Radical esophagectomy for thoracic esophageal cancer is highly invasive and frequently results in postoperative pulmonary complications. Postoperative pneumonia is the most common such complication and affects hospital mortality and survival rates. Oral care has been very effective in reducing pneumonia. In Japan, preoperative professional oral care is highly recommended. However, there are few studies on the effect of preoperative improvements in oral hygiene as a result of intervention on the incidence of postoperative pneumonia. The primary end-point of this retrospective study was the incidence of postoperative pneumonia after radical esophagectomy. The oral health levels of 46 patients were individually categorized, and then patients were grouped according to whether they maintained or improved their oral hygiene. At the first dental examination, oral health levels were classified as good in 22 patients and bad in 24. Of the 46 patients studied, 39 patients maintained or improved their oral hygiene (good control group), whereas 7 showed no improvement (bad control group). Postoperative pneumonia occurred in eight patients: four in the good control group and four in the bad control group. Statistical analysis with postoperative pneumonia as a dependent variable showed a significant effect of oral hygiene improvement on the incidence of pneumonia. Logistic regression analysis with this factor as an independent variable demonstrated that the risk of postoperative pneumonia was reduced in the good control group (OR 0.086, 95% CI 0.014–0.529). Therefore, preoperative professional oral care may improve oral hygiene and oral health, which may in turn reduce the incidence of postoperative pneumonia.

Keywords: esophageal cancer, esophagectomy, oral hygiene, postoperative pneumonia, professional oral care

Introduction
Radical esophagectomy for thoracic esophageal cancer is highly invasive with a high frequency of postoperative complications. Pulmonary complications are the most common complications (19.6–38.0%)\(^1\text{-}\text{3}\) that influence hospital mortality.\(^3\text{-}\text{4}\) Pneumonia, in particular, accounts for 6.4–37.8% of complications,\(^1\text{-}\text{4}\text{,}\text{1}\text{5}\text{-}\text{1}\text{6}\) and is correlated...
with survival rates. Recently, the development of surgical techniques and devices, such as video-assisted thoracoscopic surgery and hand-assisted laparoscopic surgery, has contributed to a reduction in the incidence of postoperative pneumonia. However, these approaches are associated with a wider range of postoperative complications, in addition to pulmonary complications, than open surgery is. In Japan, there is an ongoing debate regarding the advantages and disadvantages of these new techniques. Preoperative management is important in preventing postoperative pneumonia after open surgery. Oral health management, respiratory physiotherapy, and rehabilitation for swallowing disorders, which are included in our clinical protocol for radical esophagectomy, are useful for reducing postoperative pneumonia. According to previous studies, dental plaque harbors pneumonia-causative pathogens, and poor oral hygiene is considered to be a relevant risk factor for nosocomial lower respiratory tract infections, including pneumonia. There is a consensus that oral care with chlorhexidine reduces the incidence of postoperative pneumonia and ventilator-associated pneumonia (VAP). In Japan, oral care without chlorhexidine, the use of which is not permitted, is effective for reducing dental plaque, bacteria, and the incidence of postoperative pneumonia. In particular, professional oral care is more effective than oral care carried out by non-dental professionals for improving oral health, and professional oral care was found to reduce the incidence of respiratory infections and pneumonia after esophagectomy. In addition, oral care with chlorhexidine combined with professional oral care was found to be superior to oral care with chlorhexidine alone. These findings suggest that professional oral care might be more important than a good level of oral health. However, these studies did not show a relationship between the preoperative improvement of oral health resulting from preoperative professional oral care and a reduction in the incidence of postoperative pneumonia. We investigated whether an improvement in oral hygiene brought about by preoperative professional oral care affected the incidence of postoperative pneumonia.

**Patients and Methods**

**Study design**

This was a retrospective study. The primary end-point was the incidence of postoperative pneumonia in the 7 days after surgery. Enrolled patients had undergone radical esophagectomy for thoracic esophageal cancer and had received preoperative professional oral care. Their oral health was evaluated at their first visit and again just before surgery. Based on these examinations, patients were divided into two groups according to whether their oral hygiene had improved. All data were obtained from medical records. This study was approved by the Institutional Ethics Review Board of Shizuoka Cancer Center (Shizuoka, Japan).

**Inclusion and exclusion criteria**

Patients who underwent radical esophagectomy for thoracic esophageal cancer between April 2010 and January 2014 at the Division of Esophageal Surgery, Shizuoka Cancer Center Hospital, and who received preoperative professional oral care were eligible for the study. The inclusion criteria were preoperative evaluations of oral hygiene, before and after professional oral care; thora
cotomy; two-field or three-field lymph node dissection; retrosternal reconstruction; and gastric roll as the substitu
tion organ. The exclusion criteria were R2 resection, interstitial pneumonia, lung resection, recurrence after treatment for cervical esophageal cancer, or a history of treatment for head and neck or lung cancer.

**Preoperative professional oral care**

In 2010, we started preoperative professional oral care for all patients scheduled to undergo esophagectomy. Two years later, we started to cooperate with regional dental clinics in the management and treatment of cancer patients. Patients first visited the Division of Esophageal Surgery, and then visited the Division of Dentistry and Oral Surgery for guidance on their oral health management. They subsequently received professional oral care at the Division of Dentistry and Oral Surgery or at a regional cooperating dental clinic. Professional oral care included oral and dental assessment, removal of calculus, swabbing of the tongue and oral mucous membranes, and instructions for self-performed oral hygiene measures. If a periodontal discharge of pus or severe tooth morbidity was evident, we performed tooth extraction and other dental treatment. During admission for radical esophagectomy, we conducted a final oral examination and, if necessary, administered treatment. After professional oral care, patients performed daily oral care by themselves throughout the perioperative period. Daily oral care was performed three times a day and included dental brushing, tongue and oral mucosa cleaning, and denture care.

**Postoperative pneumonia**

As described in previous reports, we defined postoperative pneumonia as pneumonia occurring within 7 days after surgery, as indicated by an increase of opacity in chest radiography in addition to at least two of the following findings: increase in temperature above 38°C, increase in white blood cell count above 10,000/µl or a
decrease to less than 3000/µl, and the presence of purulent sputum.

**Measures**

We compared the incidence of postoperative pneumonia occurring up to 7 days after surgery between the group with improved oral hygiene as a result of professional oral care intervention and the group with no improvement. To validate any findings that the level of oral hygiene independently affects the incidence of postoperative pneumonia, we also evaluated many other clinical factors that could bias the onset of pneumonia to establish that they did not affect our results.

**Oral measures.** We evaluated oral health with reference to the amount of remaining plaque and then classified the results into four categories: good, moderate, poor, and bad (Table 1). Furthermore, to simplify statistical analyses, patients who were evaluated as good or moderate were defined as the healthy oral health group (healthy group) and those evaluated as bad or poor were defined as the unhealthy oral health group (unhealthy group). Subsequently, we classified patients according to whether they maintained or improved their oral health between the two evaluation points, i.e., at the first visit and just before surgery. To facilitate precise evaluation, we established four ranks of oral health. Patients who improved and raised their oral health level or maintained good or moderate levels after professional oral care were assigned to the good control group. Those whose oral health worsened or stagnated at poor or bad levels were assigned to the bad control group. We also evaluated periodontal pocket depth, tooth morbidity, number of remaining teeth, denture use, and the discharge of pus from gingivae.

**Other measures.** Patient background characteristics included sex, age, clinical cancer stage and TNM classification (according to the UICC TNM 7th edition),27 the primary location of the tumor, Eastern Cooperative Oncology Group preoperative performance status (PS), neoadjuvant therapy (e.g., chemotherapy or chemoradiotherapy), salvage surgery, body mass index, habitual alcohol use, weight loss, period of nonsmoking, Brinkman index, respiratory function (i.e., vital capacity as a percentage of predicted %VC and the ratio of forced expiratory volume in one second to the forced vital capacity FEV1/FVC), comorbidity (e.g., diabetes, stroke, and myocardial infarction), postoperative recurrent laryngeal nerve paralysis (RLNP), blood parameters, and cooperation with the dental clinic.

**Statistical analysis**

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 23 for Windows (IBM, Armonk, NY, USA). Univariate analysis was performed using Fisher’s exact test for categorical data and the Mann–Whitney U test for continuous data. Statistically significant variables were subjected to multivariate analysis, based on logistic regression. Two-sided $P$ values of less than 0.05 were considered statistically significant.

**Results**

**Patient characteristics**

Forty-six patients (38 men and 8 women) with a median age of 64 years (30–74 years) were included in this study (Fig. 1). In total, 38 patients had preoperative PS 0 (82.6%) and 8 patients had preoperative PS 1 (17.4%). No patient had PS 2. Six patients were at cStage I (13.0%), 10 patients at cStage II (21.7%), 26 patients at cStage III (56.5%), and 4 patients at cStage IV (8.7%). The primary location of the tumor was the upper thoracic esophagus in 6 patients (13.0%), the middle thoracic esophagus in 26 patients (56.5%), and the lower thoracic esophagus in 14 patients (30.4%). Thirty-nine patients received adjuvant therapy (84.8%), and six patients underwent salvage surgery (13.0%). All patients were extubated immediately after the surgery had been completed. No patients suffered myocardial infarction. Postoperative RLNP occurred in 10 patients (21.7%). The median of all patients’ remaining teeth was 24 (range: 0–31). Three patients were edentulous.
Oral health levels

At the first dental examination, 22 patients (47.8%) were assigned to the healthy group and 24 patients (52.2%) to the unhealthy group. At the preoperative examination, the number of patients in the healthy group had increased to 37 (80.4%) and the number in the unhealthy group had decreased to 9 (19.6%). Of the 37 patients in the preoperative healthy group, 20 (54.1%) showed improvement in their oral hygiene. Although there were nine patients in the preoperative unhealthy group, two of these demonstrated improvement in their oral hygiene (Table 2).

There were 39 patients in the good control group (84.8%) and 7 patients in the bad control group (15.2%). No significant differences were found in terms of patient characteristics between the good and bad control groups (Table 3).

Table 2. Oral hygiene improvement

| Oral hygiene          | Not improved | Improved | Total |
|-----------------------|--------------|----------|-------|
| Preoperative oral health level | Healthy     | 17       | 20    | 37    |
|                       | Unhealthy    | 7        | 2     | 9     |
Table 3. Characteristics of the oral hygiene good control group and bad control group based on univariate analysis

| Patient characteristics | Oral hygiene |   |   |   |   |
|-------------------------|--------------|---------|---------|---------|---------|
|                         | Good control (n =39) | Bad control (n =7) |   |
| Sex                     | Female | 8 (20.5%) | 0 (0%) | 0.325 |
| Age (years)             | Median (range) | 64 (30–74) | 60 (36–74) | 0.725 |
| cStage                  | I | 4 (10.3%) | 2 (28.6%) | 0.283 |
|                         | II | 10 (25.6%) | 0 (0%) |   |
|                         | III | 21 (53.8%) | 5 (71.4%) |   |
|                         | IV | 4 (10.3%) | 0 (0%) |   |
| Primary location of tumor | Ut | 6 (15.4%) | 0 (0%) | 0.239 |
|                         | Mt | 23 (59%) | 3 (42.9%) |   |
|                         | Lt | 10 (25.6%) | 4 (57.1%) |   |
| T                       | 1 | 7 (17.9%) | 1 (14.3%) | 1.000 |
|                         | 2 | 5 (12.8%) | 1 (14.3%) |   |
|                         | 3 | 23 (59%) | 4 (57.1%) |   |
|                         | 4 | 4 (10.3%) | 1 (14.3%) |   |
| Not N0                  |       | 28 (71.8%) | 5 (71.4%) | 1.000 |
| MI                      |       | 4 (10.3%) | 0 (0%) | 1.000 |
| PS 1                    |       | 6 (15.4%) | 2 (28.6%) | 0.587 |
| Neoadjuvant therapy     |       | 34 (87.2%) | 5 (71.4%) | 0.286 |
| Salvage surgery         |       | 5 (12.8%) | 1 (14.3%) | 1.000 |
| Diabetes                |       | 5 (12.8%) | 1 (14.3%) | 1.000 |
| Stroke                  |       | 1 (2.6%) | 1 (14.3%) | 0.284 |
| Weight loss (%)         | ≥5 | 20 (51.3%) | 4 (57.1%) | 1.000 |
| BMI (kg/m²)             | Median (range) | 20.42 (14.1–28.02) | 18.87 (15.98–41.32) | 0.174 |
| Habitual alcohol use    |       | 29 (74.4%) | 5 (71.4%) | 1.000 |
| WBC (/L)                | ≥9.8 × 10⁹ (M), ≥9.1 × 10⁹ (F) | 1 (2.6%) | 1 (14.3%) | 0.284 |
| Hb (g/L)                | <135 (M), <113 (F) | 30 (76.9%) | 5 (71.4%) | 1.000 |
| TP (g/L)                | <67 | 13 (33.3%) | 4 (57.1%) | 0.397 |
| ALB (g/L)               | <40 | 11 (28.2%) | 4 (57.1%) | 0.193 |
| Brinkman index          | ≥400 | 20 (51.3%) | 3 (42.9%) | 1.000 |
| No smoking period (months) | <2 | 12 (30.8%) | 2 (28.6%) | 1.000 |
| %VC (%)                 | <80 | 2 (5.1%) | 1 (14.3%) | 0.398 |
| FEV1/FVC (%)            | <70 | 5 (12.8%) | 1 (14.3%) | 1.000 |
| Cooperation with dental clinics |       | 18 (46.2%) | 4 (57.1%) | 0.694 |
| First examination oral health level | Unhealthy | 20 (51.7%) | 4 (57.1%) | 1.000 |
| Periodontal pocket depth (mm) | ≥6 | 9 (23.1%) | 3 (42.9%) | 0.136 |
| Denture use             |       | 11 (28.2%) | 1 (14.3%) | 0.655 |
| Periodontal discharge of pus |       | 2 (5.1%) | 1 (14.3%) | 0.405 |
| Tooth morbidity         | ≥Grade2 | 4 (10.3%) | 0 (0%) | 1.000 |
| Number of remaining teeth | Median (range) | 24.5 (0–31) | 22.0 (14–25) | 0.172 |
| The period of oral care before surgery (days) | Median (range) | 33 (6–137) | 65 (11–816) | 0.134 |

Fisher's exact test was used for categorical data and the Mann–Whitney U test for continuous data.
Ut: upper thoracic esophagus, Mt: middle thoracic esophagus, Lt: lower thoracic esophagus, PS: performance status, BMI: body mass index, WBC: white blood cell, Hb: hemoglobin, TP: total protein, ALB: albumin, %VC: vital capacity as percent of predicted, FEV1/FVC: ratio of forced expiratory volume in one second to forced vital capacity.
Postoperative pneumonia occurred in eight patients (17.4%), four in the good control group and four in the bad control, and the pneumonia started before the commencement of oral food intake. Statistical analysis including improvement of oral hygiene as an independent variable revealed a significant difference in the incidence of pneumonia between the good and bad control groups ($P = 0.012$). In the unhealthy group after professional oral care intervention, four of the nine patients experienced postoperative pneumonia. Of the five unhealthy group patients without postoperative pneumonia, two showed oral hygiene improvement from bad to poor. Similar analyses indicated that the incidence of postoperative pneumonia differed significantly between the healthy group and the unhealthy group ($P = 0.036$) (Table 4). Univariate analyses performed with patient characteristics and surgical factors as independent variables revealed that there were no other significant differences in factors other than oral hygiene control and the level of preoperative oral health ($P = 0.012$).

Analysis based on logistic regression was performed with postoperative pneumonia as a dependent variable and with improvement of oral hygiene and preoperative oral health as the independent variables. Because preoperative oral hygiene was a strong confounding factor for the improvement of oral health, we analyzed these factors separately as the independent variables in multivariate analyses. The results of the analyses demonstrated that the risk of postoperative pneumonia was significantly lower in the good control group (odds ratio =0.086, $P = 0.008$, 95% confidence interval 0.014–0.529) and in the healthy group (odds ratio =0.152, $P = 0.027$, 95% confidence interval 0.028–0.809).

### Discussion

This study indicated that preoperative professional oral care improved poor oral hygiene, and that this could be a factor in reducing the incidence of postoperative pneumonia. Previously, it was not known whether improving oral hygiene could directly prevent pneumonia; however, the results of the current study demonstrated a direct relationship between preoperative improvement of oral hygiene and the incidence of postoperative pneumonia.

A previous study showed that oral care with chlorhexidine and dental brushing alone was not superior to oral care with chlorhexidine alone for preventing postoperative pneumonia and VAP. This might indicate that chlorhexidine prevents postoperative pneumonia and VAP, and that a good level of oral health is more important than an improvement in oral hygiene. Other previous studies showed that oral care with chlorhexidine along with professional oral care was superior to oral care with chlorhexidine alone. In the current study, postoperative pneumonia did not occur in the two patients who showed oral hygiene improvement from bad to poor in the unhealthy group. These findings suggest that (1) preoperative oral care by dental professionals is more effective than that without dental professionals, e.g., dental brushing alone, for improving oral health, and that the resultant good oral health can enhance the effect of oral care with chlorhexidine, and (2) the preoperative improvement of oral hygiene might be more important than the oral health level achieved by chlorhexidine alone in reducing the incidence of pneumonia.

The reasons for non-improvement of oral hygiene was not clear in this study. Moreover, there was no significant difference between patient characteristics in the good and bad control groups. One factor may be that our instructions on self-performance of oral hygiene were not appropriate for the patients in the bad control group.

Statistical analysis demonstrated that improvement of oral hygiene alone was related to the incidence of postoperative pneumonia. Other previously reported measures related to postoperative pneumonia include male sex, chronic obstructive pulmonary disease (COPD), FEV1/FVC, number of comorbidities, smoking, blood loss, and RINP. The reason that comorbidity and COPD were not found to be significant factors in the current study might be related to the selection of patients.
Table 5. Effect of patient characteristics and surgical factors on the incidence of postoperative pneumonia based on univariate analysis

|                          | Postoperative pneumonia |      |      |
|--------------------------|-------------------------|------|------|
|                          | No (n=38)               | Yes (n=8) | \(P\) |
| **Patient characteristics** |                        |      |      |
| Sex                      | Female                  | 7 (18.4%) | 1 (12.5%) | 1.000 |
| Age (years)              | Median (range)          | 63 (30–74) | 67 (58–74) | 0.131 |
| cStage                   |                         |      |      |
| I                        | 5 (13.2%)               | 1 (12.5%) | 1.000 |
| II                       | 8 (21.1%)               | 2 (25%)  |      |      |
| III                      | 21 (55.3%)              | 5 (62.5%) |      |      |
| IV                       | 4 (10.5%)               | 0 (0%)   |      |      |
| Primary location of tumor|                         |      |      |
| Ut                       | 5 (13.2%)               | 1 (12.5%) | 0.862 |
| Mt                       | 22 (57.9%)              | 4 (50%)   |      |      |
| Lt                       | 11 (28.9%)              | 3 (37.5%) |      |      |
| T                        |                         |      |      |
| 1                        | 6 (15.8%)               | 2 (25%)  | 0.717 |
| 2                        | 6 (15.8%)               | 0 (0%)   |      |      |
| 3                        | 22 (57.9%)              | 5 (62.5%) |      |      |
| 4                        | 4 (10.5%)               | 1 (12.5%) |      |      |
| Not N0                   |                         |      |      |
| MI                       | 4 (10.5%)               | 0 (0%)   | 1.000 |
| PS 1                     | 5 (13.2%)               | 3 (37.5%) | 0.129 |
| Neoadjuvant therapy      |                         |      |      |
|                          | 32 (84.2%)              | 7 (87.5%) | 1.000 |
| Salvage surgery          |                         |      |      |
|                          | 5 (13.2%)               | 1 (12.5%) | 1.000 |
| Diabetes                 |                         |      |      |
|                          | 5 (13.2%)               | 1 (12.5%) | 1.000 |
| Stroke                   |                         |      |      |
|                          | 1 (2.6%)                | 1 (12.5%) | 0.321 |
| Weight loss (%)          | ≥5                      | 18 (47.4%) | 6 (75%)  | 0.247 |
| BMI (kg/m²)              | Median (range)          | 20.39 (14.1–41.32) | 19.51 (15.98–23.81) | 0.297 |
| Habitual alcohol use     |                         |      |      |
| ≥9.8 × 10⁹ (M), ≥9.1 × 10⁹ (F) | 2 (5.3%)   | 0 (0%)   | 1.000 |
| Hb (g/L)                 | <135 (M), <113 (F)      | 27 (71.1%) | 8 (100%) | 0.169 |
| TP (g/L)                 | <67                     | 13 (34.2%) | 4 (50%) | 0.443 |
| ALB (g/L)                | <40                     | 10 (26.3%) | 5 (62.5%) | 0.092 |
| Brinkman index           | ≥400                    | 18 (47.4%) | 5 (62.5%) | 0.371 |
| No smoking period (months)| <2                     | 11 (28.9%) | 3 (37.5%) | 0.646 |
| %VC (%)                  | <80                     | 2 (5.3%)   | 1 (12.5%) | 0.444 |
| FEV1/FVC (%)             | <70                     | 5 (13.2%)  | 1 (12.5%) | 1.000 |
| Surgical factors         |                         |      |      |
| Operation time (min)     | ≥420                    | 16 (42.1%) | 4 (50%)  | 0.713 |
| Bleeding (ml)            | ≥400                    | 10 (26.3%) | 3 (37.5%) | 0.669 |
| Blood transfusion        | 5 (13.2%)               | 2 (25%)   | 0.587 |
| Recurrent laryngeal nerve paralysis | 8 (21.1%) | 2 (25%) | 1.000 |
| Oral characteristics     |                         |      |      |
| First examination oral health level | Healthy | 19 (50%) | 3 (37.5%) | 0.702 |
| Preoperative oral health level | Healthy | 33 (86.8%) | 4 (50%) | 0.036* |
| Oral hygiene             | Good control            | 35 (92.1%) | 4 (50%) | 0.012* |
| Cooperation with dental clinics | 18 (47.4%) | 4 (50%) | 1.000 |
| Periodontal pocket depth (mm) | ≥6          | 8 (21.1%) | 4 (50%) | 0.165 |
| Denture use              | 9 (23.7%)               | 3 (37.5%) | 0.661 |
| Periodontal discharge of pus | 2 (5.3%)   | 1 (12.5%) | 0.452 |
| Tooth morbidity          | ≥Grade 2               | 4 (10.5%)  | 0 (0%)   | 1.000 |
| The period of oral care before surgery (days) | Median (range) | 62 (11–816) | 75 (6–137) | 0.717 |
| Number of remaining teeth | Median (range)          | 24 (0–31)  | 20.5 (0–28) | 0.122 |

Fisher's exact test was used for categorical data and the Mann–Whitney U test for continuous data.

*\(P < 0.05\).

Ut: upper thoracic esophagus, Mt: middle thoracic esophagus, Lt: lower thoracic esophagus, PS: performance status, BMI: body mass index, WBC: white blood cell, Hb: hemoglobin, TP: total protein, ALB: albumin, %VC: vital capacity as percent of predicted, FEV1/FVC%: ratio of forced expiratory volume in one second to forced vital capacity.
for surgery in our hospital. Moreover, blood loss, FEV₁/FVC, RLNP, and being male were previously also reported not to be significant factors.⁹ Pneumonia is clearly related to aspiration and respiratory function, and there is a correlation between aspiration and respiratory function. Furthermore, smoking is related to respiratory function, whereas RLNP is related to aspiration. These factors may not have been significant in our study because of the respiratory physiotherapy and rehabilitation for swallowing disorders implemented at our institution. Moreover, only one case of pneumonia occurred after the start of oral intake in this study. Blood loss might not have been a significant factor because of perioperative management.

The limitations of this study are its retrospective design, the small cohort size, and the subjective evaluation of oral health. Furthermore, despite the preoperative professional oral care, postoperative pneumonia occurred in 17.4% of our patients, a level similar to that noted in previous reports.¹⁻¹⁶ In addition, there were some missing data. Investigation of a larger cohort may show that other factors are significantly related to the incidence of pneumonia. Consequently, to confirm that preoperative improvement of oral hygiene is a significant factor in reducing the incidence of postoperative pneumonia, prospective studies with a larger cohort and objective evaluations are needed. In the current study, postoperative pneumonia did not occur in two of the five patients in the unhealthy group whose oral hygiene had improved. Another reason for these findings might be that our evaluation criteria of oral health were not appropriate in terms of the occurrence of postoperative pneumonia. Also, an improvement in oral hygiene itself may have helped prevent postoperative pneumonia regardless of good or bad overall oral health levels. Currently, there are no objective criteria for assessing oral health that can assist in preventing pneumonia. The criteria for oral health in the context of preventing pneumonia should be evaluated using objective measures. In the absence of such objective measures, it may be possible to evaluate how different degrees of improvement in oral hygiene influence the occurrence of postoperative pneumonia regardless of whether the patients’ oral health is good or bad. These investigations could lead to the development of standards for oral care. In this study, there was no evidence of significant differences in the occurrence of postoperative pneumonia between those patients undergoing professional dental care at regional cooperating dental clinics or at our hospital because all patients underwent standardized oral care treatment.

In conclusion, we found that an improvement in oral hygiene as a result of preoperative professional oral care may be a factor in reducing the incidence of postoperative pneumonia. This study was retrospective in nature with a small cohort and should be regarded as a pilot study. To confirm these results and the degree of improvement in oral hygiene required for the prevention of postoperative pneumonia, prospective trials are needed using objective measures to evaluate the improvement of oral hygiene and the effects of such improvements on the incidence of postoperative pneumonia.

Acknowledgments

This study was supported by a grant from the National Center for Bacterial Early Detection and Development Fund (00052) of Japan. We received support and cooperation from Keio University School of Medicine which was based on the promotion plan for the platform of human resource development of cancer with Shizuoka Cancer Center.

Conflict of Interest

The author declares no conflict of interest for this study.

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