Predictability of Oral and Laryngopharyngeal Function for Aspiration and Limitation of Oral Intake in Patients After Surgery for Head and Neck Cancer

CHRISTIANE HEY[1], BENJAMIN P. LANGE[2], CHRISTINA AERE[1], SILVIA EBERLE[1], YEVGEN ZARETSKY[1], ROBERT SADER[3], TIMO STÖVER[4] and JENS WAGENBLAST[4]

Departments of [1]Phoniatrics and Pediatric Audiology, [3]Oral, Cranio-Maxillofacial and Facial Plastic Surgery, and [4]Oto-Rhino-Laryngology, Head and Neck Surgery, University of Frankfurt/Main, Frankfurt/Main, Germany; [2]Department of Medical Psychology and Medical Sociology, Center of Psychosocial Medicine, Faculty of Medicine, University of Göttingen, Göttingen, Germany

Abstract. *Swallowing disorders are common in patients after surgery for head and neck cancer. The clinical assessment of oral and laryngopharyngeal abilities is widely used as a dysphagia assessment tool in this patient group, despite a lack of research. The goal of this study was to assess the predictability of clinical parameters for aspiration and limitation of oral intake. A swallowing disorder with the need for further intervention was identified by fiberoptic endoscopic evaluation of swallowing (FEES) in 65%, with aspiration in 49%, silently in 21%, and limited oral intake with tube dependency in 56% of studied patients. Four clinical parameters (dysglossia, wet voice, tongue motility, and tongue strength) correlated significantly with aspiration and limitation of oral intake. However, none of these clinical parameters was able to predict one of our two reference criteria, due to low positive likelihood ratios, mostly less than two. Clinical assessment is therefore inappropriate for early detection of swallowing disorders in such patients.*

Swallowing disorders are still a common sequelae of tumor resection in patients with head and neck cancer (HNC) (1), despite improved modern resection and reconstruction procedures (2-5). The prevalence rate is reported to be up to 88% (6-8) depending on localization, tumor size, and chosen treatment. Due to the frequent occurrence of post-surgical biomechanical dysfunctions, the examination of the swallowing-related oral and laryngopharyngeal abilities in this patient group is widely used as a dysphagia assessment tool, irrespective of the lack of research concerning its clinical utility.

Today, research is largely focused on the examination of non-swallowing oral and laryngeal functions as clinical parameters due to the possibility of predicting swallowing problems, predominantly in patients after stroke. The most frequently reported parameters are dysarthria (9-15), wet voice (10, 11, 12, 16), limited tongue motility (17, 18) and strength (19, 20), abnormal volitional cough (10, 11, 12, 21-23), and absent gag reflex (10-12, 22, 24, 25) as more or less sensitive signs of aspiration, are the most critical aspect of swallowing disorders in patients after stroke. Limitation of oral intake as a typical result of impaired bolus propulsion is not rare post-surgically in patients with HNC as a sign of severe oropharyngeal dysphagia even without signs of aspiration. It is of interest whether these clinical parameters, together with limitations in mouth opening, often occurring in patients with HNC (26), can be predictive of swallowing disorders with the need for further intervention in patients after surgery for HNC.

Therefore, the goal of the present study was to identify in such patients: (a) the predictability of the clinical parameters dysglossia, wet voice, abnormal volitional cough, reduced mouth opening, limited tongue motility, limited tongue strength, and gag reflex for the reference criteria aspiration and limitation of oral intake defined by fiberoptic endoscopic evaluation of swallowing (FEES); and (b) whether the combination of significantly correlating parameters enhances the predictability of these disorders.

Patients and Methods

Patients. Between November 2010 and December 2012, 98 patients were recruited for the presented prospective study after surgery for HNC. Inclusion criteria were defined as Union internationale contre

Correspondence to: Christiane Hey, MD, Department of Phoniatrics and Pediatric Audiology, University of Frankfurt/Main, Theodor-Stern-Kai 7, house 7A, D-60590 Frankfurt/Main, Germany. Tel: +49 06963015775, Fax: +49 06963015002, e-mail: Christiane.Hey@kgu.de

Key Words: Clinical predictors, swallowing disorder, dysphagia, head and neck cancer, post-surgical screening.

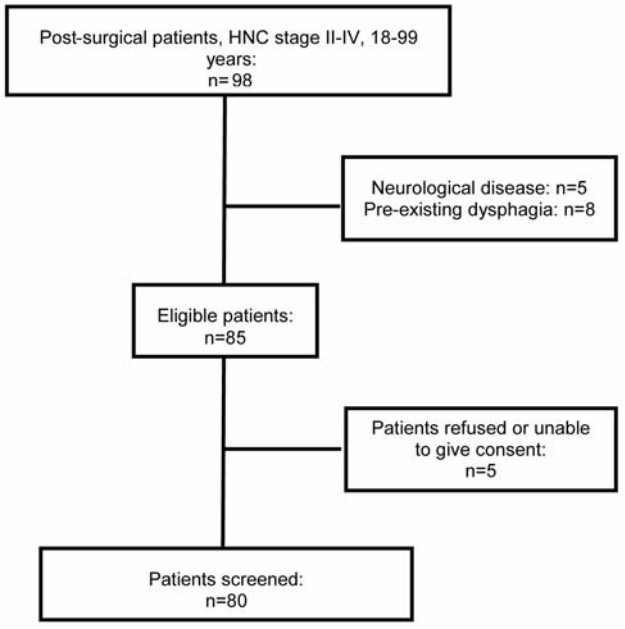

Figure 1. *Study inclusion flow diagram.*

Table I. *Patients' characteristics.*

	n	%
Age (years)		
≤40	4	5.0
41-60	34	42.4
>60	42	52.5
Gender		
Male	58	72.5
Female	22	27.5
Tumour stage		
II	23	28.8
III	9	11.3
IV	48	60.0
Tumour site		
Cavitas oris	30	37.5
Oropharynx	34	42.5
Hypopharynx/larynx	16	20.0

le cancer (UICC) stage II–IV, age between 18 and 99 years, and written informed consent. Exclusion criteria were neurological diseases and pre-existing oropharyngeal dysphagia. Out of the 98 patients, five were excluded due to neurological diseases, eight due to pre-existing oropharyngeal dysphagia, and five due to refused consent (Figure 1).

A total of 80 patients were thus included in our study, predominantly men (58 male, 22 female), with a mean age of 60.96 years (SD=12.93 years; range=18.92 to 87.75 years). Refer to Table I for patient characteristics.

The study was approved by the Institutional Review Board of the University Hospital Frankfurt/Main, Germany (approval # 240/10).

Procedure. After tumor resection and surgeon's approval for oral intake, all included patients firsty underwent clinical swallowing assessment performed by one of two speech and language pathologists (SLP), both with over five years' experience in dysphagia evaluation and treatment. As a reference standard, fiberoptic endoscopic evaluation of swallowing (FEES, Langmore standard) (27) was performed with a time frame of one hour after the clinical swallowing assessment. The examiner and rater of the FEES was a phoniatrician with over 10 years' FEES experience, blinded to information regarding the results of the two SLPs.

Clinical swallowing assessment. The clinical swallowing assessment, including dysglossia, wet voice, volitional cough, range of mouth opening, tongue motility, tongue strength, and gag reflex, was standardized and binarily scored with a pass/fail judgment (see Table II). Both SLPs were trained in administering and interpreting the seven clinical parameters on five healthy subjects and 20 patients with HNC who were not included in the study to optimize test reliability. Confirming inter- and intra-rater reliability tests was performed on 24 additional patients with HNC. The entire clinical swallowing assessment was administered and scored in less than 10 minutes.

Reliability. The overall intra-rater reliability (Cohen's κ=1.00, $p<0.001$) and the overall inter-rater reliability (Cohen's κ=0.98; $p<0.001$) were both excellent.

FEES. The FEES examinations were performed by the first author Christiane Hey according to the FEES protocol by Langmore *et al.* (27). The recordings were taken with the ENT video endoscopy system EndoStrob-DX (Xion medical GmbH, Berlin, Germany) (video system: PAL; output: S-Video, DVI-I, VGA IEEE/1394 (DV); input DVI-I, S-Video; 3 lux; sensor: CCD matrix with micro lenses and mosaic filter, 1/3" 752 (h) x 582 (v) pixels; digital interfaces: IEEE/1394 FireWire DV; light source: power 50 W; color temperature 5.700 K; camera head with integrated microphone, videoadapter: focal length 22 mm; clip coupling) and the transnasal flexible endoscope 11101 RP2 (Karl Storz GmbH, Tuttlingen, Germany).

The examination was initiated with 2 ml water and followed accordingly with 5, 10, and 20 ml. In addition, pure and solid consistencies with progressive volume were tested. If a patient aspirated, without the possibility of improving swallowing ability by therapeutic maneuvers, the FEES examination was discontinued.

The level of aspiration was scored by the eight-point penetration-aspiration scale (PAS) by Rosenbek *et al.* (28), the level of oral intake by the seven-point functional oral intake scale (FOIS) (29). Dysphagia with the need for further intervention was defined by a PAS ≥4 (4=material enters the airway, contacts the vocal folds, and is ejected from the airway), or FOIS ≤4 (4=total oral diet of a single consistency), aspiration by a PAS ≥6 (6=material enters the airway, passes below the vocal folds, and is ejected into the larynx or out of the airway), and therapy-relevant limitation of oral intake by FOIS ≥4.

FEES reliability. Assessments were rated by the first author Christiane Hey, who also re-rated 20% of the digital clips at least two months after the initial examination in order to assess the intra-rater reliability. Ten percent of the recordings were rated by the second person with experience in FEES, who was blinded to the

Table II. *Examination of the clinical parameters.*

Parameter	Method
1. Dysglossia:	Evaluation during initial dialog
2. Wet voice:	Evaluation during initial dialog
3. Volitional cough:	Command to cough
4. Mouth opening:	Command to open mouth as wide as possible
5. Tongue motility:	Tasks:
	Protraction
	Lateral movements
	Vertical movements in median position
	Circular tongue movements on the lips
	Articulation: tutututututut, kukukukukuk
6. Tongue strength:	Task: tongue pressed against the cheek with resistance of two fingers of the examiner
7. Gag reflex:	Triggered by the touch of the right/left palatal arch and posterior wall of the pharynx

patients' details, to assess the inter-rater reliability. The overall intra-rater reliability (Cohen's κ=0.89, p<0.001) and the overall inter-rater reliability (Cohen's κ=0.92, p<0.001) were both excellent.

Statistical analyses. The prevalence of dysphagia as well as both reference criteria aspiration and limitation of oral intake in our study population were determined by descriptive statistics.

Direction and strength of relationships with both reference criteria were tested using Pearson's correlation.

An analysis of variance (ANOVA) was calculated to test the effects of tumor site and stage.

For the significantly correlating clinical parameters, the accuracy was determined by sensitivity, specificity, and the positive likelihood ratio (LR).

All statistical analyses were performed using SPSS (Version 20, International Business Machines Corp., Armonk, New York, USA).

Results

FEES results. A swallowing disorder with the need for further intervention was identified by FEES in 65.0% (52/80), with aspiration in 48.8% (39/80), silently in 21.3% (17/80), and limitation of oral intake with tube dependency in 56.3% (45/80) of all patients with HNC. A level of 4 in the FOIS did not occur in any of the patients.

The more advanced the tumor stage, the higher the rate of aspiration and tube dependency. Refer to Table III for prevalence, as well as tumor stage and site-related details.

Regarding the tumor site, the patients with oropharyngeal carcinoma presented therapy-relevant dysphagia in 73.5% (25/34) aspiration in 61.8% (21/34), and tube dependency in 67.7% (23/34) of cases. However, as revealed by ANOVA, the tumor site had no effect on the two reference criteria (p>0.4; η_p^2<0.03), whereas tumor stage influenced both aspiration (p=0.005; η_p^2=0.138) and limitation of oral intake (p=0.010; η_p^2=0.122).

Correlation of the clinical parameters with aspiration, oral intake, and therapy-relevant dysphagia. Three out of seven clinical parameters, namely mouth opening, volitional cough, and gag reflex, showed no noteworthy correlation with either reference criterion (r≤0.2; p>0.05) and were thus considered negligible (see Table IV).

The remaining four parameters, namely dysglossia, wet voice, tongue motility, and tongue strength, were identified to be significantly related to limitation of oral intake and, except for dysglossia, with aspiration (Table IV).

The raw data, sensitivity, specificity, and the positive LR are listed for these four clinical parameters and their combinations in Table V.

The highest sensitivity for aspiration and limitation of oral intake was identified for tongue strength (aspiration=79.49%, limitation of oral intake=75.56%) and tongue motility (aspiration=74.36%, limitation of oral intake=71.11%) but

Table III. *Fiberoptic endoscopic evaluation of swallowing (FEES) results regarding dysphagia (*defined as penetration-aspiration scale (PAS) ≥4 or functional oral intake scale (FOIS) ≤4), aspiration, and limitation of oral intake.*

Patient characteristic	n	Dysphagia* n (%)	Aspiration (PAS ≥6) n (%)	Limitation of oral intake (FOIS ≤4) n (%)
Tumour stage				
II	23	9 (39.1)	5 (12.8)	6 (26.1)
III	9	5 (55.6)	3 (33.3)	4 (44.4)
IV	48	38 (79.2)	31 (79.4)	35 (72.9)
Tumour site				
Cavitas oris	30	19 (63.3)	11 (36.7)	16 (53.3)
Oropharynx	34	25 (73.5)	21 (61.8)	23 (67.7)
Hypopharynx/larynx	16	8 (50.0)	7 (43.8)	6 (37.5)
Total	80	52 (65.0)	39 (48.8)	45 (56.3)

Table IV. *Pearson's correlation of all clinical parameters with aspiration and limitation of oral intake.*

	Aspiration (PAS ≥6) (r)	Limitation of oral intake (FOIS ≤4) (r)
Dysglossia	0.20	0.37**
Wet voice	0.38**	0.45**
Volitional cough	0.01	0.09
Mouth opening	0.11	0.20
Tongue motility	0.28*	0.35**
Tongue strength	0.28*	0.33**
Gag reflex	0.13	0.12

df=79 for all correlations; *$p<0.05$; **$p<0.01$.

both with low specificity (with values from 51.22% to 57.14%) and therefore with a low positive likelihood ratio. The highest specificity was detected for wet voice (aspiration=90.24%, limitation of oral intake=94.29%) with a good likelihood ratio (aspiration 4.21, limitation of oral intake 7), however with low sensitivity (aspiration=41.02%, limitation of oral intake=40%). The lowest accuracy parameters were presented by dysglossia, especially for aspiration, with a positive LR of 1.23.

Analyzed combinations of two or more failed clinical parameters, and three or more failed clinical parameters did not improve the diagnostic accuracy significantly (Table V).

Discussion

The high prevalence of aspiration (49%), limitation of oral intake (56%), and swallowing disorder with need for further intervention (65%) in our study underlines that post-surgically patients with HNC have to be defined as a high-risk group for developing dysphagia and aspiration. Noteworthy is the rate of silent aspiration, over 20% of our patients, which is as high as that reported normally for patients with HNC following (chemo-)radiation (30-32). While tumor site did not influence the prevalence rate, increasing tumor stage extended the risk of aspiration and limitation of oral intake. This corresponds to the results of previous research showing that the larger the tumor size and resection, the greater the signs of dysphagia (30, 33-36).

The goal of our study was to examine the predictability of seven clinical parameters of non-swallowing oral and laryngeal functions for aspiration and limitation of oral intake in patients after surgery for HNC. To enhance the reliability of testing, we standardized the examination and simplified interpretation with binary pass/fail decisions. We also trained two SLPs in the administration and judging of the clinical assessment before commencement of the study. As a result, the intra- and inter-rated reliability was excellent in our study when compared to studies in which prior training was not applied (23), which underscores the necessity for standardization and training in order to achieve unified and valid examinations of clinical parameters as recommended in several articles (17, 18, 37).

In our study population, which is representative insofar as it matches the prevalence rate of German patients with HNC (38), four clinical parameters, namely dysglossia, wet voice, tongue motility, and tongue strength, correlated significantly with the FEES-detected signs of dysphagia; the three others, namely reduced mouth-opening, abnormal volitional cough, and absent gag reflex, did not. The two latter are also discussed controversially for patients after stroke, and categorically denied among others (23, 39, 40-42).

In our study, tongue motility and tongue strength presented the highest sensitivity, with values from 71% to 80% in all target conditions, therefore these two parameters could be interpreted as possible predictors. However, ruling a disease for subsequent management or not, has to result in a comparison of pre- and post-test probability instead of considering sensitivity and specificity in isolation as is widespreadly done (43). The LR is a statistic quality criterion that is more useful clinically than other statistical criteria (44). It converts the pre-test into post-test probability by combining sensitivity and specificity. In contrast to predictive values it is prevalence-independent and indicates how more or less probable patients with aspiration or limitation of oral intake are to have a positive test result within our clinical parameters than patients without the target condition. A positive LR value of 1 demonstrates that the probability of having a specific test result is equal for patients both with and without the target condition, which points out that such a test result is not able to differentiate between patients with and without the target condition. LR of 1 to 2 alters probability to a small and rarely important degree; LR of 2 to 5 generates small changes in probability; LR of 5 to 10 generates moderate shifts in pre-test to post-test probability (45). Given this, none of our four significantly correlating clinical parameters was able to predict aspiration or limitation of oral intake sufficiently, with values of LR mostly being less than two. Even if wet voice demonstrates a remarkably high specificity (90% to 94%) and good LR (4 to 7), because specificity influences the positive LR (46), wet voice does not reflect a valid predictor due to its low sensitivity.

Combining reliable clinical parameters is proposed in order to enhance validity over single items for the better predictability of aspiration in patients after stroke (10-12, 17, 23). Daniels *et al*. revealed that the presence of two out of six clinical parameters (dysarthria, dysphonia, abnormal volitional cough, abnormal gag reflex, cough or throat clearing and voice change after swallow) validly predicts aspiration in patients

Table V. *Diagnostic accuracy measures for the four identified clinical parameters for aspiration and limitation of oral intake.*

Item	Aspiration				Limitation of oral intake			
	Results (tp/fp/fn/tn)	Sensitivity % (95% CI)	Specificity % (95% CI)	LR (95% CI)	Results (tp/fp/fn/tn)	Sensitivity % (95% CI)	Specificity % (95% CI)	LR (95% CI)
Dysglossia	21/18/18/23	53.85 (37.18-69.91)	56.1 (39.75-71.53)	1.23 (0.78-1.93)	28/11/17/24	62.22 (46.54-76.23)	68.57 (50.71-83.15)	1.98 (1.15-3.40)
Wet voice	16/4/23/37	41.02 (25.57-57.90)	90.24 (76.87-97.28)	4.21 (1.54-11.48)	18/2/27/33	40.00 (25.70-55.67)	94.29 (80.84-99.3)	7.00 (1.74-28.17)
Tongue motility	29/18/10/23	74.36 (57.87-86.96)	56.10 (39.75-71.53)	1.69 (1.14-2.51)	32/15/13/20	71.11 (55.69-83.63)	57.14 (39.35-73.68)	1.66 (1.08-2.54)
Tongue strength	31/20/8/21	79.49 (63.54-90.7)	51.22 (35.13-67.12)	1.63 (1.15-2.32)	34/17/11/18	75.56 (60.46-87.12)	51.43 (33.99-68.62)	1.56 (1.07-2.27)
Combination 1	22/19/9/30	70.97 (51.96-85.78)	61.22 (46.24-74.80)	1.83 (1.21-2.78)	21/14/10/35	67.74 (48.63-83.32)	71.43 (56.74-83.42)	2.37 (1.43-3.93)
Combination 2	28/13/16/23	63.64 (47.77-77.59)	63.89 (46.22-79.18)	1.76 (1.08-2.87)	26/9/18/27	59.09 (43.25-73.66)	75.00 (57.8-87.88)	2.36 (1.28-4.38)

tp: True-positive; fp: false-positive; fn: false-negative; tn: true-negative; LR: positive likelihood ratio; CI: confidence interval. Combination 1: ≥2 failed clinical parameters; combination 2: ≥3 failed clinical parameters.

after stroke (Sensitivity=69.6%, Specificity=84.4%, LR=4.46) (11). McCullough *et al*. detected a better validity with the presence of four rather than two of the same clinical parameters (Sensitivity=77.8%, Specificity=71.9%, LR=2.76) (23). Leder *et al*., however, denied that these six clinical parameters are able to predict aspiration in patients after stroke (Sensitivity=86.4%, Specificity=29.6%, LR=1.23) (40). In contrast to the former studies, Leder *et al*. used FEES instead of the Videofluoroscopic Swallowing Study (VFSS) as the reference gold standard. In our study, the combination of the four correlating parameters (dysglossia, wet voice, tongue motility, and tongue strength), as a combination of two or more failed clinical parameters (aspiration: Sensitivity=71.0%, Specificity=61.2%, LR=1.83; limitation of oral intake: Sensitivity=67.7%, Specificity=71.4%, LR=2.37), and as a combination of three or more failed clinical parameters (aspiration: Sensitivity=63.6%, Specificity=63.9%, LR=1.76; limitation of oral intake: Sensitivity=59.1%, Specificity=75.0%, LR=2.36), did in fact improve the test properties when compared to the validity of each single parameter but was still not convincing.

However, beside the obvious fact that these four clinical parameters are really not able to predict aspiration and limitation of oral intake, a possible reason for this result, compared to the studies by Daniels *et al*. and McCullough *et al*., is that we had only four rather than six clinical parameters to combine, and used FEES as the gold standard like Leder *et al*. Furthermore, we used only seven clinical parameters, although the ones most reported, and even if our patient group is representative of the prevalence rate for German patients with HNC, the patient group is too small to carry out calculations for different tumor sites.

To our knowledge, the present study is the first to examine the predictability of clinical parameters of non-swallowing oral and laryngeal functions in patients with HNC post-surgically. Various studies carried out on neurological patients, predominantly after stroke, mostly referred to videofluoroscopy with aspiration as the main reference criterion. The use of limitation of oral intake or dysphagia in general is rare as reference criteria but is important for the patients with HNC due to the well-known high risk of malnutrition and therewith high risk of enhanced morbidity and reduced overall survival (47, 48). Furthermore, aspiration pneumonia, a common sequela, especially in silent aspiration, leads to a significant increase in mortality, co-morbidities, length of hospital stay, and attendant health care costs (49) in patients with HNC, whereas early detection of dysphagia can reduce them, as proven in patients after stroke (50), and is therefore suggested for HNC. However, at present no data support the predictability of clinical examinations in patients with HNC after surgery for aspiration or limitation of oral intake. Even if their use might be of value for the therapy of patients with HNC, the clinical assessment of oral and laryngeal function analyzed in our study is not acceptable as screening for the accurate identification of aspiration and limitation of oral intake in patients with HNC postsurgically.

References

1 Meyer A, Dietz A, Wollbrück D, Oeken J, Danker H, Meister EF, Sandner A, Völkel W, Brähler E and Singer S: Swallowing disorders after partial laryngectomy. Prevalence and predictors. HNO *60*: 892-900, 2012.

2 Bozec A, Poissonnet G, Chamorey E, Casanova C, Laout C, Vallicioni J, Demard F, Peyrade F, Follana P, Bensadoun RJ, Benezery K, Thariat J, Marcy PY, Sudaka A, Weber P and Dassonville O: Quality of life after oral and oropharyngeal reconstruction with a radial forearm free flap: Prospective study. J Otolaryngol Head Neck Surg *38*: 401-408, 2009.

3 Tschiesner U, Stier-Jarmer M, Strieth S, Singer S, Dietz A, Fietkau R, Wollenberg B, Mast G, Cieza A and Harréus UA: Development of an ICF-based clinical practice guideline for the assessment of function in head and neck cancer. Laryngorhinootologie *92*: 314-325, 2013.

4 Smith RB, Sniezek JC, Weed DT, Wax MK, and Microvascular Surgery Subcommittee of American Academy of Otolaryngology-Head and Neck Surgery: Utilization of free tissue transfer in head and neck surgery. Otolaryngol Head Neck Surg *137*: 182-191, 2007.

5 Thorwarth M, Eulzer C, Bader R and Wolf C, Schmidt M and Schultze-Mosgau S: Free flap transfer in cranio-maxillofacial surgery: A review of the current data. Oral Maxillofac Surg *12*: 113-124, 2008.

6 Adelstein DJ, Saxton JP, Lavertu P, Rybicki LA, Esclamado RM, Wood BG, Strome M and Carroll MA: Maximizing local control and organ preservation in stage IV squamous cell head and neck cancer with hyperfractionated radiation and concurrent chemotherapy. J Clin Oncol *20*: 1405-1410, 2002.

7 Salama JK, Stenson KM, List MA, Mell LK, Maccracken E, Cohen EE, Blair E, Vokes EE and Haraf DJ: Characteristics associated with swallowing changes after concurrent chemotherapy and radiotherapy in patients with head and neck cancer. Arch Otolaryngol Head Neck Surg *134*: 1060-1065, 2008.

8 Tschiesner U, Linseisen E, Baumann S, Siedek V, Stelter K, Berghaus A and Cieza A: Assessment of functioning in patients with head and neck cancer according to the International Classification of Functioning, Disability and Health (ICF): A multicenter study. Laryngoscope *119*: 915-923, 2009.

9 Horner J, Buoyer FG, Alberts MJ and Helms MJ: Dysphagia following brain-stem stroke. Clinical correlates and outcome. Arch Neurol *48*: 1170-1173, 1991.

10 Daniels SK, McAdam CP, Brailey K and Foundas AL: Clinical assessment of swallowing and prediction of dysphagia severity. Am J Speech Lang Pathol *6*: 17-24, 1997.

11 Daniels SK, Brailey K, Priestly DH, Herrington LR, Weisberg LA and Foundas AL: Aspiration in patients with acute stroke. Arch Phys Med Rehabil *79*: 14-19, 1998.

12 Daniels SK, Ballo LA, Mahoney MC and Foundas AL: Clinical predictors of dysphagia and aspiration risk: Outcome measures in acute stroke patients. Arch Phys Med Rehabil *81*: 1030-1033, 2000.

13 Logemann JA, Veis S and Colangelo L: A screening procedure for oropharyngeal dysphagia. Dysphagia *14*: 44-51, 1999.

14 Falsetti P, Acciai C, Palilla R, Bosi M, Carpinteri F, Zingarelli A, Pedace C and Lenzi L: Oropharyngeal dysphagia after stroke: Incidence, diagnosis, and clinical predictors in patients admitted to a neurorehabilitation unit. J Stroke Cerebrovasc Dis *18*: 329-335, 2009.

15 Kumar S, Doughty C, Doros G, Selim M, Lahoti S, Gokhale S and Schlaug G: Recovery of swallowing after dysphagic stroke: An Analysis of Prognostic Factors. J Stroke Cerebrovasc Dis .2012 Oct 23 [Epub ahead of print].

16 Cichero JA, Heaton S and Bassett L: Triaging dysphagia: Nurse screening for dysphagia in an acute hospital. J Clin Nurs *18*: 1649-1659, 2009.

17 Martino R, Silver F, Teasell R, Bayley M, Nicholson G, Streiner DL and Diamant NE: Toronto Bedside Swallowing Screening Test (TOR-BSST): Development and validation of a dysphagia screening tool for patients with stroke. Stroke *40*: 555-561, 2009.

18 Leder SB, Suiter DM, Murray J and Rademaker AW: Can an oral mechanism examination contribute to the assessment of odds of aspiration? Dysphagia. 2013 Jan 5. [Epub ahead of print]

19 Kidd D, Lawson J, Nesbitt R and MacMahon J: Aspiration in acute stroke: A clinical study with videofluoroscopy. Q J Med *86*: 825-829, 1993.

20 Logemann JA, Shanahan T, Rademaker AW, Kahrilas PJ, Lazar R and Halper A: Oropharyngeal swallowing after stroke in the left basal ganglion internal capsule. Dysphagia *8*: 230-234, 1993.

21 Smithard DG, O'Neill PA, Park C, England R, Renwick DS, Wyatt R, Morris J, Martin DF and North West Dysphagia Group: Can bedside assessment reliably exclude aspiration following acute stroke? Age Ageing *27*: 99-106, 1998.

22 Horner J, Massey W and Brazer SR: Aspiration in bilateral stroke patients. Neurology *40*: 1686-1688, 1990.

23 McCullough GH, Wertz RT and Rosenbek JC: Sensitivity and specificity of clinical/bedside examination signs for detecting aspiration in adults subsequent to stroke. J Commun Disord *34*: 55-72, 2001.

24 Mann G and Hankey GJ: Initial clinical and demographic predictors of swallowing impairment following acute stroke. Dysphagia *16*: 208-215, 2001.

25 Horner J, Brazer SR and Massey EW: Aspiration in bilateral stroke patients: A validation study. Neurology *43*: 430-433, 1993.

26 Weber C, Dommerich S and Pau HW: Limited mouth opening after primary therapy of head and neck cancer. Oral Maxillofac Surg 14: 169–173, 2010.

27 Langmore SE, Schatz K and Olson N: Fiberoptic endoscopic examination of swallowing safety: A new procedure. Dysphagia *2*: 216-219, 1988.

28 Rosenbek JC, Robbins JA, Roecker EB, Coyle JL and Wood JL: A penetration-aspiration scale. Dysphagia *11*: 93-98, 1996.

29 Crary MA, Mann GD and Groher ME: Initial psychometric assessment of a functional oral intake scale for dysphagia in stroke patients. Arch Phys Med Rehabil *86*: 1516-1520, 2005.

30 Pauloski BR: Rehabilitation of dysphagia following head and neck cancer. Phys Med Rehabil Clin N Am *19*: 889-928, 2008.

31 Nguyen NP, Moltz CC, Frank C, Millar C, Smith HJ, Dutta S, Nguyen PD, Nguyen LM, Lemanski C, Ludin A, Jo BH and Sallah S: Effectiveness of the cough reflex in patients with aspiration following radiation for head and neck cancer. Lung *186*: 243-248, 2007.

32 Goguen LA, Posner MR, Norris CM, Tishler RB, Wirth LJ, Annino DJ, Gagne A, Sullivan CA, Sammartino DE and Haddad RI: Dysphagia after sequential chemoradiation therapy for advanced head and neck cancer. Otolaryngol Head Neck Surg *134*: 916-922, 2006.

33 Nicoletti G, Soutar DS, Jackson MS, Wrench AA and Robertson G: Chewing and swallowing after surgical treatment for oral cancer: Functional evaluation in 196 selected cases. Plast Reconstr Surg *114*: 329-338, 2004.

34 Gagnebin J, Jaques B and Pasche P: Reconstruction of the anterior floor of mouth by surgical flap microanastomosis: Oncologic and functional results. Schweizerische Medizinische Wochenschrift *116*: 39S-42S, 2000.

35 Zuydam AC, Rogers SN, Brown JS, Vaughan ED and Magennis P: Swallowing rehabilitation after oro-pharyngeal resection for squamous cell carcinoma. Br J Oral Maxillofac Surg *38*: 513-518, 2000.
36 Konsulov SS: Surgical treatment of anterolateral tongue carcinoma. Folia Medica Plovdiv *47*: 20-23, 2005.
37 Scott A, Perry A and Bench J: A study of interrater reliability when using videofluoroscopy as an assessment of swallowing. Dysphagia *13*: 223-227, 1998.
38 Robert Koch-Institut, Gesellschaft der epidemiologischen Krebsregister in Deutschland e.V. (eds.): Krebs in Deutschland 2007/2008. 8. Ausgabe. Berlin, 2012.
39 McCullough GH, Rosenbek JC, Wertz RT, McCoy S, Mann G and McCullough K: Utility of clinical swallowing examination measures for detecting aspiration post-stroke. J Speech Lang Hear Res *48*: 1280-1293, 2005.
40 Leder SB and Espinosa JF: Aspiration risk after acute stroke: comparison of clinical examination and fiberoptic endoscopic evaluation of swallowing. Dysphagia *17*: 214-218, 2002.
41 Leder SB: Gag reflex and dysphagia. Head Neck *18*: 138-141, 1996.
42 Leder SB: Videofluoroscopic evaluation of aspiration with visual examination of the gag reflex and velar movement. Dysphagia *12*: 1221-1223, 1997.
43 Boyko EJ: Ruling out or ruling in disease with the most sensitive or specific diagnostic test: Short cut or wrong turn? Med Decis Making *14*: 175-179, 1994.
44 Sackett DL, Straus S, Richardson WS, Rosenberg W and Haynes RB: Evidence-based Medicine. How to Practice and Teach EBM. Second edition. Edinburgh: Churchill Livingston, pp. 67-93, 2000.
45 Jaeschke R, Guyatt GH and Sackett DL, for the Evidence-Based Working Group: Users' guide to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and how will they help me in caring for my patients? JAMA *271*: 703-707, 1994.
46 Bianchi MT and Alexander BM: Evidence-based diagnosis: Does the language reflect the theory? BMJ *333*: 442-445, 2006.
47 Chang PH, Yeh KY, Huang JS, Lai CH, Wu TH, Lan YJ, Tsai JC, Chen EY, Yang SW and Wang CH: Pretreatment performance status and nutrition are associated with early mortality of locally advanced head and neck cancer patients undergoing concurrent chemoradiation. Eur Arch Otorhinolaryngol *270*: 1909-1915, 2013.
48 Chang PH, Wang CH, Huang JS, Lai CH, Wu TH, Lan YJ, Tsai JC, Chen EY, Yang SW and Yeh KY: Low body mass index at three months following adjuvant chemoradiation affects survival of postoperative locally advanced oral cavity cancer patients. Laryngoscope *122*: 2193-2198, 2012.
49 Semenov YR, Starmer HM and Gourin CG: The effect of pneumonia on short-term outcomes and cost of care after head and neck cancer surgery. Laryngoscope *122*: 1994-2004, 2012.
50 Daniels SK, Anderson JA and Willson PC: Valid items for screening dysphagia risk in patients with stroke: A systematic review. Stroke *43*: 892-897, 2012.

Received May 29, 2013
Revised June 27, 2013
Accepted July 2, 2013