4	5	6	7
10	나의 의료진(의사, 간호사)은 내 기분이 어떤지 항상 살핀다	1	2	3	4	5	6	7
11	내 가족은 의사 결정을 할 때 기꺼이 나를 도와준다	1	2	3	4	5	6	7
12	친구들에게 나의 문제점에 대해 얘기할 수 있다	1	2	3	4	5	6	7

- 6 -

Appendix 2 Survey questionnaire (continued)

Ⅳ. 대상자의 특성

◆ 다음의 문항들은 개인적, 건강 및 질병 관련, 환경적 특성과 관련된 질문입니다.
아래의 질문들을 읽으시고 해당하는 부분에 V 표시하거나, 작성해주시기 바랍니다.

1. 귀하의 나이는 어떻게 되십니까? 만 _____세

2. 귀하의 성별은 무엇입니까? ① 남 ② 여

3. 귀하의 종교는 무엇입니까?
① 무교 ② 기독교 ③ 천주교 ④ 불교 ⑤ 기타 ( )

4. 귀하의 결혼 상태는 어떻게 되십니까?
① 미혼 ② 기혼 ③ 사별 ④ 이혼 또는 별거 ⑤ 기타

5. 귀하의 직업 상태는 어떻게 되십니까?
① 있음 (휴직 포함) ② 퇴직함 ③ 없음

6. 귀하의 교육 수준은 어떻게 되십니까?
① 중학교 졸업 이하 ② 고등학교 졸업 ③ 대학교 졸업 ④ 대학원 졸업

7. 귀하가 속한 가구의 월 평균 수입은 어떻게 되십니까? _____만원

8. 귀하가 스스로 생각하는 경제적 수준은 어느 정도이십니까?
① 상 ② 중상 ③ 중 ④ 중하 ⑤ 하

9. 귀하가 함께 거주하는 사람을 **모두** 골라주십시오.
① 혼자 거주 ② 배우자 ③ 부모 ④ 형제자매 ⑤ 자녀
⑥ 손자녀 ⑦ 기타 ( )

10. 귀하의 체질량 지수 계산을 위한 신장과 체중은 어떻게 되십니까?
신장: _____cm, 체중: _____kg

- 7 -

Appendix 2 Survey questionnaire (continued)

11. 귀하의 흡연 상태는 어떻게 되십니까?
① 한 번도 피운 적 없음
② 과거에 피웠으나 현재 피우지 않음 (금연 시기: _____년 _____월)
③ 현재 흡연 중임 (하루 흡연량: _____개비)

12. 귀하의 음주 상태는 어떻게 되십니까?
① 한 번도 마신 적 없음
② 과거에 마셨으나 현재 마시지 않음
③ 현재 음주 중임 (한 번에 마시는 술의 양: _____잔)

13. 귀하의 수술 전 항암 및 방사선 치료 여부는 어떻게 되십니까?
① 받지 않음 ② 항암 치료 ③ 방사선 치료 ④ 항암 및 방사선 치료

14. 귀하의 주 보호자는 누구입니까?
① 본인 ② 배우자 ③ 부모 ④ 형제자매
⑤ 자녀 ⑥ 손자녀 ⑦ 기타 ( )

15. 귀하가 수술 후 퇴원한 장소는 어디입니까?
① 본인 집 ② 보호자의 집 ③ 요양병원 ④ 기타 ( )

16. 전자의무기록을 통해 질병 관련 정보를 확인하기 위하여 귀하의 성명과 병원 등록번호를 기입해주십시오.
성명: _____, 병원등록번호: _____

* 전자의무기록을 통해 확인하는 질병 관련 정보는 아래와 같습니다.
- 동반질환, 수술 전 폐기능 수치, 체중 변화, 폐암의 병기, 폐암의 종류, 폐 절제술 방향, 폐 절제술 부위, 폐 절제 범위, 폐 절제 방법, 수술 소요 시간, 수술 시 출혈량, 수술 후 흉관 개수, 흉관 삽입 기간, 중환자실 입실 여부 및 기간, 재원기간, 수술 후 합병증

17. 연구 관련 연락 및 사례품 제공을 위해 귀하의 휴대폰 번호를 기입해주십시오.

_____-_____-_____

★ 설문지를 작성해주셔서 진심으로 감사드립니다. ★

- 8 -

KOREAN ABSTRACT

폐 절제술을 받은 폐암 환자의 종단적 증상 군집 전이 패턴과 건강 결과

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폐암은 전 세계적으로 가장 많이 발병하는 암 중 하나이며, 치료를 위해 폐 절제술을 받아 생존율이 점차 증가하고 있다. 그러나 폐 절제술을 받았음에도 불구하고 환자들은 여전히 다양한 증상과 증상 군집으로 고통받고 있어, 시간의 경과에 따른 증상과 증상 군집의 변화를 파악하는 것에 대한 중요함이 강조되고 있다. 또한 증상과 증상 군집은 폐암 환자의 건강 결과에 부정적인 영향을 미치는 것으로 나타났다. 따라서 본 연구는 폐 절제술을 받은 초기 폐암 환자를 대상으로 시간 경과에 따른 수술 후 증상, 증상 군집의 유형 및 전이 패턴을 파악하고, 이들이 수술 12주 후 건강 결과에 미치는 영향에 대해 조사하고자 한다.

본 연구는 전향적 종단 연구 설계로서 퇴원 후 첫 외래 진료 방문 시(T1), 수술 4주 후(T2), 8주 후(T3), 12주 후(T4)와 같이 총 4회 자료수집을 실시하였다. T1에서는 병원에서 대면으로 자가보고 설문지를 통해 자료를 수집하였고, T2부터 T4는 대상자가 병원을 방문하지 않는 시기임을 고려하여 모바일 폰으로 접속 가능한 온라인 설문지를

통해 자료를 수집하였다. 연구 대상자는 서울 소재 3차 병원에서 병리학적으로 폐암을 진단받고 폐 절제술을 받은 만 19세 이상의 환자이다. 16가지 증상으로 구성된 MD Anderson Symptom Inventory - Lung Cancer를 이용하여 증상을 측정하였고, 점수가 높을수록 증상이 심함을 의미한다. 건강 결과는 삶의 질과 치료 복귀로 구성되었다. 삶의 질은 Functional Assessment of Cancer Therapy - General을 이용하여 측정하였고, 점수가 높을수록 삶의 질이 좋음을 의미한다. 치료 복귀는 전자 의무 기록을 검토하여 계획되지 않은 외래 방문, 응급실 방문, 재입원이 포함되었다. 잠재 프로파일 분석은 16개 증상을 기준으로 각 시점의 증상 군집을 분류하기 위해 수행되었고, 잠재 전이 분석은 퇴원 후 첫 외래 진료 방문 시점과 수술 12주 후 시점 사이 증상 군집의 전이 패턴을 파악하기 위해 수행되었다. 건강 결과와 관련된 요인을 파악하기 위해 선형 및 로지스틱 회귀 분석이 수행되었다. 본 연구에서는 SPSS Statistics version 26, Mplus version 8.8, R version 4.3.2 프로그램을 이용하여 자료를 분석하였다.

본 연구에 등록된 177명의 대상자 중 T1에 163명, T2에 138명, T3에 120명, T4에 101명이 자료 분석에 포함되었다. 대상자의 평균 연령은 61.99 ± 9.61세였고, 60.1%가 여성이었다. T1에서 심각도가 높은 5개의 증상으로는 피로, 기침, 통증, 숨가쁨, 졸음 순이었다. 이 중 피로는 네 시점 모두 심각도가 가장 높게 나타났다. 증상 군집은 각 시점의 증상 심각도 점수에 따라 낮은 증상 군집, 중간 증상 군집, 높은 증상 군집과 같이 세 유형으로 분류되었고, 네 시점 모두 낮은 증상 군집에 많은 대상자가 포함되었다. T1에서 낮은 증상 군집과 중간 증상 군집에 속한 대상자는 각각 T4에서 동일한 유형에 속할 가능성이 높았으나, T1에서 높은 증상 군집에 속한 대상자는 T4에서 중간 또는 높은 증상 군집에 속할 가능성이 높았다. T1과 T4 사이 증상 군집의

전이 패턴으로는 체류자(50.5%), 악화된 이동자(29.7%), 개선된 이동자(19.8%)로 분류되었다. T4에서 삶의 질은 108점 만점에 74.31 ± 17.15점이었고, 치료 복귀는 총 13건(8.4%) 발생하였으며, 그 중 계획되지 않은 외래 방문이 가장 많았다. 증상 군집 유형이 중간(B = -17.00, p < .001) 및 높은 경우(B = -26.85, p < .001) 삶의 질이 유의하게 낮게 나타났다. 증상 군집 유형의 전이 패턴이 악화된 이동자인 경우 삶의 질이 유의하게 낮게 나타났고(B = -12.03, p < .001), 개선된 이동자인 경우 유의하게 높게 나타났다(B = 11.58, p = .012). 그러나 치료 복귀와 관련된 유의한 요인은 없었다.

본 연구는 수술 후 회복 기간 동안 증상, 증상 군집, 전이 패턴 및 건강 결과에 대한 포괄적인 이해를 얻기 위해 종단적 접근 방식을 수행하였다. 본 연구는 상대적으로 증상이 경미할 것으로 예상되는 초기 폐암 환자를 대상으로 수술 12주 후까지 증상 군집을 개인 중심적 접근 방식으로 파악함으로써, 시간이 경과하여도 여전히 증상 심각도가 높고 증상 악화를 경험하는 환자가 있다는 것을 발견하였다. 또한 증상 군집 유형 및 전이 패턴은 삶의 질에 유의한 영향을 미치며, 이는 수술 후 회복 기간 동안 증상 관리의 중요성을 강조한다. 따라서 고위험 증상군을 조기에 선별하고 중재를 제공하는 것은 수술 후 폐암 환자의 증상 완화 및 삶의 질 향상에 기여할 수 있다.

핵심되는 말: 폐암, 폐 절제술, 증상, 증상 군집, 전이 패턴, 삶의 질, 치료 복귀, 수술 후 회복, 잠재 전이 분석