

Development of Dysphagia Risk Assessment Scale for Elderly Living at Home

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development of scale
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ABSTRACT

This study aimed to develop a dysphagia risk assessment scale for the elderly living at home. The scale was initially developed with 24 items, adopting a 4-grade answering method, focusing on dysphagia due to aging and diseases, related aspiration, aspiration pneumonia, and malnutrition during the following 4 swallowing stages, excluding the anticipatory stage: oral preparatory stage; oral stage; pharyngeal stage; and esophageal stage. To select appropriate items from these, structured interviews were conducted with 81 elderly individuals living in facilities, while conducting a self-administered questionnaire survey, involving 658 elderly individuals living at home, to confirm their validity and reliability. Furthermore, a 3-ounce water swallow test was performed as the gold standard.

Based on the results of content validity analysis, 17 items were selected for the scale. The validity of the scale was examined by performing factor analysis, and the following 4 factors were extracted: aspiration; poor pharyngeal clearance; difficulty in posterior propulsion of bolus by the tongue and triggering the pharyngeal swallow; and esophageal dysphagia. The reliability of the scale was examined by performing internal consistency analysis and adopting the retest method; Cronbach's alpha was 0.9 for the entire scale, with $r=0.62$ as test-retest reliability. The cut-off was set at 4, based on the ROC curve, with 57.1% sensitivity and 69.6% specificity.

These results confirmed the validity and reliability of the scale consisting of 17 questions.

I. Introduction

Japan became classified as an aging society in 1994, and is currently becoming a super-aging society. It is important for all Japanese people to know how to lead a healthy and independent old age, and they commonly desire to maintain their eating skills even in their final days. On the other hand, it has been reported that 12.7% of the elderly living at home, aged 65 and over, have difficulty in swallowing while eating, such as choking while eating rice, and the incidence of such symptoms increases with age¹⁾. In another study examining 56 elderly individuals without swallowing difficulty, abnormalities were identified by videofluoroscopic (VF) examination of swallowing: oral stage: 63%; pharyngeal stage: 25%; hypopharyngo-esophageal junction: 39%; and esophageal stage: 36%²⁾. These findings suggest that the elderly living at home may be at risk of dysphagia during daily activities. The presence of untreated dysphagia may lead to life-threatening problems, such as malnutrition, dehydration, and choking. Furthermore, according to the Annual of Pathological Autopsy Cases published by the Japanese Society of Pathology, 78.2% of those who died due to aspiration pneumonia were aged 60 and over³⁾; dysphagia is closely associated with pneumonia and bronchitis as the fourth leading cause of death in the elderly aged 65 and over.

Under such circumstances, it is necessary to establish social systems to address the age-related incidence of dysphagia in the elderly living at home; however, in Japan, dietary life is frequently regarded as a domestic issue. In addition, the needs assessment sheet used in the long-term care system contains only 1 item related to swallowing: <Possible to appropriately swallow; requiring assistance; or impossible to swallow>. Although detailed dysphagia assessment is performed by municipalities, social support for the prevention and early identification of dysphagia remains insufficient. The elderly

and their families tend to be unaware of the presence of dysphagia, and, even if they are aware of it, they frequently regard occasional choking while eating as an inevitable, natural, age-related symptom, rather than a problem to address. Considering such a situation, this study aimed to develop a self-administered dysphagia risk assessment scale (scale), with a view to identifying the elderly living at home with such risks and supporting them in the early stages.

II. Methods

1. Development of a dysphagia risk assessment scale (Figure 1)

Ingestion is generally classified into 5 stages: anticipatory stage; oral preparatory stage; oral stage; pharyngeal stage; and esophageal stage⁴⁾. Up to the present, dysphagia has been examined based on this classification. Aiming to develop a self-administered assessment scale, this study focused on dysphagia during the oral, pharyngeal, and esophageal stages, and that during the anticipatory stage, associated with difficulty in recognizing food due to cognitive dysfunction, such as emotional incontinence and dementia, was excluded. Logemann⁵⁾ classified the factors influencing the swallowing mechanism as follows: primary: the aging process; secondary: the course of diseases in the elderly; and tertiary: environmental, social, and psychological issues. This study examined the primary and secondary influencing factors; in short, dysphagia related to aging and diseases was classified into the oral preparatory, oral, pharyngeal, and esophageal stages. Also, considering the possibility of dysphagia being complicated with aspiration, aspiration pneumonia, and malnutrition, these items were also included in the initial scale.

Subsequently, based on the literature⁶⁻¹²⁾, subjective symptoms due to age- and disease-related dysphagia during the oral preparatory, oral, pharyngeal, and esophageal stages were included in the scale. Oral preparatory dysphagia included symptoms influencing the subsequent oral stages, such as oral dryness, incomplete lip closure, and difficulty in bolus formation. Similarly, that during the following stages

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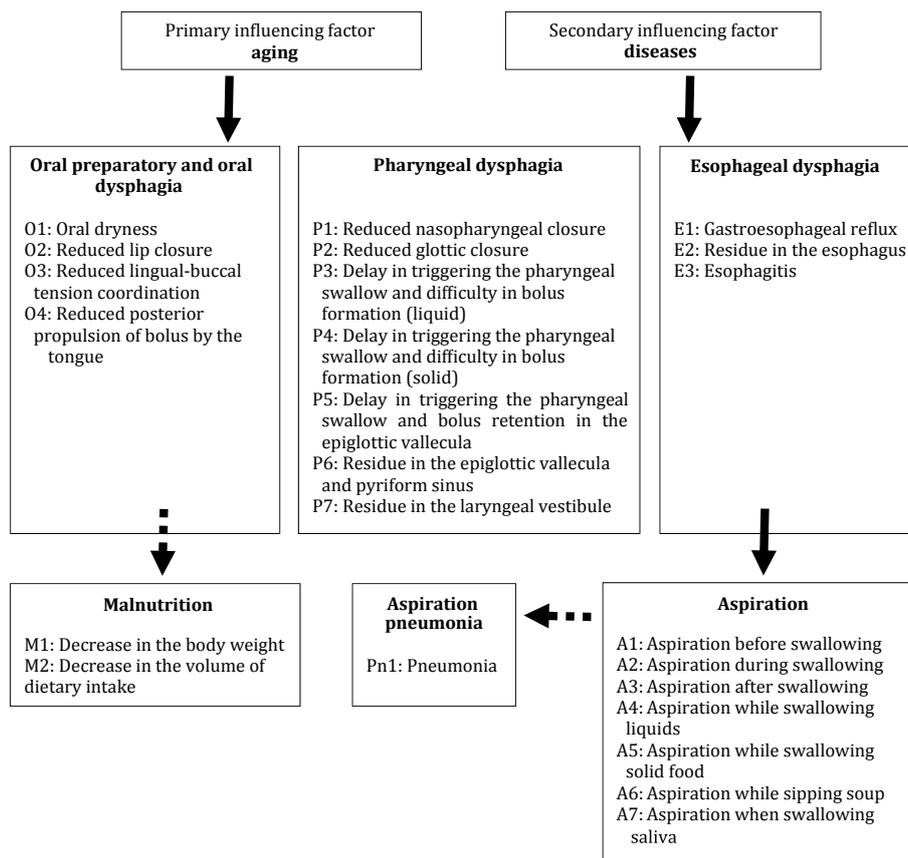


Figure 1. Construct and Questions of the Scale

included: oral dysphagia: difficulty in posterior propulsion of bolus by the tongue and coordinating the lingual and buccal tension; pharyngeal dysphagia: nasopharyngeal and glottic insufficiency; a delay in triggering the pharyngeal swallow; and poor pharyngeal clearance (bolus retention in the epiglottic vallecula, pyriform sinus, and laryngeal vestibule); and esophageal dysphagia: gastro-esophageal reflux; bolus retention in the esophagus; and esophagitis. Furthermore, adopting the classification by Logemann¹²⁾, aspiration was classified into before, during, and after swallowing to facilitate the elderly's self-assessment of aspiration while eating.

As the symptoms of dysphagia and aspiration vary, depending on the types of food, 24 questions were developed, including those when drinking and eating rice, based on the literature^{1, 13-16)}. Among these questions, 4 (O1 to O4) were related to oral preparatory dysphagia, 7 (P1 to P7) were related to pharyngeal dysphagia, 3 (E1 to E3) were related to esophageal dysphagia, and 7 (A1 to A7) were related to aspiration. To answer the questions, a 4-grade response scale was adopted: <Always>; <Sometimes>; <Rarely>; and <Almost never>. In addition, 1 question related to aspiration pneumonia due to dysphagia (Pn1) and 2 related to malnutrition (M1 and M2) were also included in the scale, with 2 possible responses: <Yes>; and <No>.

2. Participants and methods

The elderly aged 60 and over, living in Owariasahi City, Aichi, who were able to cooperate with the study, following the

researchers' instructions, were studied. Structured interviews were initially conducted to examine the appropriateness of each question, focusing on the participants' comprehension of its content and the incidence of dysphagia. Subsequently, to confirm the validity and reliability of the scale, a self-administered questionnaire survey was conducted. To determine the gold standard, a 3-ounce water swallow test¹⁷⁾ was also performed. The details of each procedure are described below.

1) Ethical considerations

Before conducting the structured interviews and 3-ounce water swallow test, the participants were provided with written explanations of the study objective, methods, and unconditional right to withdraw to obtain their consent for cooperation. Similar explanations were also added to the self-administered questionnaire sheet, and respondents' consent to participate was obtained when they returned the sheet.

2) Structured interviews

The structured interviews were conducted with 53 residents of nursing homes for the elderly and 28 day-service users, giving a total of 81 elderly individuals living in facilities (facility group), whose attributes were similar to those of the elderly living at home. Furthermore, after approximately 3 to 4 weeks, a retest was performed, involving 73 of them, whose consent for cooperation was obtained.

3) Self-administered questionnaire survey

The self-administered questionnaire survey was conducted, involving a total of 2,508 senior club members (at-home group). The questionnaire sheet contained the questions selected based on the results of the above-mentioned interviews. The study objective was initially explained at a meeting of the association of senior clubs, and, after obtaining members' consent, the questionnaire sheets were distributed to them through the chairman, with a return envelope to submit responses. In principle, the elderly themselves answered the questionnaire sheet; however, when it was difficult for them to do so for health-related reasons, their close relatives filled in the sheet, representing their opinions as accurately as possible. One to 2 months after the survey, a retest was performed, involving 90 whose consent for participation in the 3-ounce water swallow test was obtained.

4) The 3-ounce water swallow test

To determine the gold standard, a 3-ounce water swallow test¹⁷⁾ (water swallow test) was performed. In this test, participants are instructed to drink 90 ml of water without intervals, and those coughing due to aspiration during the test or within the following 1 minute or wet hoarseness after the test are considered to be at risk. The test for the 81 facility group members was performed 1 week after the interviews, and that for the 90 at-home group members, whose consent was obtained during the questionnaire survey, was performed 1 to 2 months after the distribution of the questionnaire sheet.

During the test, the risks of dysphagia were assessed, with indices to confirm the reliability of this assessment, such as the sounds of coughing due to aspiration, wet hoarseness, and sounds of breathing before and after swallowing with cervical auscultation, using the 8-ch Standard MacLab System, PowerLab System Ver. 3.6/s, and GPamp (ADInstruments). The obtained data were input into a laptop computer. When measuring the sounds of coughing, a heart sound microphone was attached to the right cervical region, where laryngeal elevation during swallowing was not interfered with, and the sounds of breathing were audible with less of an influence of the carotid pulse. The data were input into the computer through the GPamp System, with a range of 100 mv, frequency bandwidth of DC~5 kHz, and sampling speed of 4K/s.

The test was performed 1 hour after a meal, while sitting on a chair in a quiet environment (temperature: 25.0±2.0 degrees C). Denture users underwent the test with their dentures. The sounds of breathing during rest and those when vocalizing <ah> were initially recorded. Subsequently, the following instructions were given: "Please drink a cup of water completely at your own pace without intervals or taking the cup away from the mouth. After drinking all the water, vocalize <ah>;" and "If you choke while drinking, or have difficulty in continuously drinking, it is possible to stop". After the explanation, the recording was resumed, while instructing the participants to start drinking a cup of water (normal temperature; 90 ml). After they finished drinking (when the cup was taken away from the mouth, and the larynx fell), and breathed once or twice, they were instructed to vocalize <ah> to confirm the presence/absence of wet hoarseness. Furthermore, to confirm the presence/absence of aspiration, the recording was continued for 1 minute after swallowing.

After the test, the data input into the computer were

replayed off-line, and the sounds were evaluated by 2 raters. Intra-rater reliability was examined twice, with an interval of 1 week, while inter-rater reliability was examined by the researchers and a third person (a nurse with clinical experience of 5 years on the dysphagia ward). The kappa coefficients representing intra- and inter-rater reliability were both 0.85.

5) Neurological examination

Neurological examination was conducted following the water swallow test, involving 57 facility group members, whose consent was obtained, to appropriately select the questions. The presence/absence of impairment of cerebral nerves (V, VII, IX, X, and XII) controlling oral, pharyngeal, and laryngeal senses and movements during swallowing, were examined.

3. Analysis

In the questionnaire survey, among the 858 responses (response rate: 34.2%), 658 (valid response rate: 76.7%), in which all items, including the name, age, and sex, and answers to the scale questions, were analyzed. The answers to the questions were scored, adopting the Likert scale method, as follows: <Always>: 3; <Sometimes>: 2; <Rarely>: 1; and <Almost never>: 0. The statistical analysis software SPSS (Ver. 9.0 for Windows) was used, and the significance level was set at 5%.

III. Results

1. Participant attributes

The mean age±SD of facility group members was 78.0±7.6, and that of at-home group members was 74.9±6.7. The number of females was 51 (63.0%) in the facility and 382 (58.1%) in the at-home group; it was higher than that of males in both groups.

The number of those with a history of stroke, respiratory or gastrointestinal disease, or Parkinson's disease, which may be a primary disease of dysphagia, was 20 (24.7%) in the facility and 256 (38.9%) in the at-home group. The number of those using drugs (antihypertensives, tranquilizers, and hypnotics) involving side effects possibly affecting the swallowing function, such as oral dryness and decreased arousal levels, was 45 (55.6%) in the former and 331 (50.3%) in the latter group.

In both groups, 95% or more were independent in activities of daily living. Rice was the staple food in 80% or more, and denture users accounted for approximately 70%.

2. Selection of scale questions

1) Mean score, incidence, comprehension, and reproducibility (Table 1)

Based on the results of the interviews, the questions with the following conditions were excluded: a low mean score and incidence; incomprehensible; involving a large number of complaints related to causes other than dysphagia; and a low test-retest reproducibility.

Mean scores for the questions were within the range between 0.02 and 0.49. The questions with a mean score of 0.10 or less were as follows: <P1: Food or liquid goes into

Table 1. Mean Score and Incidence for Each Question of the Dysphagia Risk Assessment Scale in the Facility Group (N=81)

Questions	Mean	±SD	Always	Sometimes	Rarely	Almost never
[Preparatory oral dysphagia]						
O1 Feeling oral dryness.	0.49	1.00	8 (9.9)	6 (7.4)	4 (4.9)	63 (77.8)
O2 Dropping food from your mouth while eating.	0.26	0.59	1 (1.2)	3 (3.7)	12 (14.8)	65 (80.2)
O3 Food remains in your cheek after swallowing.	0.77	1.04	8 (9.9)	12 (14.8)	14 (17.3)	47 (58.0)
O4 Food remains on your tongue after swallowing.	0.09	0.39	0 (0.0)	3 (3.7)	1 (1.2)	77 (95.1)
[Pharyngeal dysphagia]						
P1 Food or liquid goes into your nasal cavity.	0.02	0.16	0 (0.0)	0 (0.0)	2 (2.5)	79 (97.5)
P2 Becoming hoarse.	0.30	0.75	3 (3.7)	5 (6.2)	5 (6.2)	68 (84.0)
P3 Difficulty in swallowing liquids.	0.12	0.53	2 (2.5)	1 (1.2)	2 (2.5)	76 (93.8)
P4 Difficulty in swallowing rice.	0.22	0.69	3 (3.7)	3 (3.7)	3 (3.7)	72 (88.9)
P5 Food becomes stuck in your throat.	0.17	0.52	0 (0.0)	5 (6.2)	4 (4.9)	72 (88.9)
P6 Food remains in your throat.	0.05	0.22	0 (0.0)	0 (0.0)	4 (4.9)	77 (95.1)
P7 Becoming hoarse while or after eating.	0.06	0.29	0 (0.0)	1 (1.2)	3 (3.7)	77 (95.1)
[Esophageal dysphagia]						
E1 Food and sour liquid comes back up into your throat from the stomach.	0.23	0.60	1 (1.2)	4 (4.9)	8 (9.9)	68 (84.0)
E2 Food becomes stuck in your esophagus.	0.15	0.48	0 (0.0)	4 (4.9)	4 (4.9)	73 (90.1)
E3 Having heartburn.	0.32	0.77	3 (3.7)	6 (7.4)	5 (6.2)	67 (82.7)
[Aspiration]						
A1 Choking or coughing before swallowing.	0.19	0.48	0 (0.0)	3 (3.7)	9 (11.1)	69 (85.2)
A2 Choking or coughing during swallowing.	0.41	0.67	0 (0.0)	8 (9.9)	17 (21.0)	56 (69.1)
A3 Choking or coughing after swallowing.	0.12	0.40	0 (0.0)	2 (2.5)	6 (7.4)	73 (90.1)
A4 Choking or coughing while swallowing liquids.	0.38	0.68	1 (1.2)	6 (7.4)	16 (19.8)	58 (71.6)
A5 Choking or coughing while swallowing rice.	0.16	0.49	0 (0.0)	4 (4.9)	5 (6.2)	72 (88.9)
A6 Choking or coughing while sipping soups.	0.11	0.39	0 (0.0)	2 (2.5)	5 (6.2)	73 (90.1)
A7 Awakened by coughing in the night.	0.12	0.40	0 (0.0)	2 (2.5)	6 (7.4)	73 (90.1)
[Aspiration pneumonia and malnutrition]						
			Yes	No		
Pn1 Having a history of pneumonia.			0 (0.0)	81 (100.0)		
M1 Losing weight.			8 (9.9)	73 (90.1)		
M2 Food intake has decreased to one-half.			2 (2.5)	79 (97.5)		

(Note) Mean scores and SDs were calculated by scoring each answer as follows: <Always>: 3; <Sometimes>: 2; <Rarely>: 1; and <Almost never>: 0. The numbers in brackets represent ratios of totals.

your nasal cavity>; <P6: Food remains in your throat >; <P7: Becoming hoarse while or after eating >; and <O4: Food remains on your tongue after swallowing >. The rates of answering <Always>, <Sometimes>, <Rarely>, or <Yes> were within the range between 2.5 and 42.0%; the rate was 5% or less for the following questions: P1; O4; P6; P7; <Pn1: Having a history of pneumonia>; and <M2: Food intake has decreased to one-half>. Questions Pn1 and M2, for which the incidence was very low, were excluded. The mean score and incidence were lowest for <P1: Food or liquid goes into your nasal cavity>, showing no association with soft palate deviation while vocalizing on neurological examination; however, this question was not excluded, as it represented dysfunction of nasopharyngeal closure, and there was a few responses to it. Among the 4 respondents who answered <Sometimes> or <Rarely> to <O4: Food remains on your tongue after swallowing>, 1 was diagnosed with lingual motor impairment on neurological examination. Also, among the 4 who answered <Sometimes> or <Rarely> to <P6: Food remains in your throat> or <P7: Becoming hoarse while or after eating>, wet hoarseness was identified in 2 (P6) and 3 (P7), respectively, during the water swallow test. Based on

these results, O4, P6, and P7 were considered to be associated with the neurological findings, and were selected.

Regarding respondents' comprehension of the questions, it was difficult for them to differentiate the symptoms described as <P2: Becoming hoarse> and <A7: Awakened by coughing in the night> from those of the common cold, requiring the revision of these expressions.

On the other hand, while the mean score for <O3: Food remains in your cheek after swallowing> was high, a large number of respondents answered that such a symptom occurred depending on the conditions of dentures. The answers to <A6: Choking or coughing while sipping soups > also varied, as some did not sip soups, and such a variation was related to eating habits. To <M1: Losing weight> and <M2: Food intake has decreased to one-half>, most respondents answered that such symptoms occurred due to other causes, such as the common cold. The questions involving complaints related to causes other than dysphagia, such as dentures, eating habits, and the common cold, were regarded as inappropriate for the scale to assess the risks of dysphagia, and were excluded.

The questions with a test-retest concordance rate of less

Table 2: Factor Structure of the Dysphagia Risk Assessment Scale (Major Factor Method with Varimax Rotation)

Questions	Questions				Commonality
	Factor 1	Factor 2	Factor 3	Factor 4	
A2 Choking or coughing during swallowing.	.828	.153	.187	.133	.762
A3 Choking or coughing after swallowing.	.700	.117	.299	.148	.615
A1 Choking or coughing before swallowing.	.682	.300	.155	.048	.582
A5 Choking or coughing while swallowing rice.	.577	.367	.301	.136	.577
A4 Choking or coughing while swallowing liquids.	.538	.277	.279	.197	.483
P6 Food remains in your throat.	.222	.751	.238	.254	.734
P5 Food becomes stuck in your throat.	.249	.631	.291	.270	.617
P7 Becoming hoarse while or after eating.	.257	.469	.123	.197	.340
P1 Food or liquid goes into your nasal cavity.	.341	.384	.331	.119	.388
O4 Food remains on your tongue after swallowing.	.182	.296	.659	.130	.572
P4 Difficulty in swallowing rice.	.312	.448	.596	.144	.674
P3 Difficulty in swallowing liquids.	.275	.491	.524	.120	.606
O2 Dropping food from your mouth while eating.	.208	.047	.485	.140	.300
O1 Feeling oral dryness.	.223	.191	.419	.225	.312
E3 Having heartburn.	.087	.087	.133	.732	.568
E1 Food and sour liquid comes back up into your throat from the stomach.	.130	.198	.104	.640	.477
E2 Food becomes stuck in your esophagus.	.135	.343	.263	.548	.505
Eigenvalue	2.90	2.40	2.16	1.66	
Contribution (%)	17.1	14.1	12.7	9.8	
Cumulative contribution (%)	17.1	31.1	43.9	53.6	

than 70% were as follows: <A2: Choking or coughing during swallowing>: 63.0%; <O3: Food remains in your cheek after swallowing>: 65.8%; <P2: Becoming hoarse>: 67.1%; and <A4: Choking or coughing while swallowing liquids>: 68.5%. Question O3 showed a low reproducibility, presumably due to the influences of denture conditions. Questions A2 and P2 also showed a low reproducibility, which may be associated with difficulty in differentiating aspiration between before, during, and after swallowing in the former, and in differentiating from the symptoms of the common cold in the latter.

For these reasons, Questions O3, A6, Pn1, M1, and M2 were excluded, and the remaining 19 were used for the following self-administered questionnaire survey after the following revision: A2: the phrases "before swallowing", "during swallowing", and "after swallowing" were emphasized with a wavy line to facilitate differentiation; and P2 and A7: the phrase "in the absence of the common cold" was added.

2) Content validity analysis

On factor analysis (major factor method) for the results of the questionnaire survey, commonality was 0.275 for <P2: Becoming hoarse in the absence of the common cold> and 0.234 for <A7: Awakened by coughing in the night in the absence of the common cold>; considering the commonalities of less than 0.3, these questions were excluded.

On good-poor (G-P) analysis, all participants were divided into 2 groups, based on a mean total score of 3.1 for the remaining 17 questions, excluding Questions P2 and A7: high-score: 166 (25.2%); and low-score: 492 (74.8%). On the Wilcoxon rank sum test for each question, significant differences between the 2 groups were observed in all questions.

On item-total (I-T) correlation analysis, the correlation coefficient between the total score and each of the 17 questions, excluding P2 and A7, was calculated; the coefficients were within the range between 0.5 and 0.75.

Based on these results, the 17 questions, excluding P2 and A7, were considered to have sufficient content validity, and were adopted for the dysphagia risk assessment scale.

3. Construct validity of the scale (Table 2)

The scale's construct initially consisted of: oral preparatory and oral dysphagia; pharyngeal dysphagia; esophageal dysphagia; aspiration; aspiration pneumonia; and malnutrition. After the selection of the 17 questions, aspiration pneumonia and malnutrition were excluded. On factor analysis of the results of the questionnaire survey (major factor method with varimax rotation), the following 4 factors were extracted: Factor 1: 5 questions (A1 to A5) related to aspiration; Factor 2: 4 questions (P1 and P5 to P7) related to pharyngeal dysphagia, particularly indicating poor pharyngeal clearance; Factor 3: 3 questions (O1, O2, and O4) related to oral preparatory and oral dysphagia associated with difficulty in posterior propulsion of bolus by the tongue, and 2 questions (P3 and P4) related to pharyngeal dysphagia associated with a delay in triggering the pharyngeal swallow; and Factor 4: 3 questions (E1 to E3) related to esophageal dysphagia. The factor loading level was high for Factors 2 and 3 (P3 and P4). The 4 factors were defined as follows: Factor 1: aspiration; 2: poor pharyngeal clearance; 3: difficulty in posterior propulsion of bolus by the tongue and triggering the pharyngeal swallow; and 4: esophageal dysphagia.

The correlation coefficient (r) between the total score for

all questions and that for the questions comprising each factor was as follows: Factor 1: 0.84; 2: 0.84; 3: 0.85; and 4: 0.69.

4. Reliability of the scale (Table 3)

On internal consistency analysis to confirm the reliability of the scale, Cronbach's alpha was 0.90 for all questions, and those for the 4 factors were within the range between 0.74 and 0.87.

Test-retest reliability was examined in comparison between the facility (73; mean age: 77.7±7.6; involved in the interviews) and at-home (90; 74.6±6.8; involved in the questionnaire survey) groups by calculating the correlation coefficient between the results of the initial and retests in relation to the following items: total score for all questions; that for the questions comprising each factor; and score for each question. The correlation coefficient (r) for the total score for all questions was 0.82 in the facility and 0.62 in the at-home group. That for each factor was 0.54 to 0.78 in the former and 0.49 to 0.69 in the latter group; Factors 1 and 2 showed a relatively low correlation, with r=0.6 or less.

The questions with r=0.3 or less included: both groups: <P7: T Becoming hoarse while or after eating>; <A1: Choking or coughing before swallowing>; and <A2: Choking or coughing during swallowing>; facility: <O4: Food remains on your tongue after swallowing>; and <P1: Food or liquid goes into your nasal cavity>; and at-home: <A3: Choking or coughing after swallowing>.

5. Sensitivity and specificity of the scale

The results of the water swallow test were as follows: facility: aspiration: 9; wet hoarseness: 3; aspiration and wet hoarseness: 9; and inadequate swallowing: 2. Among the 2 who withdrew, 1 had a history of gastrectomy, and had difficulty in completely drinking a cup of water in the presence of gastroesophageal reflux. Also showing a slight but persistent fever of unknown origin, this participant was assessed as <with risks>. The other 1 was excluded due to difficulty in assessment. A total of 22 (27.5%) were assessed as <with risks>. For the at-home group, the results were as follows: aspiration: 9, wet hoarseness: 9; and aspiration and wet hoarseness: 3. A total of 21 (23.3%) were assessed as <with risks>.

Total scores for all 17 questions were within the range between 0 and 51. The mean total score±SD was 3.5±4.8 (range: 0-22) in the facility and 4.1±5.0 (0-24) in the at-home group; in both groups, the range peaked between 0 and 2.

A Receiver Operating Characteristic (ROC) curve was created based on the results of the water swallow test and total score for the scale questions. The Y- and X-axes represent sensitivity and 1-specificity, respectively. In the facility group, when the cut-off was set at 2, both sensitivity and specificity were 60% or more; however, based on the ROC curve (Figure 2A), it was finally set at 4, as the upper left position closer to the peak was considered theoretically more appropriate¹⁸⁾. On the other hand, in the at-home group, when the cut-off was set at 2, sensitivity was 76.2%, while specificity was as low as 37.7%. When it was set at 3 or 4, while high sensitivity was similarly maintained, specificity was higher in the latter case, 69.6%. In addition, in the ROC curve (Figure 2B), the upper left position close to the peak confirmed the appropriateness of this cut-off, and, therefore, it was also set at 4. With a cut-off of 4, sensitivity and specificity were 59.1 and 75.9%, respectively, in the facility and 57.1 and 69.6%, respectively, in the at-home group.

IV. Discussion

In an aging society, it is desirable to support the elderly so that they can continuously perform high-quality daily activities in order to lead a healthy, independent life, and normal eating skills may be one of the requirements of such independence. On the other hand, the elderly are at an increased risk of age-related dysphagia, in addition to diseases, and, therefore, their conditions markedly vary among individuals. In line with this, the early identification of a decreased swallowing function in the elderly living at home and early provision of support for them are crucial to improve the elderly's quality of life. Furthermore, since the Long-term Care Insurance System was initiated in 2000, difficulty in assessing the swallowing-related questions of the needs assessment sheet has been pointed out, highlighting the social necessity of the development of appropriate dysphagia risk assessment scales.

Up to the present, although screening methods to assess patients with cardiovascular impairment and neurological diseases have been examined^{13,19-23)}, no studies have focused on the elderly living at home. The applicability of conventional assessment scales to the elderly and their safety and accuracy are discussed below:

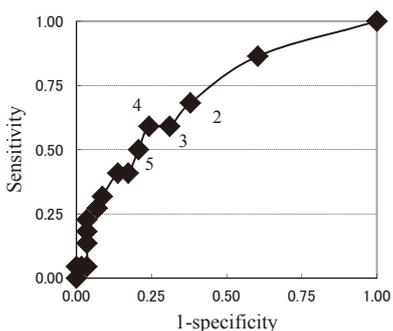
The sensitivity and specificity of conventional clinical assessment scales¹⁹⁻²¹⁾ to examine symptoms during swallowing, in addition to the labial, lingual, and laryngeal functions, have been reported as follows: Splaingard, M.L. et al.¹⁹⁾: 42 and 91%; Mari, F. et al.²⁰⁾: 74 and 74%; and Logemann, J.A. et al.²¹⁾: 78 and 58%, respectively. While these scales have

Table 3: Reliability of the Dysphagia Risk Assessment Scale

	Internal consistency Coefficient alpha N=658	Test-retest reliability	
		Facility group N=73	At-home group N=90
Factor 1 Aspiration	.87	.54	.49
Factor 2 Poor pharyngeal clearance	.78	.58	.51
Factor 3 Difficulty in posterior propulsion of bolus by the tongue and triggering the pharyngeal	.76	.72	.69
Factor 4 Esophageal dysphagia	.74	.78	.60
Total score	.90	.82	.62

(Note) Test-retest reliability was examined by calculating the correlation coefficient between the results of the initial and retests, focusing on the total score for the questions comprising each factor.

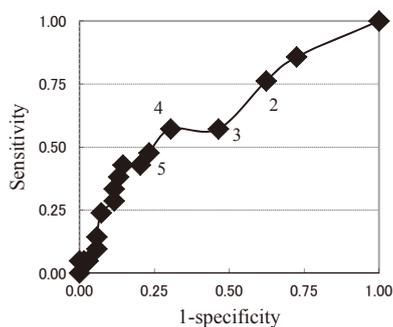
A. Facility group



Score	3-ounce water swallow test (golden standard)		Total
	With risks	Without risks	
4 or more	13	14	27
With risks	(16.3)	(17.5)	(33.8)
Less than 4	9	44	53
Without risks	(11.3)	(55.0)	(66.3)
Total	22	58	80
	(27.5)	(72.5)	(100.0)

Sensitivity=59.1% and specificity=75.9%

B. Elderly living at home



Score	3-ounce water swallow test (golden standard)		Total
	With risks	Without risks	
4 or more	12	21	33
With risks	(13.3)	(23.3)	(36.7)
Less than 4	9	48	57
Without risks	(10.0)	(53.3)	(63.3)
Total	21	69	90
	(23.3)	(76.7)	(100.0)

Sensitivity=57.1% and specificity=69.6%

Figure 2. ROC Curve Showing Sensitivity and Specificity

(Note) The numbers in brackets represent facility and at-home group members as a ratio of each total (N).

been shown to be noninvasive and safe, it is difficult to apply them to all elderly individuals living at home, as their duration is 30 minutes or more.

More convenient assessment methods include: the 30-ml Water Swallow Test²²; and Repetitive Saliva Swallowing Test²³. Considering that their duration is shorter than that of the above-mentioned clinical assessment scales, they appear to be more applicable to the elderly living at home, and, solely using water, they may be safe. At the same time, it should be noted that the 30-ml Water Swallow Test assesses the ability to swallow 30 ml of water within 5 seconds without aspiration by a single swallow. As it has been reported that some healthy individuals need multiple swallows to drink water of 20 ml or less²⁴⁻²⁶, and the maximum volume of water for healthy individuals to completely drink by a single swallow is 20 ml²⁷, such a criterion may be questionable.

The Repetitive Saliva Swallowing Test focuses on the triggering of the pharyngeal swallow, and, therefore, may be inappropriate to assess dysphagia during the swallowing stages other than the pharyngeal stage. It is also necessary to consider that these clinical assessment scales and water swallow tests require professional training for raters, resulting in difficulty in obtaining sufficient levels of intra- and inter-rater reliability.

The method developed by Fujishima et al.¹³ to assess the history of pneumonia, nutritional state, and dysphagia during the oral, pharyngeal, and esophageal stages, using an interview sheet, may be regarded as safe. In addition, its level

of accuracy is sufficiently high, with an alpha coefficient of 0.85, 92.0% sensitivity, and 90.1% specificity, and, therefore, it may be more applicable to the elderly living at home, compared to the conventional clinical assessment scales; however, to promote the healthy, independent lives of the elderly living at home, self-administered scales, which enable them to assess their own swallowing function, and perform self-care, such as maintaining or improving their eating skills, may be more appropriate than those based on interviews.

In these respects, the conventional scales to assess patients with cardiovascular impairment and neurological diseases may be inappropriate to assess the risks of dysphagia in the elderly living at home. It is necessary for dysphagia risk assessment scales to evenly and comprehensively cover not only aspiration and oral, pharyngeal, and esophageal dysphagia, but also related pneumonia and malnutrition. The scale developed in this study, with an appropriately set cut-off as a dividing point for risk judgment, may facilitate the early identification of those with risks of dysphagia. Furthermore, adopting the self-administered method, it may be possible for researchers to help the elderly become aware of their own swallowing conditions by showing them their scores, and perform self-care, such as maintaining or improving their eating skills. In line with this, it may also be possible to recommend them to undergo VF, and, based on the results, provide them with training for supraglottic swallowing or compensatory postural techniques and nutritional guidance, such as changing the types of food.

For the scale, 17 questions were selected based on the results of factor, G-P, and I-T correlation analyses to examine content validity. The 4 factors extracted through the factor analysis: aspiration, poor pharyngeal clearance, difficulty in posterior propulsion of bolus by the tongue and triggering the pharyngeal swallow, and esophageal dysphagia, may be associated with the construct of the scale, consisting of dysphagia during the oral preparatory, oral, pharyngeal, and esophageal stages and aspiration, excluding aspiration pneumonia and malnutrition. Also, considering the high correlation coefficients between the total score for all questions and that for the questions comprising the 4 factors, $r=0.69$ to 0.85 , the scale is likely to have sufficient construct validity.

The overall reliability of the scale consisting of 17 questions was also confirmed with a Cronbach's alpha of 0.90 , indicating sufficient internal consistency; this meets the criterion for the measurement of personal data, $0.90^{26)}$. In addition, the test-retest reliability level examined during the questionnaire survey was as stable as $r=0.62$.

Based on these results, it may be appropriate to consider the entire scale to have sufficient construct validity and reliability, and, therefore, the scale may be applicable to the elderly who are able to subjectively evaluate their own symptoms and answer the scale questions, or explain such symptoms to their relatives. The evaluation time of approximately 10 minutes may also support its applicability to the elderly living at home. Furthermore, being questionnaire-based, it may be safe, and may facilitate the determination of the presence/absence of risks.

On the other hand, while the reliability of each factor of the scale was within the range between 0.74 and 0.87 , meeting the level necessary for group comparisons, $0.7^{28)}$, Factors 1 and 2 showed $r=0.60$ or less on the retest during both the interviews and questionnaire survey, suggesting slightly insufficient stability; this may be explained by the presence of questions with a correlation coefficient (r) of 0.3 or less, rather than differences related to methods, such as interviews and questionnaire surveys. Such questions included: Factor 1: <A1: Choking or coughing before swallowing>; <A2: Choking or coughing during swallowing>; and <A3: Choking or coughing after swallowing>; and Factor 2: <P1: Food or liquid goes into your nasal cavity>; and <P7: Becoming hoarse while or after eating>. The low correlation coefficients for Questions A1-A3 may be associated with difficulty in differentiating between aspiration before, during, and after swallowing, while those for Questions P1 and P7 may be caused by difficulty in realizing these symptoms due to a lack of experience in the elderly. Therefore, in order to increase reliability, it may be necessary to reconsider the necessity of differentiating between aspiration before, during, and after swallowing in the former, and enhance the elderly's knowledge regarding the occurrence of these symptoms of dysphagia in the latter.

Based on the results of the water swallow test and total scores of the scale, an ROC curve was created, and the cut-off was set at 4 as a dividing point to determine the presence/absence of risks of dysphagia: a total score of 4 or more: with; and that of less than 4: without risks. With a cut-off of 4, sensitivity and specificity were 59.1 and 75.9% in the facility and 57.1 and 69.6% in the at-home group; compared to the accuracy of the above-mentioned clinical assessment scales used at the bedside^{20, 21)}, a similar specificity was

obtained, whereas the sensitivity was slightly lower, indicating the necessity of addressing the following issues for clinical application: the presence of questions with low test-retest reliability; and the elderly's insufficient knowledge of dysphagia-related symptoms, as they stated that they had never paid attention to such symptoms. In addition to these issues, the exclusion of masticatory dysfunction during the oral preparatory stage, preceding the oral, pharyngeal, and esophageal stages, from the scale may also be associated with this result, as mastication dysfunction leads to difficulty in preparing the food bolus, and affects the subsequent swallow. To increase the sensitivity of the scale to a sufficient level for application, the questions should be reconsidered to cover masticatory dysfunction. It may also be necessary to examine more comprehensible expressions, while developing the elderly's knowledge of age-related dysphagia.

V. Conclusion

This study aimed to develop a dysphagia risk assessment scale for the elderly living at home.

The scale was initially developed with 24 questions, adopting a 4-grade answering method, focusing on dysphagia due to aging and diseases, related aspiration, aspiration pneumonia, and malnutrition during the following 4 swallowing stages, excluding the anticipatory stage: oral preparatory stage; oral; stage pharyngeal stage; and esophageal stage. To select appropriate questions from these, structured interviews were conducted with 81 elderly individuals living in facilities, followed by a self-administered questionnaire survey, involving 2,508 elderly individuals living at home to confirm their validity and reliability. The number of valid responses was 658. Furthermore, a 3-ounce water swallow test was performed as the gold standard. The results were as follows:

1. Based on the results of content validity analysis after the interviews and questionnaire survey, 17 questions were selected. On factor analysis, the following 4 factors were extracted, confirming the construct validity of the scale: Factor 1: aspiration; 2: poor pharyngeal clearance; 3: difficulty in posterior propulsion of bolus by the tongue and triggering the pharyngeal swallow; and esophageal dysphagia.
2. Cronbach's alpha, representing internal consistency, was 0.90 for the entire scale, and the test-retest reliability was $r=0.82$ in the facility and $r=0.62$ in the at-home group, confirming the reliability of the scale.
3. Based on the ROC curve created in consideration of the total scores and results of the water swallow test, the cut-off was set at 4 to obtain 59.1% sensitivity and 75.9% specificity for the facility, and 57.1% sensitivity and 69.6% specificity for the at-home group.

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