

## Effect of Multidisciplinary Team Approach on Prevention of Postoperative Pulmonary Complications in Patients with Esophageal Cancer

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4.3% and 16.2% in the MDT group and NMDT group, respectively. After the logistic regression analysis and multivariate analysis for correction of all considerable confounding factors, the MDT group demonstrated a significantly lesser incidence rate of PPCs than the NMDT group (OR: 0.16, 95% confidential interval: 0.02-0.75).

**CONCLUSION:** This study revealed that the MDT approach reduced the occurrence of PPCs in esophageal cancer patients who underwent esophagectomy. The adequate perioperative management and considerable early rehabilitation and mobilization with risk management should be provided to prevent PPCs.

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**Key words:** Esophagectomy; Multidisciplinary team approach; Postoperative pulmonary complications; Early mobilization; Respiratory rehabilitation

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### ABSTRACT

**AIM:** This study aimed to investigate the possible prevention of postoperative pulmonary complications (PPCs) by introduction of multidisciplinary team (MDT) approach in esophageal cancer patients who underwent esophagectomy.

**METHODS:** The retrospective cohort study of 132 esophageal cancer patients in a 900-bed university academic hospital between April 2008 and May 2011. The subjects included 120 patients who underwent esophagectomy. They were divided into two groups: 46 patients in the MDT approach group (MDT group) and 74 patients in the non-MDT approach group (NMDT group).

**RESULTS:** The results demonstrated that the rates of PPCs were

### INTRODUCTION

Surgical operation has been recently performed in an increasing number of elderly patients. The high prevalence of comorbidities, such as cardiopulmonary diseases and diabetes mellitus (DM), limited functional reserve, and malnutrition are the risk factors for postoperative complications in elderly patients<sup>[1-4]</sup>. Esophagectomy is the optimal therapy for patients with resectable esophageal cancer. However, thoracic and abdominal surgical procedures in esophagectomy are associated with a high incidence of postoperative pulmonary complications (PPCs). The incidence rates of PPCs related

to esophagectomy were reported to range from 15.9 to 30%<sup>[5,6]</sup>. In any thoracic and abdominal surgeries, PPCs increase postoperative morbidity and mortality, prolong the duration of hospital stay, and contribute to additional medical costs<sup>[7-9]</sup>.

Patients with esophageal cancer have innate risk factors for PPCs, such as advanced age, comorbidities like heart failure, chronic obstructive pulmonary disease (COPD), and DM, limited cardiopulmonary functional reserve, malnutrition from difficulty in oral intake, and deconditioning following neoadjuvant chemotherapy (NAC) and preoperative radiotherapy. Therefore, seamless and excellent perioperative management and early rehabilitation are indispensable to prevent PPCs. In order to provide optimal perioperative care and rehabilitation, there should be different perspectives from different health care specialists. Thus, a multidisciplinary team (MDT) approach composed of different professionals in the perioperative phase is important<sup>[10]</sup>. In previous studies, it is reported that the MDT approach could reduce the intensive care unit (ICU)/hospital length of stay and duration of intubation, improves the sedation status, and accelerates the independence on activities of daily living (ADL)<sup>[11-13]</sup>. However, the subjects in these MDT approach studies were patients who had been managed with mechanical ventilation. To our knowledge, there is yet no study on the effect of the MDT approach on the prevention of PPCs. Therefore, in this study, the effect of the MDT approach was investigated for the prevention of PPCs in esophageal cancer patients who underwent esophagectomy.

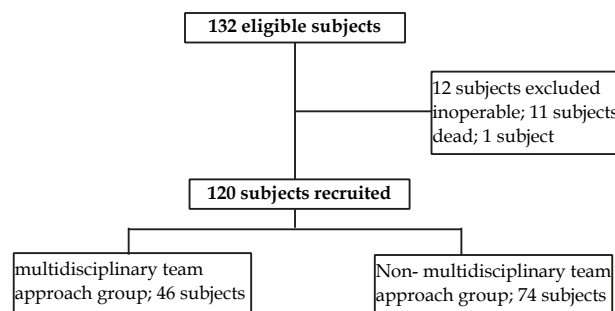


Figure 1 Flow of participants.

### Design

The study design was a retrospective cohort study. In our facility, the physiotherapists mainly provided rehabilitation in the preoperative, perioperative, and postoperative phases until March 2010. The MDT has been organized in March 2010 and has taken care of operative patients since then. The patients were divided into two groups according to the status of MDT approach; MDT approach group (MDT group) and non-MDT approach group (NMDT group). The MDT group included 46 patients (41 males and 5 females with mean age 66.8±7.5 years), and the NMDT group included 74 patients (60 males and 14 females with mean age 65.5±9.4 years). The classification of the patients is shown in figure 1.

### Contents of MDT approach

The MDT aimed to provide seamless and excellent care and early rehabilitation to patients who undergo major surgery. The MDT in our hospital consisted of surgeons, anesthetists, ICU nurses, physiotherapists, and medical engineers. The activities of the MDT include (1) information sharing of patients' physical and psychological conditions from preoperative to perioperative phases through the preoperative check sheet and conference; (2) discussion about perioperative cardiopulmonary management (ventilator settings, sedation status, extubation timing, etc.); (3) confirmation of perioperative treatment and respiratory rehabilitation plans; (4) early respiratory rehabilitation and mobilization (seamless rehabilitation including during holidays); and (5) case conference and staff education.

### Rehabilitation Program

The preoperative respiratory rehabilitation protocol consisted of (1) inspiratory muscle training with intensive spirometer (IS) Coach 2 (DHD Healthcare; NY, USA); (2) respiratory muscles and thoracic cage stretching; (3) deep diaphragmatic breathing; (4) efficient coughing and huffing with vigorous contraction of abdominal

## MATERIALS AND METHODS

### Subjects

One hundred and thirty-two patients with esophageal cancer (113 males and 19 females with mean age 66.3±8.7 years), who were admitted for esophagectomy at the Division of Gastroenterological Surgery in Kobe University Hospital between April 2008 and May 2011, were enrolled in this study (Figure 1).

The exclusion criteria were as follows: patients who were inoperable due to contraindications during preoperative examination and patients' death during the preoperative stage. A total of 120 patients (101 males and 19 females with mean age 66.0±8.7 years) were finally included in the study; wherein, the excluded subjects were composed of 11 inoperable patients and 1 mortality prior to the operation (Figure 1). The characteristics of the patients are shown in table 1. This study was approved by the Nursing Research Ethics Committee of Kobe University Hospital which sanctioned all portions of the present retrospective review without obtaining retroactive informed consent.

Table 1 Patient characteristics.

	n=120	MDT group (n=46)	NMDT group (n=74)	p value
age, mean (SD)	66.0 (8.7)	66.8 (7.5)	65.5 (9.4)	0.41
sex, male n (%)	101 (84.2)	41 (89.1)	60 (81.1)	0.24
BMI (kg/m <sup>2</sup> ), mean (SD)	20.9 (2.9)	21.2 (2.6)	20.7 (3.0)	0.29
BI, mean (SD)	649.3 (720.9)	508.3 (617.2)	738.2 (770.0)	0.09
clinical stage, n (%)				
	0 (2.5)	2 (4.3)	1 (1.4)	0.76
	I (27.5)	11 (23.9)	22 (29.7)	
	II (28.3)	12 (26.1)	22 (29.7)	
	III (35.0)	18 (39.1)	24 (32.4)	
	IV (6.7)	3 (6.5)	5 (6.8)	
NAC, n (%)	68 (56.7)	28 (60.9)	40 (54.1)	0.46
preoperative respiratory rehabilitation of >= 7 days, n (%)	69 (58.0)	28 (60.9)	41 (56.2)	0.61
anamnesis of respiratory diseases, n (%)	14 (11.7)	3 (6.5)	11 (14.9)	0.17

SD: standard deviation; BMI: body mass index; BI: Brinkman Index; NAC: neoadjuvant chemotherapy.

muscles; (5) muscle strength exercises for upper/lower limbs and abdominal muscles; and (6) biking on ergometer during the hospital stay. The preoperative rehabilitation program during the hospital stay was carried out for 40 to 60 minutes daily on weekdays under the supervision of a physiotherapist in the rehabilitation center. During the outpatient period, the patients underwent self-training at home, which included IS training, respiratory muscles and thoracic cage stretching, deep diaphragmatic breathing, and efficient coughing and huffing.

All the patients performed the perioperative respiratory rehabilitation, which consisted of (1) positioning; (2) respiratory muscles and thoracic cage stretching; (3) deep diaphragmatic breathing; (4) inspiratory muscle training with IS Coach 2; (5) coughing and huffing; (6) muscle strength exercises for upper/lower limbs and abdominal muscles; and (7) early mobilization from the first postoperative day until the day of discharge from ICU. The perioperative rehabilitation program during the ICU stay was carried out for 40 to 60 minutes daily under the supervision of a physiotherapist and/or an ICU nurse. Even though the patients were intubated in the ICU during the perioperative phase, feasible exercises in the programs according to their respective conditions without sedation were performed. After ICU management, the same rehabilitation program as in the preoperative phase continued until the day of discharge from the hospital for 40 to 60 minutes daily on weekdays under the supervision of a physiotherapist in the rehabilitation center and general wards.

### Outcomes

The primary outcome of this study was the determination of the presence of PPCs before the beginning of oral intake. In our protocol, oral intake is initiated around the 10<sup>th</sup>-12<sup>th</sup> postoperative days after ruling out recurrent laryngeal nerve palsy through the use of a flexible fiberoptic by the otolaryngologist to prevent aspiration pneumonia. PPCs were identified in patients who presented with four or more of the following eight dichotomous factors as defined by Reeve JC *et al*<sup>[14]</sup>: chest X-ray finding of atelectasis or consolidation; elevated white blood cell count ( $>11.2 \times 10^9/L$ ) or administration of respiratory antibiotics postoperatively (in addition to prophylactic antibiotics); temperature  $>38^\circ C$ ; signs of infection on sputum microbiology; purulent sputum different from preoperative status; oxygen saturation  $>90\%$  on room air; clinical pneumonia; and prolonged high-dependency unit stay or readmission to high-dependency unit/intensive therapy unit for respiratory complications.

The secondary outcomes were the duration of intubation after operation, days prior to ambulation after the operation, and duration of ICU hospitalization.

### Measurements

The measurements consisted of body mass index (BMI) as a substitute of body compositions, Brinkman Index (BI) for smoking status, and predicted vital capacity (%VC), predicted forced vital capacity (%FVC), and predicted forced expiratory volume in one second (%FEV1.0) as substitutes of preoperative pulmonary functions. The preoperative pulmonary functions were measured at the pulmonary function laboratory within three days before the operation. Moreover, data on the presence of NAC, preoperative respiratory rehabilitation of more than 7 days, anamnesis of respiratory diseases, clinical stage, operation time, amount of blood loss during operation, presence of open thoracic and/or abdominal surgical procedures, and occurrence of recurrent laryngeal nerve palsy after operation were extracted from the medical records.

### Statistical Analysis

Differences in nominal variables between the two groups were tested with  $\chi^2$  test. Differences in continuous variables with normal distribution were tested with unpaired t test and those without normal distribution were tested with Mann-Whitney U test. The relation between the MDT approach and PPCs was assessed by logistic regression analysis, and multiple logistic regression analysis was performed to correct for all considerable confounding factors. As the confounding factors, age, sex, and BI were selected according to the previous studies<sup>[15-18]</sup>, and the outcomes with a p-value of 0.10 or lower between the two groups were selected.

All analyses were conducted using the JMP version 5.1.2 (SAS Institute Inc.; NC, USA). All P values were two-sided, and P values of less than 0.05 were considered as statistically significant.

## RESULTS

Among the measurements, BMI, BI, clinical stage, and preoperative pulmonary functions have no significant differences between the two groups. Moreover, the presence of NAC, preoperative respiratory rehabilitation, anamnesis of respiratory diseases, operation time, blood loss, and surgical procedures have no significant differences between the two groups (Table 1 and 2). Recurrent laryngeal nerve palsy was identified in 28 patients (60.9%) in the MDT group and 17 patients (23.0%) in the NMDT group. The ratio of recurrent laryngeal nerve palsy was significantly higher in the MDT group ( $p<0.01$ ) than in the NMDT group (Table 3).

**Table 2** Comparison of preoperative pulmonary functions.

Outcomes	MDT group (n=46)	NMDT group (n=74)	p value
%VC (%), mean (SD)	113.2 (21.8)	108.6 (16.5)	0.19
%FVC (%), mean (SD)	105.9 (16.5)	105.0 (15.9)	0.77
%FEV1.0 (%), mean (SD)	98.5 (19.8)	93.3 (17.0)	0.13

SD: standard deviation; %VC: predicted vital capacity; %FVC: predicted forced vital capacity; %FEV1.0: predicted forced expiratory volume in one second.

**Table 3** Comparison of operation-related factors.

Outcomes	MDT group (n=46)	NMDT group (n=74)	p value
open thoracic and/or abdominal procedures, n (%)	15 (32.6)	20 (27.0)	0.51
operation time (min), mean (SD)	665.2 (111.1)	626.9 (155.3)	0.15
blood loss (mL), mean (SD)	447.4 (332.3)	566.9 (371.6)	0.08
unilateral recurrent laryngeal nerve palsy, n (%)	28 (60.9)	17 (23.0)	<0.01
duration of intubation (day), mean (SD)	1.10 (0.43)	2.00 (5.06)	0.23

SD: standard deviation.

PPCs occurred in 2 patients (4.3%) in the MDT group and in 12 patients (16.2%) in the NMDT group ( $p=0.03$ ). The incidence rate of PPCs significantly decreased in the MDT group compared with the NMDT group.

The durations of intubation after operation were  $1.10 \pm 0.43$  days in the MDT group and  $2.00 \pm 5.06$  days in the NMDT group ( $p=0.23$ ) (Table 3). There was no significant difference between the two groups. However, the MDT group showed a tendency for a shorter intubation period than the NMDT group.

The days prior to ambulation after the operation were  $3.50 \pm 1.96$  days in the MDT group and  $5.13 \pm 3.03$  days in the NMDT group ( $p<0.01$ ). The MDT group started walking significantly earlier than the NMDT group.

The durations of ICU hospitalization were  $4.65 \pm 1.83$  days in the MDT group and  $5.66 \pm 4.43$  days in the NMDT group ( $p=0.14$ ). There was no significant difference between the two groups. However, the MDT group showed a tendency for shorter duration of ICU hospitalization.

Age, sex, BI, blood loss, and recurrent laryngeal nerve palsy were selected as the confounding factors. The result of the analysis demonstrated that the MDT group had significantly lesser incidence rate of PPCs than the NMDT group after statistical adjustment (OR: 0.16, 95% confidential interval: 0.02-0.75) (Table 4).

**Table 4 Independent risk factors.**

	OR	95% CI	<i>p</i> value
MDT			
Not introduced	Ref		
Introduced	0.16	0.02 to 0.75	0.03
Age	0.26	0.01 to 5.46	0.40
Sex			
Male	Ref		
Female	2.13	0.32 to 42.8	0.50
BI	0.20	0.01 to 3.66	0.25
Blood loss	0.54	0.04 to 9.56	0.65
Recurrent laryngeal nerve palsy			
Without palsy	Ref		
With palsy	3.04	0.84 to 11.4	0.09

OR: odds ratio; CI: confidence interval; MDT: multidisciplinary team; BI: Brinkman Index.

## DISCUSSION

In this study, the MDT approach was investigated if it could reduce the incidence of PPCs in esophageal cancer patients who underwent esophagectomy. The result demonstrated the significantly lower incidence rate of PPCs in the MDT group than in the NMDT group (4.3% vs 16.2%). In addition, the MDT group started walking significantly earlier after operation than the NMDT group. Moreover, the MDT group showed a tendency for shorter durations of postoperative intubation and ICU hospitalization after operation.

Patients who underwent esophagectomy experienced a high incidence rate of PPCs with the range of 20 to 35%<sup>[19-25]</sup>. Previous studies demonstrated an incidence rate of 7.7 to 11.1% of pneumonia even in patients who underwent thoracoscopic surgery, which is considered as a minimally invasive procedure<sup>[26,27]</sup>. Moreover, it was reported that PPCs were related to 40 to 60% of the hospital mortality in patients who underwent open thoracic and abdominal surgery<sup>[28-30]</sup>, and contributed to the increased postoperative morbidity, prolonged duration of hospital stay, and additional medical costs<sup>[7-9,31]</sup>. In this study, the incidence rate of PPCs in the MDT group (4.3%) was lower compared to the results of previous studies, even though the ratio of recurrent laryngeal nerve palsy was significantly higher in the MDT group than in the NMDT group. This result showed the possible prevention of PPCs by the MDT approach.

Barbetti *et al.*<sup>[32]</sup> documented that the roles and contributions of MDT were the observation and recognition of clinically abnormal conditions in patients prior to the clinical events and the promotion of early intervention in clinically deteriorating patients. In order to respond promptly to patients who become acutely ill, MDT should provide the hospital staff members with education and training to improve their skills and competences. Furthermore, communication among the staff members is vital to success with the implementation of MDT. Bellomo *et al.*<sup>[33]</sup> showed that the introduction of MDT was associated with a reduced incidence of postoperative adverse events, postoperative mortality rate, and shorter duration of hospital stay. The mechanism of the lower incidence rate of PPCs by MDT approach

is unclear, but several factors may have influences in its success. The introduction of MDT in our facility brings about the sharing of information on patients' physical and psychological conditions from the preoperative to perioperative phases and creates a lively discussion about postoperative cardiopulmonary management among the staff members. Therefore, the preoperative risk factors were readily understood and adequate perioperative management was rendered which led to the accomplishment of shorter duration of intubation and earlier ambulation after the operation.

The previous studies documented that early mobilization while still in the ICU was associated with statistically significantly shortened days in bed and reduced the ICU length of stay<sup>[34,35]</sup>. The establishment of a protocol on early respiratory rehabilitation and mobilization may have served as a significant factor. Vital capacity (VC) and functional residual capacity (FRC) were reduced after the thoracic and upper abdomen surgeries because of the functional disorder of respiratory muscles, influence of general anesthesia, and use of muscle relaxants during operation<sup>[36,37]</sup>. Pulmonary collapse results in atelectasis and pneumonia. Atelectasis induces postoperative pneumonia and respiratory failure, so it is important to prevent the occurrence of postoperative atelectasis by early respiratory rehabilitation and mobilization<sup>[38]</sup>. The previous studies about ICU care reported that the established care by nurses and respiratory therapists increased the delivery frequency of patient care, such as daily awakening, weaning, and mobilization<sup>[39,40]</sup>. Under our protocol, the MDT could assess the patients' conditions appropriately from the preoperative to perioperative phases, and provide early rehabilitation, and facilitate mobilization with adequate risk management. The MDT has reduced the frequency of missed opportunities for rehabilitation sessions with the sedation status controlled, as seamless rehabilitation is provided even on holidays. Needham *et al.*<sup>[12]</sup> reported that the MDT approach could control the sedation status, secure a greater median number of rehabilitation treatment with a higher level of functional mobility, and decrease the ICU length of stay.

In this study, PPCs developed in 2 of 46 patients (4.3%) in the MDT group and 12 of 74 patients (16.2%) in the NMDT group. Moreover, 3 of 12 patients with PPCs in the NMDT group developed acute respiratory distress syndrome (ARDS) and unfortunately died during the perioperative phase. Whooley *et al.*<sup>[29]</sup> reported that 45.5-50.0% of postoperative hospital mortality was caused by PPCs. On the other hand, the MDT group had no mortality. Therefore, PPCs could be prevented through the adequate perioperative management and considerable early rehabilitation and mobilization with risk management by the MDT approach.

There are two limitations in this study. The first one is the existence of selection bias. The subjects were not randomly allocated to the MDT group and NMDT group, so various confounding factors exist. In the measurements, BI and blood loss had a higher tendency in the NMDT group than in the MDT group. It is reported that age, sex, and BI were considered as predictors of PPCs<sup>[21-24]</sup>. In this study, age, sex, BI, blood loss, and presence of recurrent laryngeal nerve palsy were selected as predictors of PPCs according to the previous studies. The outcomes with *p*-values of 0.10 or lower between the two groups were labeled as the confounding factors, and multivariate analysis was then performed. Therefore, the confounding factors thought to be clinically significant were corrected to some extent. Future RCT studies should be performed to further elucidate the contribution of the said confounding factors.

The second limitation is the unexplained mechanism for the prevention of PPCs through the MDT approach because it was unclear what functions of the patients have been changed the approach.



Further studies to examine the relationship between the MDT approach and PPCs are necessary.

Despite the limitation described above, this study firstly showed that the MDT approach reduced the incidence of PPCs. The adequate perioperative management and considerable early rehabilitation and mobilization with risk management should be provided to prevent PPCs.

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