Medical Research Archives,Volume 4 ,Issue 7.November 2016.

Signs for identifying risk factors for aspiration pneumonia in elderly people needing nursing care

Authors:
Hiroki Shindo,[1]
Takeshi Kikutani,[1,2]
Mitsuyoshi Yoshida,[3]
Yuri Yajima,[1]
Fumiyo Tamura,[2]

Email Address:

Hiroki Shindo: shinou-ndu@umin.ac.jp;
Takeshi Kikutani:kikutani@tky.ndu.ac.jp;
Mitsuyoshi Yoshida: mitsu@hiroshima-u.ac.jp;
Yuri Yajima:yajima@tky.ndu.ac.jp;
Fumiyo Tamura:fumita@tky.ndu.ac.jp

Authors note:

[1]Division of Clinical Oral Rehabilitation, The Nippon Dental University Graduate School of Life Dentistry at Tokyo,1-9-20 Fujimi, Chiyoda-ku, Tokyo, 102-8159, Japan

[2]Division of Rehabilitation for Speech and Swallowing Disorders, The Nippon Dental University, Tama Oral Rehabilitation Clinic, 4-44-19 Higashi-cho, Koganei-city, Tokyo 184-0041, Japan

[3]Department of advanced Proshodontics, Hiroshima University Graduate School of Biomedical Sciences, 1-2-3 Kasumi, Minami-ku, Hiroshima, 734-8553, Japan

Keywords:aspiration pneumonia, nutritional status, swallowing function, oral care, nursing home, caregiver

Correspondence:
Professor Takeshi Kikutani DDS, PhD,
Division of Clinical Oral Rehabilitation, The Nippon Dental University Graduate School of Life Dentistry, 4-44-19 Higashi-cho Koganei-city, Tokyo 184-0041, Japan.
Phone:+81-42-316-6211,
Fax:+81-42-316-6212,
Email: kikutani@tky.ndu.ac.jp

Abstract

Aim: To identify signs predictive of pneumonia development that can be recognized at nursing homes where limited medical staff and equipmentare available.

Methods: Subjects were 761 elderly individuals needing nursing care (172 men 594 women; mean age, 86.8±7.2 years), from 42 nursing homes across Japan who could eat orally and had not received antibiotic treatment during the previous three months.Dental hygienists examined each subject for wet hoarseness during and after eating a meal as a sign of impaired swallowing function, prolongation of mealtime length, refusal of oral care, dry mouth and halitosis. Data on the subjects' activities of daily living, body mass index (BMI) calculated from body height and weight as a measure of nutritional status, and underlying diseases were transcribed from the medical records kept at each nursing home.

Results: During the study period, pneumonia occurred in 116 subjects (44 men, 72 women). Significant associations with pneumonia development were identified for nutritional status (P=0.007) and swallowing function (P=0.002). Analysis including comorbid conditions further identified heart disease (P=0.03).

Conclusion: In this study, decreased BMI and wet hoarseness during and after eating a meal were identified as signs of pneumonia risk at nursing homes.

1. Introduction

Pneumonia is associated with high morbidity and mortality worldwide, and is one of the leading causes of death in Japan, where the population is rapidly aging (Furuta et al., 2013). In Japan, elderly people aged ≥65 years account for 94.4% of deaths due to pneumonia, and aspiration pneumonia in elderly people aged ≥70 years accounts for 80% of all pneumonia cases (Furuta et al., 2013).

Recently, various efforts have been made to prevent pneumonia (DiBardino et al., 2015).However, the increasing number of elderly people requiring care has led to an increasing number of people at high risk of developing pneumonia (Teramoto et al., 2008). Under these circumstances, effective and efficient intervention is needed to achieve optimal pneumonia prevention. A previous study identified the existence of the following three major risk factors for the development of pneumonia:1) bacteria as a source of infection, 2) aspiration as a route of infection, and 3) compromised immunity and malnutrition as host factors (Langmore et al., 1998). Some of these risk factors can be detected only by imaging and/or blood testing, which are not always available in daily nursing care practice. The aim of this study was to achieve the optimal prevention of pneumonia by identifying predictive sign for the development of pneumonia from among variables that can be assessed in daily nursing care practice, such as nursing care at home and in nursing homes, without employing highly trained specialist skills or special tools.

2. Materials and methods

Of 2420 elderly individuals needing nursing care in 42 nursing homes across Japan. At these facilities, dental hygienists had provided facility staff with oral care four times a month. From these elderly individuals, those who met any of the following criteria were excluded:1) those receiving nutritional management with tube or intravenous feeding, 2) those who had received oral treatment with an antibiotic within 3 months before the study, 3) those unable to undergo oral examination because of cognitive impairment.

After application of the above exclusion criteria, 766 individuals remained as candidates. Of them, five individuals who refused to participate in follow-up were excluded, and the remaining 761 individuals (mean age 86.8 ±7.2 years) were included in the final sample population. The gender composition was 172 men (mean age 82.5 ± 2.5 years) and 594 women (87.7 ± 6.8 years).

2.1 Measurements

Dental hygienists who had at least ten years of clinical experience involved in the study at each site collected demographic information, recorded oral conditions and assessed oral function of subjects during the same period.

The follow-up period was ten months, and onset of pneumonia during this period was assessed. Pneumonia was diagnosed by each participant's primary physician. Criteria for diagnosis of pneumonia were a new pulmonary infiltrate seen on a chest radiograph and one of the following features:cough, temperature greater than 37.8, or subjective dyspnea.

The subjects' activities of daily living (ADL) was assessed using the Independence Degree of Daily Living for the Disabled Elderly (Ministry of Health, Labour and Welfare of Japan, 2011) (Table 1), and they were divided into two groups:those with normal ADL (Ranks J and A) and those with impaired ADL (Ranks B and C).

To assess nutritional status, body height and weight were measured to calculate body mass index (BMI) (Kondrup et al., 2002). Subjects with BMI <18.5 were defined as the malnutrition group and those with BMI ≥18.5 as the normal nutrition group. Subjects were observed while eating, and those with wet hoarseness(Waito et al., 2011) were defined as the "impaired swallowing function" group. The subjects were also divided into two groups based on the length of mealtimes (<30 minutes or ≥30 minutes).

The subjects were also assessed for refusal or acceptance of oral care, and divided into two groups. Those who were unwilling or refused to be touched or to

receive oral care were defined as the "oral care refusal" group, and those willing to receive oral care were defined as the "oral care no refusal" group. Oral dryness was assessed based on the clinical diagnostic criteria proposed by Kakinoki (Kakinoki et al., 2004). Subjects diagnosed as grade 2 (moderate), defined as foamy saliva, or grade 3 (severe), defined as almost no saliva on the tongue or oral mucosa, were considered to have a dry mouth group, while those diagnosed as grade 1 (mild) or lower, defined as viscous saliva, were considered not to have a dry mouth. The degree of halitosis was determined based on the sensory test criteria proposed by Miyazaki (Miyazaki et al., 1995).Subjects diagnosed as grade ≥3, defined as easily detectable malodor in daily life, were considered to have halitosis, whereas those diagnosed as grade ≤2, defined as barely detectable malodor, were considered not to have halitosis.

The subjects' medical records were reviewed for the following comorbid conditions:cerebrovascular disease, intractable neurological disorder, head trauma, hypertension, heart disease, dementia, diabetes mellitus, and bone/joint disease.

2.2 Statistical analysis

The association between each factor and pneumonia development was analyzed using chi-squared test and t-test , followed by two Cox regression analyses.In model 1, analysis was performed with age and sex, in addition to signs. In model 2, analysis was performed with age and sex as adjustment factors, in addition to factors including underlying diseases. The level of significance was set at 0.05 in all analyses.

2.3 Ethics

There is no conflict of interest regarding the publication of the study results. The present study was conducted after obtaining approval from the Ethics Committee of the Nippon Dental University School of Life Dentistry (Approval No. NDU-T2011-25).

3. Results

The results of chi-squared test and t-test conducted to assess the association of pneumonia development with each factor are summarized in Table 2. During the 10-month observation period, pneumonia occurred in 116 subjects (mean age 86.9 ± 7.3 years), whereas the remaining 645 subjects (mean age 86.6 ± 7.0 years) did not develop pneumonia. Pneumonia occurred in 26.0% of male and 12.2% of female subjects, with a significant difference ($P < 0.001$) between male and female subjects. Similarly, significant differences were observed between those with malnutrition and those with normal nutrition (21.4% vs 11.8%, $P < 0.001$), between those with impaired swallowing function and those with normal swallowing function (22.9% vs 12.2%, $P < 0.001$), and between the "oral care refusal" group and "oral care no refusal" group (20.5% vs 13.5%, $P = 0.02$). As for comorbid conditions, 4.4% of subjects with heart disease developed pneumonia ($P = 0.04$), with a significant difference also in those with diabetes mellitus (1.9%, $P =0.04$) and bone/joint disease (1.9%, $P = 0.02$). In contrast, no significant difference was observed with respect to age ($P = 0.67$), ADL ($P = 0.12$), mealtime length ($P = 0.08$), dry mouth ($P = 0.37$), halitosis ($P = 0.20$), cerebrovascular disease ($P = 0.75$), intractable neurological disorder ($P = 0.83$), head trauma ($P = 0.39$), hypertension ($P = 0.41$) or dementia ($P = 0.72$).

The results of analysis using the Cox proportional hazard model are summarized in Table 3. In model 1, a significant difference was observed with respect to sex ($P < 0.001$), nutritional status ($P = 0.003$) and swallowing function ($P = 0.03$). In model 2, which included comorbid conditions, a significant difference was also observed for heart disease ($P = 0.03$), in addition to sex ($P < 0.001$), nutritional status ($P = 0.01$) and swallowing function ($P = 0.02$).

Figure 1 shows the 10-month cumulative survival rate and cumulative incidence of pneumonia in subjects with malnutrition and normal nutritional status, as grouped based on BMI (< 18.5 or ≥ 18.5), which was the factor showing the highest hazard ratio (HR), apart from sex (an

adjustment factor). The cumulative incidence of pneumonia at 10-month follow-up significantly differed between subjects with and without malnutrition (P = 0.002; Log rank). Figure 2 also shows the cumulative survival rate and cumulative incidence of pneumonia in subjects with impaired swallowing function and those with normal swallowing function, as grouped based on the presence or absence of wet hoarseness during and after eating a meal, which was the factor showing the next highest HR. A significant difference was observed in the 10-month cumulative incidence of pneumonia between subjects with and without impaired swallowing function (P = 0.007; Log rank).

4. Discussion

The results of the present study suggest that employment of BMI as a measure of nutritional status obtained from anthropometric measurements, and wet hoarseness during and after eating a meal as a sign of impaired swallowing function, is useful for identifying individuals at high risk of pneumonia. Early identification of these high-risk individuals and early introduction of interventions will enhancethe effectiveness of pneumonia prevention.

Aspiration pneumonia accounts for the majority of pneumonia cases in elderly people needing nursing care (Furuta et al., 2013). It is thus likely that many of the pneumonia cases in the present study also had aspiration pneumonia.

A number of studies have attempted to identify risk factors for aspiration pneumonia. The three major risk factors relate to source of infection, route of infection and host (DiBardino et al., 2015), which can be further specified as the presence of bacteria as a source of infection, aspiration as a route of infection, and compromised immunity and malnutrition as host factors (Furuta et al., 2013, DiBardino et al., 2015, Langmore et al., 1998).Some of the bacterial species identified as causative of pneumonia are also associated with oral conditions, such as periodontal disease and halitosis(El-Solh et al, 2004, Quagliarello et al., 2005).The causes of dysphagia associated with aspiration pneumonia include decreased saliva secretion as an age-related change or an adverse reaction to medication (Van der Putten et al., 2014), impaired tongue motor function(Robbins et al., 1995), impaired chewing function due to tooth loss, (Witter et al., 1990) decreased strength of the pharyngeal constrictor muscle, decreased laryngeal elevation, impaired laryngeal sensation and impaired upper esophageal sphincter function (Jones et al., 1985, Sivit et al., 1988). Dysphagia can also occur as a sequela of cerebrovascular disease and in association with dementia, Parkinson's disease and other diseases (Langmore et al., 1998). Whether aspiration pneumonia is associated with these factors can be determined by videofluoroscopic examination of swallowing or videoendoscopic evaluation of swallowing. Silent saliva aspiration has been considered to have a particularly high risk of aspiration pneumonia (Teramoto et al., 2008, 2009, Kikuchi et al., 1994). Host factors include aging, pneumonia risk factors identified in previous studies (such as diabetes mellitus and cerebrovascular disorder), and underlying conditions (such as dementia, Parkinson's disease and chronic respiratory disease) that are associated with increased susceptibility to infection, decreased general body function and a resulting decrease in ADL (Teramoto et al., 2008, 2009). Malnutrition can lead to decreased physical activity and impaired immune function. Many studies have assessed nutritional status using variables that reflect the nutritional status of visceral proteins (such as serum albumin, prealbumin, transferrin or total lymphocyte count), of which serum albumin has been identified as a prognostic survival factor (Antonelli et al., 1996).

Some of these risk factors for aspiration pneumonia can only be detected by imaging, bacterial culture, blood biochemical tests or immunological tests, which may not always be available in ordinary nursing care practice. We therefore attempted to identify predictive sign for pneumonia development from variables that can be assessed in nursing care practice without employing highly

trained skills or special tools.

The variables used in this study were selected from variables that have been identified as pneumonia risk factors in previous studies, and can be assessed easily without specialized medical knowledge or extensive testing (Teramoto et al, 2008, 2009, Langmore et al., 1998, 2002, Guigoz et al., 1996, Warms et al., 2000).

This study identified sex, nutritional status as assessed by BMI, and impaired swallowing sign by wet hoarseness during and after eating a meal to be significantly associated with pneumonia development. When comorbid conditions were included in the analysis, heart disease and diabetes mellitus were further identified as significant factors.

A previous study conducted in a nursing home also showed a higher incidence of pneumonia in men than in women (Langmore et al., 1998, 2002), which is consistent with the present results. This may be due to differences in various factors between men and women, such as smoking and other lifestyle factors. The involvement of smoking and associated respiratory disease is also suggested.

Malnutrition is another risk factor for pneumonia development, as it leads to decline impaired immune function and increased susceptibility to infection (DiBardino et al., 2015). Previous studies have demonstrated the usefulness of assessing the risk of malnutrition based on BMI (Guigoz et al., 1996). The present study also identified a significant association between nutritional assessment based on BMI and the risk of pneumonia development, suggesting the usefulness of this variable for identifying hosts susceptible to infection. Nutritional assessment based on anthropometric measures, instead of blood test parameters, can be useful for identifying the risk of pneumonia development in nursing care facilities.

Cervical auscultation (Takahashi et al., 1994) is a screening method for assessing swallowing function that can be performed relatively easily in nursing homes. The presence of wet hoarseness heard on auscultation has been pointed out by Warms et al. to be associated with aspiration (Warms et al., 2000). Cervical auscultation using a pharyngeal microphone or a stethoscope has been proved to be effective in detecting wet hoarseness. In contrast, moist breath sounds during or after eating a meal can be heard without using a stethoscope. Therefore, we focused only on wet hoarseness without using auscultation during breathing during and after eating a meal. With this method, however, it is impossible to distinguish whether wet hoarseness caused by aspiration of food or by preexisting aspiration of saliva. However, whether wet hoarseness caused by food or not does not matter for detecting impaired swallowing function. The present data demonstrate that the detection of wet hoarseness during breathing during and after eating a meal is useful sign for identifying risk of pneumonia associated with impaired swallowing function.

Some diseases have been reported to be associated with risk of aspiration, impaired immunity and dental diseases, and thus have been identified as risk factors for aspiration pneumonia. These diseases include diabetes mellitus, cerebrovascular disorder, dementia, Parkinson's disease, chronic respiratory disease and heart failure (Teramoto et al., 2008, 2009, Langmore et al., 1998, 2002). In the present study, heart disease was identified as a risk sign for pneumonia.

Decrease in ADL was assessed simply based on whether the subject was decline of ADL or not. No significant difference was observed with respect to ADL, which might have been due to biased selection of subjects, since nearly 80% of the subjects were declined ADL.

Prolonged mealtime has also been reported to be a risk factor for pneumonia development (Langmore et al., 2002). We used this variable as an index of both ADL and swallowing function, but observed no significant association with pneumonia development. On the other hand, univariate analysis with mealtime length set as the objective variable showed significant associations with impaired ADL (P = 0.021)

and impaired swallowing function ($P< 0.001$), suggesting the usefulness of mealtime length as an index of decreased ADL and swallowing function, and its potential as a risk sign for pneumonia.

We used halitosis as potential indexes of the degree of oral contamination, as the presence of bacteria is known to be a source of infection. Halitosis is reported to be caused by an increased number of oral bacteria, especially gram-negative bacteria, which are associated with risk of pneumonia (Persson et al., 1990, Kleinberg et al., 1995). Dry mouth can be caused not only by aging, but also by multiple drug use or dehydration, which are known risk factors for pneumonia (Teramoto et al., 2008, Langmore et al., 1998, 2002, Van der Putten et al., 2014, Sivit et al., 1988). Dry mouth is a condition in which the oral self-cleaning function mediated by saliva is impaired, and thus increases the degree of oral contamination (Van der Putten et al., 2014). In this study, however, neither factor was identified as a significant predictor of pneumonia. We used these factors as measures to estimate oral bacterial contamination, as they can be assessed by people without dental expertise. However, the degree of halitosis has been reported to be affected by gastrointestinal disease and the types of food and drugs taken, which may explain the difficulty in using halitosis as a measure of oral contamination.

It is important to be able to receive proper oral care. Elderly people with cognitive impairment are known to be less willing to receive oral care (Volicer et al., 2007). Whether a person can receive oral care or not has been shown to influence his/her intraoral environment (degree of oral contamination) (Henry, 1995). While performing oral care, proper elimination of biofilm attached to teeth and other oral structures from the oral cavity is important, and this can be achieved only when the subject agrees to receive oral care. We therefore included refusal of oral care as a risk sign. However, an association of this sign with pneumonia development could not be determined in the present study.

In this study, signs were evaluated by dental hygienists. Further studies are needed to determine whether decreased BMI and wet hoarseness during and after eating a meal, the two significant predictors of pneumonia risk identified in this study, can be recognized by caregivers without specialized knowledge, and to identify signs significantly associated with oral hygienic status, which could not be clarified in the present study.

5. Conclusion

The present study suggests that malnutrition as determined by BMI, which can be readily calculated at a nursing home, and wet hoarseness, which can be heard during and after eating a meal by listening to breath sounds and is a sign of impaired swallowing function, can be used as clues to identify the risk of pneumonia development.

Acknowledgment

The authors contributed equally to this work.

Disclosure statement

No potential conflicts of interest were disclosed.

References

1. Antonelli Incalzi R, Landi F, Cipriani L, Bruno E, Pagano F, Gemma A, Capparella O, Carbonin PU. Nutritional assessment:a primary component of multidimensional geriatric assessment in the acute care setting. J Am Geriatr Soc. 1996; 44(2):166-174. [PubMed: 8576507]
2. DiBardino DM, Wunderink RG. Aspiration pneumonia: A review of modern trends. J Crit Care. 2015; Feb;30(1):40-48. doi:10.1016/j.jcrc.2014.07.011. Epub 2014 Jul 22. Review. [PubMed: 25129577]
3. El-Solh AA, Pietrantoni C, Bhat A, Okada M, Zambon J, Aquilina A, Berbary E. Colonization of dental plaques a reservoir of respiratory pathogens for hospital acquired pneumonia in institutionalized elders. Chest 2004; 126(5):1575-1582. [PubMed: 15539730]
4. Furuta M, Komiya-Nonaka M, Akifusa S, Shimazaki Y, Adachi M, Kinoshita T, Kikutani T, Yamashita Y. Interrelationship of oral health status, swallowing function, nutritional status, and cognitive ability with activities of daily living in Japanese elderly people receiving home care services due to physical disabilities. Community Dent Oral Epidemiology 2013;41(2) : 173-181. [PubMed: 22934613]
5. Jones B, Ravich WJ, Donner MW, Kramer SS, Hendrix TR. Pharyngoesophageal interrelationships:observations and working concepts. Gastroenterol Radiol. 1985; 10(3):225-233. [PubMed: 4029538]
6. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly. The Mini Nutrition assessment as part of the geriatric evaluation. Nutr Rev. 1996; 54(1):S59-S65. [PubMed: 8919685]
7. Henry RG. Functionally dependent veterans. Issues related to providing and improving their oral health care. Med Care. 1995; Nov;33(11 Suppl):NS143-163. Review. [PubMed: 7475426]
8. Jones B, Ravich WJ, Donner MW, Kramer SS, Hendrix TR. Pharyngoesophageal interrelationships:observations and working concepts. Gastroenterol Radiol. 1985; 10(3):225-233. [PubMed: 4029538]
9. Kakinoki Y, Nishihara T, Arita M, Shibuya K, Ishikawa M. Usefulness of new wetness tester for diagnosis of dry mouth in disabled patients. Gerodontology 2004; Dec; 21(4):229-231. [PubMed: 15603283]
10. Kikuchi R, Watabe N, Konno T, Mishina N, Sekizawa K, Sasaki H. High incidence of silent aspiration in elderly patients with community-acquired pneumonia. Am J Respir Crit Care Med. 1994; Jul;150(1):251-253. [PubMed: 8025758]
11. Kleinberg I, Codipilly M. The biological basis of oral malodor formation. Bad breath: research perspectives, ed. Rosenberg, M., P. 13-39, Ramot Publishing -Tel Aviv University, Tel Aviv, 1995.
12. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. Educational and Clinical Practice Committee, European Society of Parenteral and Enteral Nutrition (ESPEN). ESPEN guidelines for nutrition screening 2002. Clin Nutr. 2003; Aug; 22(4):415-421. [PubMed: 12880610]
13. Langmore SE, Terpenning MS, Schork A, Chen Y, Murray JT, Lopatin D, Loesche WJ. Predictors of aspiration pneumonia:how important is dysphagia? Dysphagia 1998; 13(2):69-81. [PubMed: 9513300]
14. Langmore SE, Skarupski KA, Park PS, Fries BE. Predictors of aspiration pneumonia in nursing home residents.

Dysphagia2002; Fall;17(4):298-307. [PubMed: 12355145]
15. Ministry of Health, Labour and Welfare of Japan, 2011. Activity of Daily Living Independence of Demented Elderly. Available at:http://www.mhlw.go.jp:80/ topics/kaigo/kentou/15kourei/sankou 4.html(accessed on May 29, 2011, in Japanese).
16. Miyazaki H, Sakao S, Katoh Y, Takehara T. Correlation between volatile sulphur compounds and certain oral health measurements in the general population. J Periodontol. 1995; 66(8):679-684. [PubMed: 7473010]
17. Persson, S, Edlund, MB, Claesson, R. Carlsson J. The formation of hydrogen sulfide and methyl mercaptan by oral bacteria. Oral Microbiol. Immun 1990; 5(4):195-201. [PubMed: 2082242]
18. Quagliarello V, Ginter S, Han L, Van Ness P, Allore H, Tinetti M. Modifiable risk factors for nursing home-acquired pneumonia. Clin Infect Dis. 2005; Jan 1;40(1):1-6. Epub 2004 Dec 1. [PubMed: 15614684]
19. Robbins J, Levine R, Wood J, Roecker EB, Luschei E. Age effects on lingual pressure generation as a risk factor for dysphagia. J Gerontol A Biol Sci Med Sci. 1995; 50(5):M257-M262. [PubMed: 7671027]
20. Sivit CJ, Curtis DJ, Crain M, Cruess DF, Winters C. Pharyngeal swallow in gastroesophageal reflux disease. Dysphagia 1988; 2(3):151-155. [PubMed: 3251690]
21. Takahashi K, Groher ME, Michi K. Methodology for detecting swallowing sounds. Dysphagia 1994; 9(1):54-62. [PubMed: 8131426]
22. Teramoto S, Fukuchi Y, Sasaki H, Sato K, Sekizawa K, Matsuse T; Japanese Study Group on Aspiration Pulmonary Disease. High incidence of aspiration pneumonia in community- and hospital-acquired pneumonia in hospitalized patients: a multicenter, prospective study in Japan. J Am Geriatr Soc. 2008; 56(3): 577-579. [PubMed: 18315680]
23. Teramoto S. Novel preventive and therapuetic strategy for post-stoke pneumonia. Expert Review Neurother. 2009;9(8):1187-1200. [PubMed: 1963607]
24. Van der Putten GJ, De baat CD, De Vischere L, Schols J. Poor oral health, a potential new geriatric syndrome. Gerodontology 2014; Feb;31 Suppl 1:17-24. doi:10.1111/ger.12086. [PubMed: 24446975]
25. Volicer L, Bass EA, Luther SL. Agitation and resistiveness to care are two separate behavioral syndromes of dementia. J Am Med Dir Assoc. 2007; Oct; 8(8):527-532. [PubMed: 17931577]
26. Waito A, Bailey GL, Molfenter SM, Zoratto DC, Steele CM.Voice-quality abnormalities as a sign of dysphagia:validation against acoustic and videofluoroscopic data. Dysphagia 2011; Jun; 26(2):125-134. doi:10.1007/s00455-010-9282-4. Epub 2010 May 8. [PubMed: 20454806]
27. Warms T, Richards J. "WetVoice" as a predictor of penetration and aspiration in oropharyngeal dysphagia. Dysphagia 2000; Spring;15(2):84-88. [PubMed: 10758190]
28. Witter DJ, Cramwinckel AB, van Rossum GM, Kayser AF. Shortened dental arches and masticatory ability. J Dent. 1990; 18(4):185-189. [PubMed: 2212200]

Figure legends

Figure 1. Survival curve for elderly people with malnutrition versus those with normal nutritional status, with pneumonia development as an endpoint.

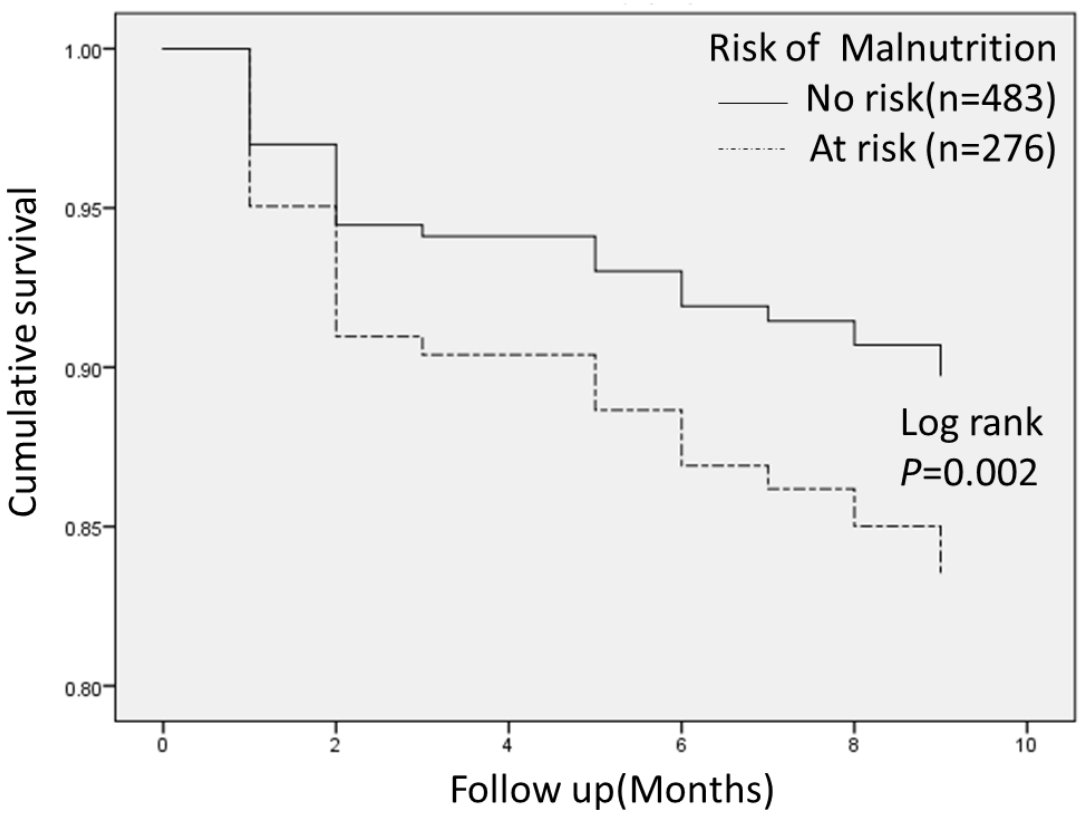

Figure 2. Survival curve for elderly people with impaired swallowing function versus those with normal swallowing function, with pneumonia development as an endpoint.

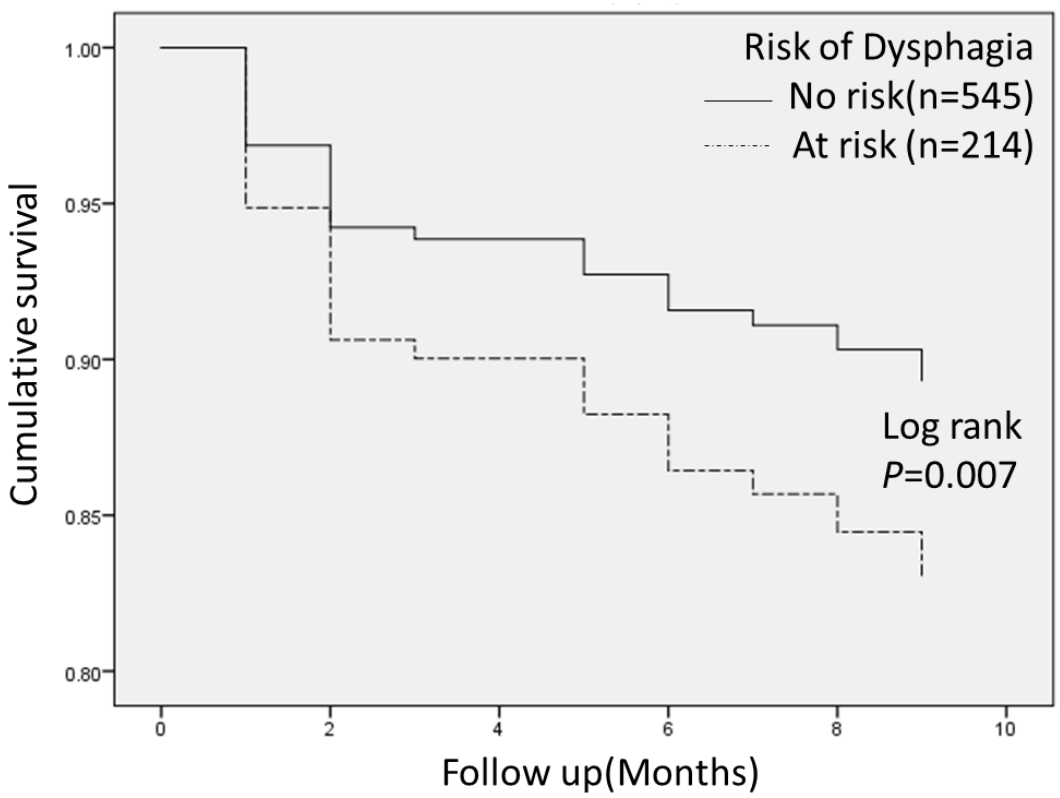

Table 1. Independence Degree of Daily Living for the Disabled Elderly

Rating criteria	Description
Rank J	The subject has some disability, but is almost dependent in everyday activities, and can go outside unassisted.
Rank A	The subject is mostly independent in daily living activities at home, but cannot go out without assistance.
Rank B	The subject requires some assistance in performing indoors, and is mostly confined to bed day and night; however, can sit up in bed.
Rank C	The subject is in bed all day and requires assistance for toileting, eating and changing clothes

The Ministry of Health, Labour and Welfare of Japan divide into two groups:those able to get out of bed (Ranks J and A) and those bedridden (Ranks B and C).

Table 2. Associations between each factor and pneumonia development identified bychi-squared test (n = 761)

Variables		Pneumonia development		*P*-value
		Yes (116)	No (645)	
Sex	Male	44	125	<.001
	Female	72	520	
Age, mean ± SD*		86.9 ± 7.3	86.6 ± 7.0	0.67
ADL	Normal	21	152	0.12
	Impaired	95	493	
Nutritional status	Normal	57	428	<.001
	Malnutrition	59	217	
Swallowing function	Normal	67	480	<.001
	Impaired	49	165	
Mealtime length	<30 min	76	474	0.08
	≥30 min	40	171	
Refusal of oral care	No	78	498	0.02
	Yes	38	147	
Dry mouth	No	70	417	0.37
	Yes	46	228	
Halitosis	No	64	397	0.20
	Yes	52	248	

Underlying diseases				
Cerebrovascular disease	No	73	396	0.75
	Yes	43	249	
Neurological disorder	No	112	612	0.83
	Yes	4	33	
Hypertension	No	69	357	0.41
	Yes	47	288	
Heart disease	No	81	507	0.04
	Yes	35	138	
Dementia	No	44	256	0.72
	Yes	72	389	
Diabetes mellitus	No	102	517	0.04
	Yes	14	128	
Bone/joint disease	NO	104	521	0.02
	Yes	12	124	

*t-test

Table 3. Cox proportional hazard model to identify risk factors for pneumonia (10-month mortality) (n = 761)

	Model 1	Model 2
Factor	Hazard ratio (95% confidence interval)	
Sex	0.44(0.29-0.66)***	0.45(0.30-0.68)***
Age	1.01(0.99-1.04)	1.01(0.98-1.03)
ADL	1.10 (0.67-1.80)	1.20 (0.73-1.96)
Nutritional status	1.75 (1.21-2.54)**	1.63 (1.12-2.38)*
Swallowing function	1.59 (1.01-2.41)*	1.65 (1.08-2.52)*
Length of mealtime	1.21 (0.82-1.80)	1.17 (0.78-1.75)
Refusal of oral care	1.34 (0.90-2.01)	1.28 (0.85-1.93)
Dry mouth	0.94 (0.62-1.42)	0.90 (0.59-1.38)
Halitosis	1.12 (0.75-1.64)	1.21 (0.81-1.78)
Underlying diseases		
Cerebrovascular disease		0.81 (0.54-1.22)
Neurological disorder		1.87 (0.65-5.31)
Hypertension		0.91 (0.62-1.33)
Heart disease		1.58 (1.04-2.21)*
Dementia		1.03 (0.69-1.55)
Diabetes mellitus		0.56 (0.31-1.04)
Bone/joint disease		0.54 (0.29-1.00)

*P<0.05, **P<0.01, ***P<0.001

