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Community-acquired Pneumonia during Long-term Follow-up of Patients after Radical Esophagectomy for Esophageal Cancer: Analysis of Incidence and Associated Risk Factors

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Abstract
Background There are no data concerning the occurrence of community-acquired pneumonia (CAP) in esophageal cancer patients during long-term follow-up after radical esophagectomy. The aims of the present study were to determine the incidence of CAP in esophageal cancer patients who underwent radical esophagectomy and to identify the risk factors.
Methods A total of 186 consecutive patients who underwent radical esophagectomy for thoracic esophageal carcinoma in our hospital between 1991 and 2000 were enrolled in this study. Data on the occurrence of CAP were retrospectively collected from medical records, follow-up files, and telephone interviews with patients. The cumulative incidence of CAP was calculated by the Kaplan–Meier method, and the risk factors for CAP were determined by univariate and multivariate analyses. The median follow-up time was 77 months (range 12–216 months).
Results Sixty patients suffered from CAP during the follow-up period. The cumulative incidence was 25.8% at 5 years and 38.4% at 10 years. Multivariate analysis revealed the following as the significant risk factors for CAP: presence of lymph node metastasis (Hazard ratio [HR], 2.64; 95% confidence interval [CI], 1.55–4.50; $P < 0.001$), colonic interposition (HR, 2.87; 95% CI, 1.41–5.82; $P = 0.004$), obstructive lung disease (HR, 1.95; 95% CI, 1.11–3.42; $P = 0.021$), and preoperative hypoalbuminemia (HR, 2.08; 95% CI, 1.20–3.60; $P = 0.009$).
Conclusions There is a high incidence of CAP in esophageal cancer patients after esophagectomy. Positive nodal metastasis, colonic interposition, obstructive lung disease, and preoperative hypoalbuminemia are risk factors for this long-term postoperative morbidity.

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Introduction

Esophageal carcinoma is notorious as one of the most difficult malignancies to cure, and it is the sixth most common cause of cancer deaths worldwide [1]. Surgery is the standard treatment for esophageal carcinoma. Although still unsatisfactory, the prognosis for esophageal cancer is gradually improving since the introduction of extensive lymph node dissection and advances in adjuvant therapies, including the introduction of new chemotherapeutic agents and innovations in radiation technology [2–4]. Thus, long-surviving patients are becoming relatively common, and the importance of medical care has increased in the follow-up of patients who have undergone radical esophagectomy.

Radical esophagectomy with lymph node dissection is one of the most highly invasive surgical procedures for gastrointestinal malignancies and requires special attention to the prevention and management of operative morbidities. Pneumonia is common and the most clinically important perioperative complication; consequently, many studies have actively investigated this surgical morbidity [5–10]. Postoperative pneumonia is thought to be caused by a combination of multiple factors, including underlying malnutrition [5], lung collapse during thoracic procedures [11], barotrauma by mechanical ventilation [12], suppressed immunity induced by surgical stress [13], and nodal-dissection–related functional loss of the bronchopulmonary system [8, 9].

Apart from the perioperative period, esophageal cancer patients who undergo esophagectomy are also considered to be at high risk for pneumonia in the follow-up period. Lymph node dissection of the mediastinum causes unavoidable destruction of the neurovascular networks surrounding the tracheobronchial tree, which can lead to functional loss in the respiratory system. Esophageal reconstruction results in occasional aspiration, combined with recurrent laryngeal nerve paralysis (RLNP), which may occur with significant incidence with lymph node dissection of the upper mediastinum and neck [14–16]. Moreover, esophagectomy and the following adjuvant treatment can impair the patient's nutritional status and compromise immunity. These conditions can influence the susceptibility of esophageal cancer patients to pneumonia. In our clinics, we commonly encounter pneumonia in patients with a history of radical esophagectomy. To improve the quality of life (QOL) of esophageal cancer patients, a sound knowledge of this clinical problem is required, along with appropriate planning for its management during the follow-up period. However, the frequency of community-acquired pneumonia (CAP) and the risk factors for morbidity remain unknown in patients who undergo radical esophagectomy.

The aim of the present study was to investigate the incidence of CAP in patients who underwent radical surgery for esophageal cancer, using detailed follow-up data at our hospital. Moreover, the risk factors for CAP during long-term follow-up of esophageal cancer patients were determined.

Methods

Patients

As this study required long-term follow-up data, we limited the study candidates to esophageal cancer patients who underwent radical esophagectomy between January 1991 and December 2000. In that period, a total of 274 consecutive patients with thoracic esophageal carcinoma underwent radical esophagectomy at Niigata University Medical and Dental Hospital. Excluded from the study were 52 patients who underwent incomplete resection and 11 patients who died in hospital. Twenty-five patients who died in the 365 days following the surgery were also excluded because the disease-free period in those patients was very short and it was practically impossible to discriminate CAP from cancer relapse or cancer-related pneumonia. The remaining 186 patients were defined as the cohort of this study. Patient age at the time of esophagectomy ranged from 43 to 83 years (median: 65 years); 170 patients were male and 16 were female. The minimal interval between CAP occurrence and tumor recurrence was 46 days.

Surgical procedure

In our department, the treatment strategy for patients with thoracic esophageal cancer was as follows. Transthoracic esophagectomy (TTE) was selected for carcinoma of the upper or middle thoracic esophagus regardless of nodal status ($n = 82$), and for carcinoma of the lower thoracic esophagus that was positive for mediastinal lymph node metastasis on clinical diagnosis ($n = 28$). Transhiatal esophagectomy (THE) associated with mid and lower mediastinal dissection was selected for carcinoma of the lower thoracic esophagus that was negative for mediastinal lymph node metastasis on clinical diagnosis ($n = 76$). Three-field lymphadenectomy was indicated for patients younger than 75 years of age who had no significant co-morbidity ($n = 75$).

Gastric pull-up was the first choice for reconstruction ($n = 160$), and colonic interposition was used when the stomach was unavailable as an esophageal substitute ($n = 26$). In the case of colonic interposition, coloduodenostomy was preferably adopted because the procedure was simpler than colojejunostomy with a Roux-Y fashion.

In all the patients, the anastomosis was made in the neck. For TTE, the esophageal substitutes were pulled up essentially via the retrosternal route ($n = 103$), whereas the posterior mediastinal route and the subcutaneous route were rarely selected ($n = 6$ and 1, respectively). Conversely, for THE, the posterior mediastinal route was the first choice ($n = 63$), followed by the retrosternal route ($n = 13$).

Follow-up

The 186 patients enrolled in this study were periodically followed up at our outpatient clinic or at those of affiliated hospitals: 77 patients were followed up at our hospital

alone; 82 were followed up at our hospital initially and at affiliated hospitals subsequently; and 27 were followed up at affiliated hospitals alone. As of 20 April 2009, 123 of the 186 patients had died. The postoperative follow-up time of the 186 patients ranged from 12 to 218 months (median: 77 months). The total number of visits to the outpatient clinics ranged from 1 to 134 (median: 25).

Demographic data of the patients and their tumors were collected from medical charts, surgical files, and pathology reports. Primary tumor characteristics were described according the tumor-node-metastasis (TNM) classification of the American Joint Committee on Cancer (AJCC) [17]. The clinicopathological characteristics of the 186 patients and the surgical procedures are summarized in Table 1.

This study was approved by the institutional review board of Niigata University Graduate School of Medical and Dental Sciences (No. 1144).

Community-acquired pneumonia

We reviewed the medical records and follow-up files of the 186 enrolled patients and identified the occurrence of CAP; i.e., pneumonia that developed during the follow-up period prior to confirmation of cancer recurrence. To ensure data accuracy, telephone interviews were also conducted with 84 of the patients or with their families.

In the present study, pneumonia was defined as having (1) clinical presentations of fever and coughing, (2) lung infiltrates on chest X-rays or CT, (3) leukocytosis or elevated C-reactive protein level on blood tests, and (4) intravenous or oral administration of antibiotics. Patients who met all four criteria were defined as having pneumonia, regardless of whether inpatient treatment was required. Pulmonary aspergillosis, pulmonary tuberculosis, and nontuberculous mycobacterial disease were excluded. Pneumonia that ensued from the recurrence of esophageal cancer or following the diagnosis of a second malignancy was also excluded.

Identification of risk factors for CAP

To identify the risk factors for CAP, we evaluated 27 variables related to patient background, including co-morbidities, clinicopathological characteristics of the primary tumors, surgical procedures, pulmonary function tests, arterial blood gas analysis, and biochemical tests. RLNP was diagnosed based on clinical symptoms and/or laryngoscopic findings; since 1994, the morbidity had been routinely checked by laryngoscopy prior to discharge. Consequently, 150 of the patients in the present study (80.6%) underwent laryngoscopy. Anastomotic stenosis was defined as postoperative narrowing that required endoscopic dilation. Postoperative weight loss was defined

Table 1 Clinicopathological characteristics and surgical procedures in 186 patients with thoracic esophageal cancer who underwent radical esophagectomy

Variable	No. of patients
Median age at time of esophagectomy, years (range)	65 (43–83)
Sex	
Male	170
Female	16
Tumor location	
Upper thoracic esophagus	14
Middle thoracic esophagus	107
Lower thoracic esophagus	65
Median tumor size, mm (range)	50 (2–240)
Depth of tumor invasion	
pT1	98
pT2	38
pT3	48
pT4	2
Lymph node metastasis	
pN0	103
pN1	83
Distant metastasis	
pM0	171
pM1	15
Pathological stage (TNM)	
0	12
I	62
II	53
III	44
IV	15
Preoperative chemotherapy	
Performed	11
Not performed	175
Postoperative chemotherapy and/or radiotherapy	
Performed	65
Not performed	121
Surgical procedure	
Transthoracic esophagectomy	110
Transhiatal esophagectomy	76
Reconstruction	
Gastric tube	160
Colonic interposition	26
Reconstruction route	
Retrosternal	116
Posterior mediastinal	69
Subcutaneous	1
Lymphadenectomy	
3-field[a]	75
Others	111

[a] Cervical, mediastinal, and abdominal lymph node dissection

as the difference between body weight on hospitalization and the minimum body weight in the year following the esophagectomy. In the present study, preoperative serum albumin level was used as an indicator of the patient's nutritional status as postoperative serum albumin level could be obtained from only a limited number of patients.

The definitions of chronic lung disease were as follows: (1) obstructive lung disease, including such symptomatic pulmonary diseases as pulmonary emphysema, chronic bronchitis, and asthma that were diagnosed by a pulmonologist, or abnormal lung function (forced expiratory volume in 1 second [FEV_1] is <70% of forced vital capacity [FVC]); and (2) restrictive lung disease, including such symptomatic pulmonary diseases as interstitial pneumonia, pneumoconiosis, and tuberculous pleurisy, or abnormal lung function (vital capacity is <80% of predicted normal).

Other concurrent illnesses included cardiovascular disease (receiving medical treatment or with a history of interventional treatment), cerebrovascular disease (receiving treatment or presenting with neurological sequelae), diabetes mellitus requiring medication, and other morbidities considered to be significant risks for esophagectomy.

Data and statistical analysis

Medical records, surgical reports, pathological findings, and follow-up data were obtained for all 186 patients. The incidence of pneumonia was calculated by the Kaplan–Meier method, and differences in incidence were evaluated with the log-rank test. In the Kaplan–Meier analysis, pneumonia events that occurred two or more times in the same patient were not counted as additional pneumonia events. Patients who died were added to a census at the time of their deaths. Cox's proportional hazards regression model was used to identify the risk factors that may influence pneumonia: stepwise selection was used for variable selection, with entry and removal limits of $P < 0.10$ and $P > 0.15$, respectively. The stability of this model was confirmed by means of a step-backward and step-forward fitting procedure. All statistical evaluations were performed with the SPSS 16.0 J software package (SPSS Japan Inc., Tokyo, Japan). A P value <0.05 (two-tailed) was considered statistically significant.

Results

Incidence of community-acquired pneumonia

Community-acquired pneumonia following radical esophagectomy developed in 60 (32.3%) of the 186 patients, with a total of 167 cases of pneumonia identified, including repeat cases. The cumulative incidence of CAP according to the Kaplan–Meier method is shown in Fig. 1. The estimated incidence was 25.8% at 5 years and 38.4% at 10 years. Thirty-five patients suffered from CAP once, and 25 patients had repeat events (median: 1 time; maximum: 19 times). Of the 60 patients who contracted CAP, 15 (25.0%) died of the disease, although autopsy was performed in only one case. In the present study cohort, four patients died of other pulmonary diseases: two of nontuberculous mycobacterial disease, one of acute exacerbation of chronic bronchitis, and one of chronic respiratory failure.

Microorganisms

Of the total of 167 cases of pneumonia, data regarding sputum culture of microorganisms were available in 81 cases (48.5%). Unfortunately, such data could not be obtained for the remaining 86 cases because of the lack of sputum culture or medical records. Pathogenic microorganisms isolated from the sputum culture are listed in Table 2. Methicillin-resistant *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *α-streptococcus* were the most common pathogens in this cohort. It was noted that enteric bacteria, including *Enterobacter cloacae, Escherichia coli, Klebsiella oxytoca, Enterococcus faecalis,* and *Enterobacter aerogenes*, comprised 21.0% of the microorganisms isolated.

Risk factors for CAP

Univariate analysis revealed that 10 of the 27 variables analyzed were related to the occurrence of CAP with statistical significance: patient age ($P = 0.001$), lymph node metastasis ($P = 0.003$), postoperative chemotherapy and/or radiotherapy ($P = 0.009$), esophageal reconstruction

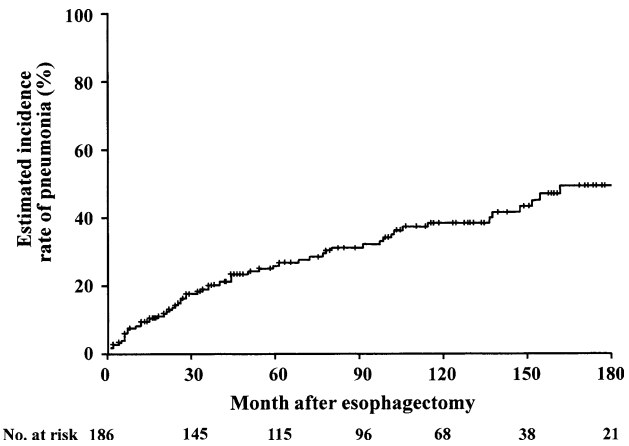

Fig. 1 Kaplan–Meier incidence estimates in 186 patients following radical esophagectomy. The cumulative incidence of community-acquired pneumonia was 25.8% at 5 years and 38.4% at 10 years

Table 2 Pathogenic microorganisms detected by sputum culture in 81 cases of community-acquired pneumonia

Organism	No. of cases
MRSA	11
Klebsiella pneumoniae	10
Streptococcus spp.	9
Pseudomonas aeruginosa	5
Other *Staphylococcus* spp.	4
Stenotrophomonas maltophilia	4
Enterobacter cloacae	4
Escherichia coli	4
Haemophilus influenzae	4
Klebsiella oxytoca	4
Enterococcus faecalis	3
Staphylococcus aureus	3
Acinetobacter baumannii	2
Enterobacter aerogenes	2
Streptococcus pneumoniae	2
Others[a]	40

MRSA methicillin-resistant *Staphylococcus aureus*

[a] Including *Candida* spp. and normal flora

($P = 0.014$), RLNP ($P = 0.048$), obstructive lung disease ($P = 0.002$), FVC ($P = 0.022$), FEV_1/FVC ratio ($P = 0.021$), serum albumin ($P = 0.001$), and weight loss ($P = 0.024$) (Table 3). Multivariate analysis of these 10 variables led to identification of the following as the independent risk factors for CAP: lymph node metastasis (HR, 2.64; 95% confidence interval [CI], 1.55–4.50; $P < 0.001$), colonic interposition (HR, 2.87; 95% CI, 1.41–5.82; $P = 0.004$), obstructive lung disease (HR, 1.95; 95% CI, 1.11–3.42; $P = 0.021$), and preoperative hypoalbuminemia (HR, 2.08; 95% CI, 1.20–3.60; $P = 0.009$) (Table 4).

Discussion

We investigated the incidence of and risk factors for CAP that developed during the follow-up period of patients who underwent radical esophagectomy. The number of patients who suffered from CAP increased with time, and the estimated incidence of CAP was 25.8% at 5 years and 38.4% at 10 years. Based on the incidence curve shown in Fig. 1, CAP incidence in this cohort was calculated as 38–52 per 1,000 patients per year, which is remarkably higher than the reported incidence in the general population. Jackson et al. [18] performed a prospective cohort study of 46,237 seniors and reported a CAP incidence of 26.7 per 1,000 patients per year in persons aged 65–68 years. Fry et al. [19] conducted a population-based study using data from the National Hospital Discharge Survey and estimated that the hospitalization rate due to CAP is 12 per 1,000 patients per year in the population aged 65–74 years. These epidemiological data permit us to understand that patients who have undergone esophagectomy show a higher risk of developing CAP than the general population, although the magnitude of the increase in risk cannot be determined.

The identification of risk factors is an essential step toward disease prevention. Mortality from CAP was 25.0% in the present series. This high mortality emphasizes the importance of prevention and early intervention in patients at risk for CAP. Our study revealed four risk factors for CAP in patients who underwent radical esophagectomy: lymph node metastasis, colonic interposition, obstructive pulmonary disease, and preoperative hypoalbuminemia.

At the early stages of the present study, we hypothesized that RLNP would be a risk factor for CAP. It is a common complication of radical esophagectomy, and several studies have reported that it is associated with pulmonary complications [14–16]. Contrary to our hypothesis, RLNP was not identified by multivariate analysis as a risk factor for CAP, although univariate analysis revealed a significant association between RLNP and the occurrence of CAP. Studies from Western countries report that the incidence of RLNP after esophagectomy ranges from 15% to 20%, while higher incidences, ranging from 36 to 70% [14, 20, 21], are reported in studies from Japan where three-field lymph node dissection is commonly applied. In the present study, we identified RLNP-positive patients from our surgical files where the diagnosis was prospectively recorded based on laryngoscopic findings, regardless of whether clinical manifestations were present or not; consequently, the incidence of RLNP was as high as 69%. The contamination of subclinical RLNP diluted the power of RLNP as a risk factor, which may partially account for the results of multivariate analysis in the present study. Furthermore, temporal factors should be considered. Several investigators [14, 20, 21] have reported that in more than 50% of cases, RLNP was temporary and many of the patients recovered spontaneously. This temporal factor also may explain why RLNP was not a risk factor for CAP.

It is noteworthy that lymph node metastasis was identified as a risk factor (HR, 2.64). To our knowledge, no previous study has reported lymph node metastasis to be a risk factor for postoperative pulmonary complications or for CAP. Nagawa et al. [6], in reviewing 170 patients who underwent esophagectomy at their hospital, revealed that tumor stage, as well as liver cirrhosis and low vital capacity, was a risk factor for postoperative pulmonary complications. They speculated that advanced tumor stage caused malnutrition in the patients, which might have led to the association with postoperative pulmonary

Table 3 Univariate analysis of risk factors for community-acquired pneumonia in 186 patients with thoracic esophageal cancer who underwent radical esophagectomy

Variable	No. of patients	Incidence of pneumonia (%)		*P* value
		5-year	10-year	
Age, years				0.001
<65	92	16.8	25.9	
≥65	94	34.7	51.1	
Gender				0.072
Male	170	27.3	40.5	
Female	16	9.1	18.2	
Tumor location				0.095
Upper thoracic esophagus	14	51.0	51.0	
Middle thoracic esophagus	107	22.4	35.1	
Lower thoracic esophagus	65	26.3	41.1	
Tumor size, mm				0.188
<50	91	24.2	35.1	
≥50	95	27.3	41.6	
Depth of tumor invasion				0.157
pT1, pT2	136	23.1	35.8	
pT3, pT4	50	36.3	47.9	
Lymph node metastasis				0.003
pN0	103	20.6	31.2	
pN1	83	32.4	50.6	
Distant metastasis				0.119
pM0	171	24.1	36.3	
pM1a, pM1b	15	51.0	75.5	
Preoperative chemotherapy				0.911
Performed	11	29.3	29.3	
Not performed	175	25.5	38.7	
Postoperative chemo and/ or radiotherapy				0.009
Performed	65	37.1	53.7	
Not performed	121	20.3	31.6	
Surgical procedure				0.123
Transthoracic esophagectomy	110	31.8	41.3	
Transhiatal esophagectomy	76	17.1	34.3	
Reconstruction				0.014
Gastric tube	160	22.9	35.6	
Colonic interposition	26	44.0	53.4	
Reconstruction route				0.748
Posterior mediastinal route	69	25.4	43.9	
Other	117	26.0	35.1	
Lymphadenectomy				0.850
3-field	75	30.2	35.1	
Others	111	22.7	40.6	
Recurrent laryngeal nerve paralysis				0.048
Absent	58	16.7	26.8	
Present	128	29.8	43.0	
Anastomotic stenosis				0.321
Absent	107	22.4	34.5	
Present	79	30.5	43.6	

Table 3 continued

Variable	No. of patients	Incidence of pneumonia (%)		*P* value
		5-year	10-year	
Perioperative pneumonia				0.305
Absent	164	25.3	38.3	
Present	22	30.8	39.5	
Brinkman index[a]				0.432
<1,000	109	27.1	42.1	
≥1,000	77	23.7	31.5	
Obstructive lung disease				0.002
Absent	135	20.6	34.2	
Present	51	38.3	48.2	
Restrictive lung disease				0.269
Absent	177	24.4	37.6	
Present	9	51.4	51.4	
Other concurrent illnesses				0.206
Absent	120	24.9	35.6	
Present	66	27.3	45.0	
FVC, l				0.022
<3.5	87	35.0	51.8	
≥3.5	99	18.8	28.4	
%FVC (% predicted)				0.131
<80	6	66.7	66.7	
≥80	180	24.7	37.6	
FEV_1, l				0.126
<2.5	79	32.4	45.2	
≥2.5	107	21.7	34.1	
FEV_1/FVC, %				0.021
<70	45	33.7	45.6	
≥70	141	23.1	35.9	
Serum albumin, g/dl				0.001
≥4.0	143	19.1	31.2	
<4.0	43	47.6	62.9	
PaO_2, mmHg				0.969
<80	55	27.5	35.8	
≥80	131	25.2	39.1	
Weight loss, kg				0.024
<10	100	18.4	32.9	
≥10	44	36.8	40.0	
Unknown	42			

[a] Cigarettes per day × years

FVC forced vital capacity, *FEV_1* forced expiratory volume in 1 second, *PaO_2* arterial oxygen tension

complications. In agreement with this, the present study showed that patients with preoperative hypoalbuminemia and body weight loss were also significantly predisposed to CAP. Low nutritional status resulting from the advanced stage of cancer may account for the association between lymph node metastasis and CAP. Moreover, patients in which lymph node metastasis is clinically evident tend to undergo lymph node dissection more widely and thoroughly. This difference in surgical procedures may result in differences in pulmonary function, which can influence the susceptibility of patients to CAP. In addition, the effect of adjuvant chemotherapy should be considered. We conducted postoperative adjuvant chemotherapy only in patients with lymph node metastasis, because this was the standard treatment in Japan. We consider that such factors as low nutritional status, pulmonary dysfunction related to lymph node dissection, and immunosuppression induced by adjuvant chemotherapy worked together, and that lymph node metastasis was abstracted as a significant risk factor for CAP by the multivariate analysis in the present study.

Of the variables related to surgical procedures, multivariate analysis identified colonic interposition as a

Table 4 Multivariate analysis of risk factors for community-acquired pneumonia in 186 patients with thoracic esophageal cancer who underwent radical esophagectomy

Variable	Hazard ratio	95% confidence interval	*P* value
Lymph node metastasis			<0.001
pN0	1.00		
pN1	2.64	1.55–4.50	
Reconstruction			0.004
Gastric tube	1.00		
Colonic interposition	2.87	1.41–5.82	
Obstructive lung disease			0.021
Absent	1.00		
Present	1.95	1.11–3.42	
Serum albumin, g/dl			0.009
≥4.0	1.00		
<4.0	2.08	1.20–3.60	

significant risk factor for CAP. Interestingly, this factor showed the highest HR of 2.87. Several investigators [22–24] have reported that colonic interposition has the advantage of lowering the risk of postoperative aspiration and cervical reflux esophagitis, and they recommended the use of this esophageal substitute, particularly in patients with benign esophageal disease. This view is apparently in disagreement with our observation that CAP commonly occurred in patients who underwent colonic interposition. However, this discrepancy could be explained by the differences in the patients' backgrounds. We essentially selected colonic interposition for the treatment of patients with a history of gastrectomy and of those who required gastric resection because the tumor extended to the stomach. Therefore, the colonic conduits used in the present study were interposed onto the duodenum or the gastric remnant, and not onto the intact stomach. The direct influx of digestive fluid from the small bowel may provide suitable circumstances for the recolonization of enteric bacteria in the colonic segment. Furthermore, patients who undergo colonic interposition are predisposed to the deterioration in nutritional status because of a previous gastrectomy or an excessive scarification of the gastrointestinal tract. We assume that these two factors act in combination and may have underpinned the selection of colonic interposition as a risk factor for CAP in the present series.

Preoperative hypoalbuminemia was also identified as a risk factor for CAP in the present study (HR, 2.08). Hypoalbuminemia is a well-known risk factor for postoperative complications after esophagectomy [6, 9] and an indicator of malnutrition. Of note in the present study was that preoperative hypoalbuminemia was associated not only with postoperative pulmonary complications but also with pneumonia that occurred in the follow-up period. Martin and Langergren [25] conducted a nationwide cohort study and found that in patients who underwent esophageal cancer surgery, body weight loss was at least 10 kg at 6 months after the surgery and lasted for more than 3 years. This result suggests that nutritional recovery is very slow in patients following esophagectomy, and that the deterioration in nutritional status indicated by hypoalbuminemia may be prolonged.

One limitation of the present study is that the design was retrospective. We rigorously reviewed all medical records of the enrolled patients and systemically determined the episodes of CAP according to the predetermined criteria. A significant number of episodes suspicious of CAP could not be confirmed because of lack of data or detailed description. These drawbacks that were generated by the retrospective study design may have led to an underestimation of the incidence of CAP. Nevertheless, the present study provided the first objective data regarding the incidence of CAP in this clinical setting and could form the basis for further studies that aim to improve the QOL of esophageal cancer patients who undergo esophagectomy.

In conclusion, the present study revealed a high incidence of CAP during follow-up of patients who underwent radical esophagectomy. Lymph node metastasis, colonic interposition, obstructive pulmonary disease, and preoperative hypoalbuminemia were identified as the significant risk factors for CAP. Careful follow-up and early antimicrobial intervention are required, especially in patients carrying these risk factors.

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Conflict of interest The authors declare no conflict of interest.

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