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Risk factors for aspiration pneumonia in geriatric patients with dementia and prolonged dysphagia

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Abstract:

Background: Dysphagia is an obvious risk factor for aspiration pneumonia in old age patients, especially those with dementia. The study aimed to determine the risk factors responsible for developing aspiration pneumonia in geriatric patients with dementia and dysphagia to enable the development of a particular preventive program accordingly.

Patients and Methods: The study recruited 98 patients diagnosed with dementia and dysphagia classified into patient and control groups according to the presence of aspiration pneumonia. Data collected included demographic and medical assessment data. Dementia severity was assessed with the clinical dementia rating (CDR) scale. According to the results of bedside clinical swallowing assessment and the Fiberoptic endoscopic evaluation of swallowing (FEES) results, the severity of swallowing impairment was determined by using the functional oral intake scale (FOIS), oropharyngeal secretion collection, penetration aspiration scale (PAS), and pharyngeal stasis scale.

Results: Patients with aspiration pneumonia were of longer hospital stay duration, with more malnutrition, recent stroke, and comorbidities with RR (risk ratio) of 3.22, 1.59, and 3.8, respectively. FEES outcome revealed significant differences between the two groups in all measures of dysphagia severity. The risk factors of aspiration pneumonia were severe penetration aspiration, combined tube, and oral feeding, malnutrition, comorbidities, and severe dementia.

Conclusion: The predictive risk factors for the development of aspiration pneumonia in dementia patients with dysphagia were malnutrition, comorbidities, severe dementia, and severe aspiration scale and tube feeding. These findings should be integrated into clinical practice to prevent aspiration pneumonia.

Keywords: Aspiration pneumonia, dementia, dysphagia, risk factors, FEES.

Introduction

Aspiration pneumonia (AP) is a prominent cause of admission and death in dementia patients, particularly in older ages.[1,2] Moreover, aspiration pneumonia is the evident type of community-acquired pneumonia (CAP), and its incidence ranges from 7 to 24% from (CAP) in many studies. [3,4] Dysphagia is an obvious risk factor for

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aspiration pneumonia in old age patients, especially those with dementia.[4] Patients with dementia and dysphagia have a higher risk of aspiration pneumonia than non-demented patients.[5] As patients with dementia suffer from impairment in their cognitive and functional abilities, behavioral eating obstacles become more evident and hinder their feeding and swallowing skills. Dysphagia can occur in the early stage of dementia with gradual eating problems as food refusal, visual agnosia, swallowing and feeding apraxia, food pocketing, food spitting, rapid eating, inadequate chewing, and impaired pharyngeal swallow. [6]

Swallowing assessment to detect aspiration in the patients with dementia starts by bedside evaluation, proceeding to a clinical swallow evaluation. It allows not only to document the signs and symptoms of dysphagia but also to evaluate functional aspects of swallowing, such as feeding and eating behaviors. These evaluations are not sufficient to assess aspiration, as it could not estimate the aspiration risk in individuals who aspirate.[7] Fiberoptic endoscopic evaluation of swallowing (FEES) is a practical, validated procedure to evaluate dysphagia, diagnose aspiration risk, and guide the management of dysphagia. FEES enhances the physicians to determine the patient's progress, make clear plans based on reliable clinical findings that help in the prevention of aspiration pneumonia. [8] However, there are few studies that use FEES in assessing the aspiration pneumonia risk factors with prolonged dysphagia in patients having dementia, especially in the Gulf region.

Studies on risk factors of aspiration pneumonia in patients with dementia and dysphagia are critical for reducing the incidence of aspiration pneumonia in this vulnerable geriatric population. The study of risks of AP in patients with

dementia and dysphagia is not studied sufficiently in the literature, as many studies compare patients with dementia with and without dysphagia. [4, 9] A previous study compares the incidence of aspiration pneumonia between the patients' group with dementia alone and a group with dementia and dysphagia. Their findings identified that participants with dementia and dysphagia had a statistically significant association with aspiration pneumonia. [9] Moreover, screening for dysphagia and aspiration risk significantly lower the incidence of pneumonia. [10]

The objectives of the study: The study aimed to determine the risk factors responsible for the development of aspiration pneumonia in geriatric patients with dementia and dysphagia in order to develop a particular preventive program accordingly.

Patients and Methods:

It is an observational cross-sectional study of 98 participants of geriatric patients admitted as inpatients or followed up in the swallowing clinic during the period from April 2018 to February 2020. All the patients were diagnosed with dementia and having dysphagia for more than three months duration. Patients were divided into two groups the 1st group are the subjects who experienced at least an attack of aspiration pneumonia in the last three months, and the 2nd group is the control group of patients who did not report any attack of aspiration pneumonia.

Aspiration pneumonia was diagnosed by the treating physician using standardized criteria (Mann criteria pneumonia). [11] AP diagnosis based on the presence of 3 or more of the following variables: fever ($\geq 38°C$), cough with purulent sputum, abnormal respiratory examination (tachypnea ≥ 22/min), inspiratory crackles, abnormal

chest radiograph, arterial hypoxemia (PO2, 70 mm Hg), and positive gram stain and culture. [11]

The inclusion criteria included patients with dementia who have prolonged dysphagia for more than three months. We excluded any patient with dementia who has normal swallowing, improved dysphagia, dysphagia less than three months, refused, or did not complete the assessment program.

All the participants were subjected to a complete history and examination, including the demographic data for each patient. Data collected included; the age, sex, duration of hospital stay, history of recent strokes, duration of the dysphagia, mode of feeding [oral, modified oral, a nasogastric tube (NG), or percutaneous endoscopic gastrostomy (PEG) feeding], tracheostomy, comorbidity of other disorders and nutritional state including BMI and malnutrition. Malnutrition in geriatric patients was defined as a BMI of less than 22 kg/m2 and weight loss of more than 5% in the last 3-6 months. [12]

Dementia severity was measured with the clinical dementia rating (CDR) scale. The Dementia Rating scale is a structured and clinician-rated interview that collects information on cognitive capacity from both the collateral source and patient to determine stages and the severity of dementia. Six factors are evaluated using a 5-point scale (except for the personal care domain) and then constructed to give a Global CDR score. The domains are memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care. Impairment is defined only when caused by cognitive loss, not by physical disability or other non-cognitive factors. [13]

Assessment of swallowing consisted of a standardized bedside clinical assessment and a Fiberoptic endoscopic evaluation of swallowing (FEES). The bedside assessment consisted of an initial measure of the patients' feeding status, posture, breathing, and cooperation levels before examining the patients' oral musculature, oral reflexes, pharyngeal swallow, and a trial feed with a 5–10-mL water bolus. [14]

FEES was done by well- trained phoniatrician according to the standard protocol described by Langmore. [15] All patients were assessed using the FEES Digital Swallowing Workstation by Kay PENTAX (Lincoln Park, NJ07035-1488, USA). The patient was asked to remain in the sitting position or a semi-upright position on the bed according to the patient's abilities. A flexible fiberoptic laryngoscope was inserted trans-nasally into the pharynx. The presence of oropharyngeal secretions was assessed and scored. The sensation tested by touching with the tip of the endoscope to various areas of the larynx, and reflex adduction of the vocal folds or reflex cough and chocking were observed. Different food consistencies, such as fluids (water), semisolids (thick juice/yogurt), and solids (a piece of biscuits or bread), mixed with green dye, were used to evaluate swallowing. Pharyngeal stasis after swallowing was scored. The salient findings noted were residue, penetration, and aspiration into the larynx. FEES was graded according to the Penetration Aspiration Scale (PAS), as proposed by Rosenbek. [16] The highest Penetration-Aspiration score achieved in the two trials was taken as the final score.

Outcome Measures: According to the results of bedside clinical swallowing assessment and the FEES results, the severity of swallowing impairment was determined by using the functional oral intake scale (FOIS) [17], oropharyngeal secretion collection, Penetration Aspiration Scale (PAS), and pharyngeal stasis scale. [15-17]

Ethics: The study was approved by the Dubai health authority research and ethics Committee. A clear explanation was given about the study objectives and plan. They were free to terminate participation in this study without the affection for their clinical management. An informed consent, including the explanation was obtained from all subjects involved in the study or their guardians before participation.

Statistical analysis :

The sample size calculated using Cohen's Tables and G. Power. The minimum recommended sample size is 85 at a confidence interval of 95%, 0.05 significance, .80 power, and four predictors.

Statistical analyses were performed with SPSS 20.0 software (SPSS Inc, Chicago, IL). The bivariant analysis was calculated to determine the independent variables that may show a significant relationship. These variables were included in the contingency tables and analyzed by Fisher's exact test. Independent factors influential on the presence of aspiration pneumonia and results of logistic regression analysis were expressed as levels of significance, estimated relative risks (approximated odds ratio-OR), and 95% confidence intervals. Results at a significance level of $p<0.05$ within a 95% confidence interval were accepted as statistically significant values.

Continuous variables were compared using the Student's t-test when variables were normally distributed and the Mann- Whitney U test when variables were non-normally distributed.

First, we used bivariate analysis and logistic analysis to examine the effect of each of the risk factors individually. Then we used multiple simultaneous logistic regression to examine which of

these factors had a significant independent effect.

Results:

The study recruited 98 (58 male and 40 female) patients diagnosed with dementia and dysphagia, the mean age was 81.97±7.35, and the duration of hospitalization was 16.2±15.6 days.

Dysphagia duration was 156±141, and the CDR score was 7.98±3.93.

We compare the aspiration pneumonia (AP) group with the control group with negative AP in different outcome measures, as shown in table 1. There was no significant difference in age, dysphagia duration, and the presence of tracheostomy between the two groups.

Positive AP was found in 58.6% of male patients and 20 % of female patients, with a significant difference between genders as males have a higher risk to develop AP than females.

Patients with AP were of longer hospital stay duration, with more malnutrition, recent stroke, and comorbidities with RR (risk ratio) of 3.22, 1.59, and 3.8, respectively, as shown in table 2 and figure 1.

Both CDR score and severity show a significant difference between the two groups. FEES outcome revealed significant differences between the two groups in all measures of dysphagia severity as penetration aspiration scale, degree of pharyngeal stasis, and secretion levels, as shown in table 1. Multinomial logistic regression revealed that PAS 4 or above has predictive value for aspiration pneumonia (pseudo R square was .521 by Cox and Snell test), pharyngeal stasis (r= .420) and secretion collection (r = .287).

The mode of feeding analysis revealed that tube feeding (NG or PEG) with supplementary oral feeding has a higher risk of aspiration pneumonia in

dementia patients than other moods of feedings, as shown in figure 2. The same for functional oral intake s feeding where the higher predictive value was in FOIS level 3, where the patient is Tube-dependent with consistent oral intake of food or liquid with r = .472.

Table 3 shows the risk factors of aspiration pneumonia by multinomial logistic regression analysis. The independent risk factors were severe penetration aspiration with PAS 4 or above, Combined tube and oral feeding, malnutrition, comorbidities, and dementia of grade 2 or above.

Table 1 Comparison of aspiration pneumonia group and control group in outcome measures

Variables	Aspiration pneumonia group (42) (Mean± SD)	Negative AP group (56) (Mean± SD)	sig	CI
Age	83.33±7.69	80.96 ± 6.79	.121	-.568-5.32
Hospital stay	26.19±17.9	8.92±7.24	.001	11.4-23.2
Dysphagia duration	182.66±146.14	136.71±135.17	.111	-10.7-103.7
Penetration aspiration scale	4.09±.532	2.50±1.09	.000	1.23-1.96
Bolus stasis level	2.04±.698	1.120±.603	.000	.73-1.27
Secretion collection	1.42±.859	.535±.785	.000	.56-1.22
FOIS	3.19±1.38	4.50±1.51	.000	-1.90--.718
CDR score /18 R= .095	9.38±3.74	6.92±3.77	.002	.92-3.97
CDR severity 0-3	1.57±.73	1.25±.51	.046	.056-.572

Significance P ≤ .05%
CI: confidence interval
FOIS: functional oral intake scale
CDR: clinical dementia rating

Table 2. Bivariate analysis of risk factors of aspiration pneumonia

Variables	Aspiration pneumonia group (42)	Negative AP group (56)	Sig.	RR	CI
Sex (No, %) Male 58	34 (58.6%)	24 (41.3%)	.001	.517	.367-.729
Female 40	8 (20%)	32 (80%)			
Malnutrition	34 (81%)	12 (21.4%)	.001	3.222	1.697- 5.348
Recent stroke	20 (47.6%)	14 (25%)	.031	1.594	1.027- 2.473
Comorbidity	30 (71.4%)	8 (14.3%)	.000	3.800	2.027- 7.125
Tube feeding	30 (71.4%)	12 (21.4%)	.000	2.75	1.67- 4.52
tracheostomy	10 (23.8%)	6 (10.7%)	.073	1.626	.844- 3.133
FEES PA scale $\geq$ 4	24 (57.1%)	9 (16 %)	.001	2.92	1.21- 7.04
FEES stasis level $\geq$ 2	36 (85.7%)	10 (17.8%)	.001	4.06	2.33- 7.10
FEES secretion $\geq$ 2	20 (47.6%)	6	.000	5.34	.56- 1.22
FOIS $\leq$ 3	32 (76.1%)	12 (21.4%)	.000	-4.39	-1.90- -.718
CDR $\geq$ 2	18 (42.8%)	12 (21.4%)	.028	1.375	1.02-1.85

Significance P $\leq$ .05%
CI: confidence interval
RR: Relative risk
FEES PA scale: Fiberoptic endoscopic evaluation of swallowing Aspiration penetration scale
FOIS: functional oral intake scale
CDR: clinical dementia rating

Table 3. Risk factors of aspiration pneumonia by multinomial logistic regression analysis.

Covariates	Coefficient	P-value	OR	95% CI
Penetration aspiration severity	1.812	.001	6.35	2.81-10.10
Combined tube and oral feeding	1.571	.003	7.98	1.81-14.91
Malnutrition	0.984	.014	8.422	2. 975-21.459
Comorbidities	1.625	.031	2.295	1.036-3.125
Severe dementia	0.754	.047	4.143	2.056-6.572

Significance P $\leq$ .05%
OR: Odd Ratio
CI: confidence interval

Fig. 1. **Histogram showing Comparison of the two groups in different risk factors of aspiration pneumonia**
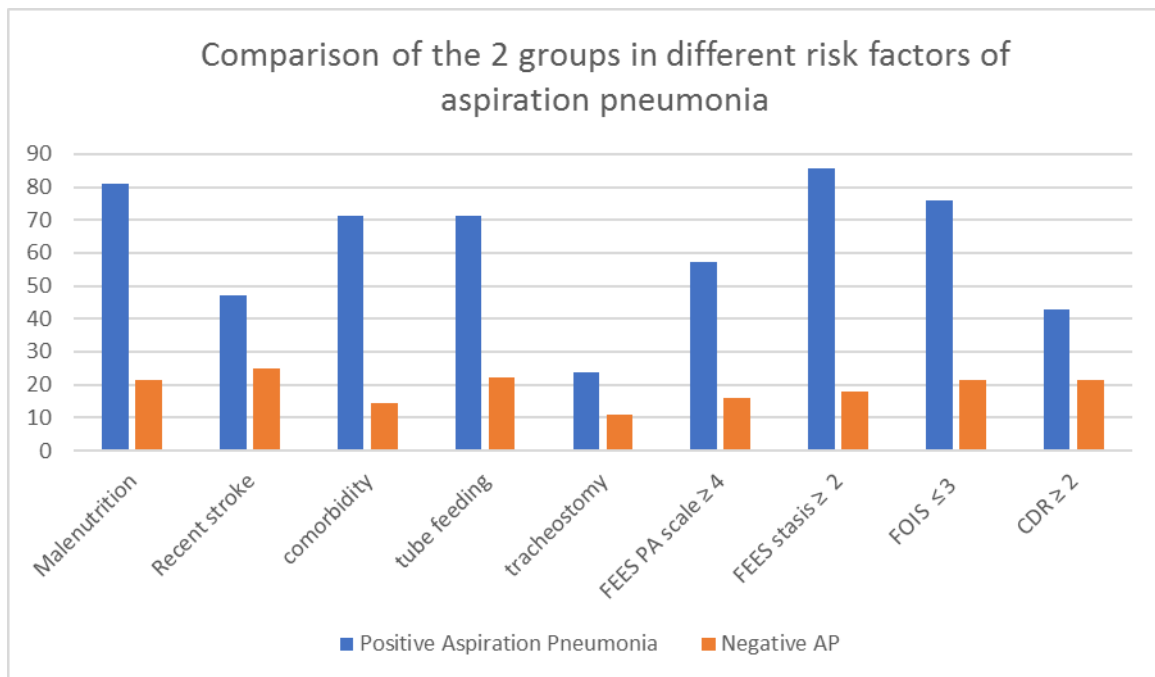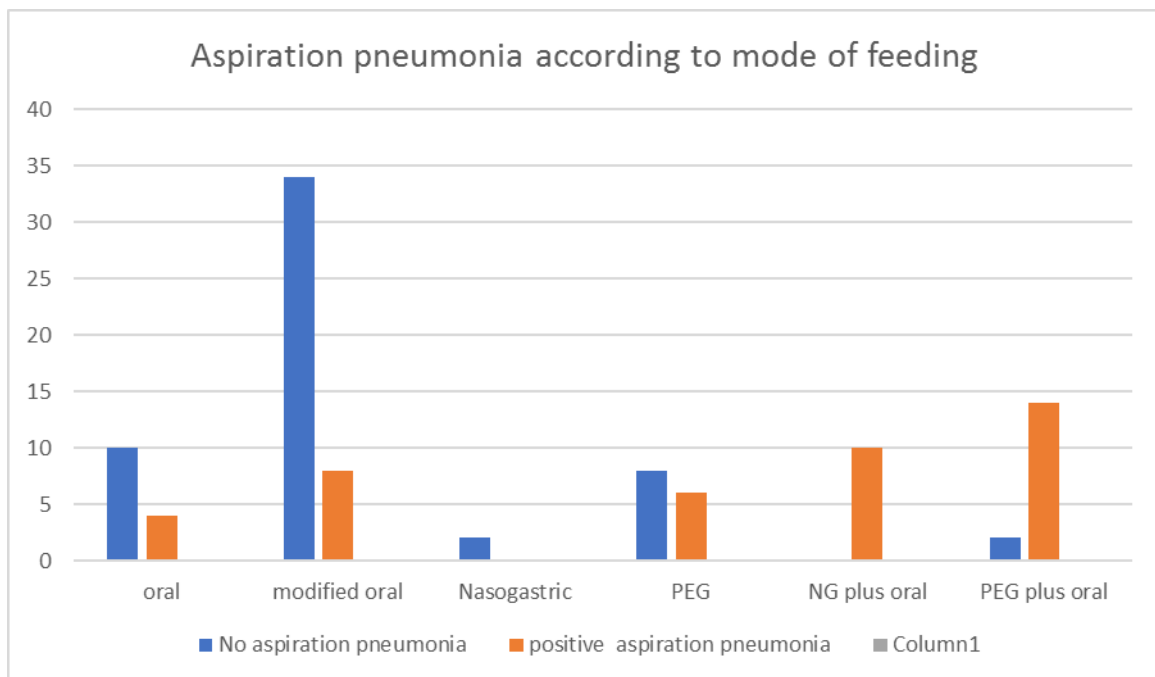

Fig. 2. **Histogram showing percentage of aspiration pneumonia in both groups according to the mode of feeding**

Discussion :

The geriatric population with dementia and dysphagia has been increasing worldwide, and it is widely known that aspiration pneumonia is one of the most likely causes of death among them.[18] In the present study, we compared patients with dementia and dysphagia, with and without aspiration pneumonia, in different outcome measures to investigate risk factors of aspiration pneumonia. This study clearly shows that malnutrition, comorbidities, severe dementia, and severe aspiration scale were independently and significantly associated with aspiration pneumonia in patients with dementia and dysphagia. Oropharyngeal dysphagia, old age, and dementia have been recognized as major geriatric syndromes and have been identified as major risk factors for AP. [19] Studies reported aspiration risks to include cerebrovascular disease, oropharyngeal dysphagia, old age, and severe dementia, malnutrition, of antipsychotic drugs, use, and GERD. [20]

Advanced age and male gender were known to be risk factors for aspiration pneumonia. Previous studies have shown that the possibility of aspiration pneumonia increases with age. However, given that we included very old patients with dementia in this study with their mean age was above 81 years, age itself may not be a risk factor for dementia. [21] The male gender carries a higher association with AP agrees with the previous studies. [1]

Dysphagia severity measures using FEES revealed that the aspiration pneumonia group has a higher penetration aspiration scale, degree of pharyngeal stasis, and secretion levels. FEES is a useful test for the evaluation of swallowing function in elderly patients; the cognitive function should be evaluated before performing a swallowing test.[18] In dementia, the presence of dysphagia could cause many serious health problems like dehydration, renal impairment, malnutrition, and aspiration pneumonia. Patients with dementia have high levels of pharyngeal dysfunction and aspirate around 45% of the time; as dementia progresses, the patients may develop reduced pharyngeal clearance, reduced upper esophageal opening, and penetration and aspiration. [22]

The study results can assume that tracheostomy is not a risk factor for AP. Five tracheostomized patients developed AP before tracheostomy, and tracheostomy was done due to AP and prolonged ventilation. Evidence regarding aspiration risk of tracheostomy is inconclusive. Tracheostomy is not a preventive measure for AP; nevertheless, it may increase risk due to decreased airway protective mechanism and salivary pooling.[23] Aspiration is the entry of oropharyngeal secretions into the larynx and the respiratory tract. In contrast, aspiration pneumonia is an infectious process due to the aspiration of oropharyngeal contents containing pathogenic bacteria.[24] Patients with a tracheostomy that aspirate could be protected from developing AP by tube cuffs or airway suctioning.

The present study findings suggest that patients with tube feeding (NG or PEG) with consistent complimentary oral intake have a higher risk of aspiration pneumonia than other moods of feedings. Elderly patients with tube feeding and those dependent on others for oral hygiene are associated with oropharyngeal colonization of more pathogenic bacteria and aspirate more when compared with orally fed patients. [25-26] If the patient is given oral food and tube feeding, the risk of aspiration of this pathogenic bacterium could progress to AP.

Previous studies found that AP is the most frequent cause of death in PEG and NGT feeding patients. [27] Results of previous studies comparing NG from PEG feeding are controversial. Some studies find that PEG is a better choice for prolonged tube feeding than NGT as it decreased the risk of Aspiration pneumonia.[28-30] Meta-analyses of AP risk did not detect that patients with NG were at higher risk than PEG; however, there is high statistical heterogeneity between different studies. [31] Studies have shown that tube placement decreases lower oesophageal sphincter tone, potentially increasing regurgitation risk. NG tube also passes through cricopharyngeal sphincter that may interfere with the protective cough reflexes causing aspiration. Aspiration of gastric contents produces pneumonitis with the resultant inflammatory response allowing for the establishment of infection by less virulent organisms. [30]

In the present study, we investigate risks of aspiration pneumonia which are more relevant clinically than the risks of aspiration. While the aspiration risks can be risks for AP, the two sets of risks are not the same, and patients with risks of aspiration do not automatically develop aspiration pneumonia. [20] The pathophysiology of aspiration pneumonia comprises three main risk factors: dysphagia with poor protective swallowing functions (aspirations), general health weakness with immunological abnormalities, and poor oral health with colonization by pathogens. [32] The risks for aspiration pneumonia include aspiration risks, pathogens factors, and the host defense. The host defense aspects associated with the AP pathogenesis include old age, male gender, malnutrition, diabetes mellitus, cerebrovascular stroke, and severe dementia. Understanding the relations between the patient, the pathogen, and the environment are essential for a better interpretation of the processes that trigger aspiration pneumonia and for creating successful plans for its prevention.[20] A recent meta-analysis study concluded that 50% of patients with dementia died due to pneumonia, and this rate may be much higher than the clinician's anticipations. They recommended that clinicians must pay careful attention to cases of AP among dementia patients to increase patients' life expectancy and quality. [33]

These findings are useful in the development of clinical guidelines for the management and prevention of aspiration pneumonia in these frail older patients with multiple risk factors. This information should be incorporated into an educational plan about long-term management for health care providers, patients, and family members.

Conclusion:

Our study results can conclude that that the predictive risk factors for the development of aspiration pneumonia in dementia patients with dysphagia were malnutrition, comorbidities, severe dementia, and severe aspiration scale and tube feeding with consistent complimentary oral intake. These findings should be integrated into clinical practice to prevent aspiration pneumonia.

Reference:

1. Manabe T, Teramoto S, Tamiya N, Okochi J, Hizawa N. Risk Factors for Aspiration Pneumonia in Older Adults. PLoS One. 2015;10(10):e0140060.

2. Kaplan V, Angus DC, Griffin MF, Clermont G, Scott Watson R, Linde-Zwirble WT. Hospitalized community-acquired pneumonia in the elderly: age-and sex-related patterns of care and outcome in the United States. American journal of respiratory and critical care medicine. 2002 Mar 15;165(6):766-72.

3. Komiya K, Rubin BK, Kadota JI, Mukae H, Akaba T, Moro H, Aoki N, Tsukada H, Noguchi S, Shime N, Takahashi O. Prognostic implications of aspiration pneumonia in patients with community acquired pneumonia: a systematic review with meta-analysis. Scientific reports. 2016 Dec 7; 6:38097.

4. Payne M, Morley JE. Dysphagia, Dementia and Frailty. J Nutr Health Aging. 2018;22(5):562.

5. Rosler A, Pfeil S, Lessmann H, Hoder J, Befahr A, von Reinteln-Kruse W. Dysphagia in dementia: Influence of dementia severity and food texture on the prevalence of aspiration and latency to swallow in hospitalized geriatric patients. J Am Med Dir Assoc 2015; 16:697-701.

6. Wirth R, Dziewas R, Beck AM, Clave P, Hamdy S, Heppner HJ, Langmore S, Leischker AH, et al. Oropharyngeal dysphagia in older persons – from pathophysiology to adequate intervention: A review and summary of an international expert meeting. Clin Interv Aging 2016; 11:189-208.

7. Boccardi V, Ruggiero C, Patriti A, Marano L. Diagnostic assessment and management of dysphagia in patients with Alzheimer's disease. Journal of Alzheimer's Disease. 2016 Jan 1;50(4):947-55.

8. Langmore S E. Evaluation of oropharyngeal dysphagia: which diagnostic tool is superior? Current Opinions in Otolaryngology Head and Neck Surgery 2003;11, 485-9.

9. Chappell LM. Does Dementia with Dysphagia Increase the Incidence of Aspiration in Long-Term Care Residents? Doctoral dissertation, DeSales University, 2019. ProQuest Number:27546753.

10. Hagglund P, Olai L, Stahlnacke K et al. Study protocol for the SOFIA project: swallowing function, oral health, and food intake in old age: a descriptive study with a cluster randomized trial. BMC Geriatr 2017; 17: 78. doi:10.1186/ s12877-017-0466-8.

11. Mann G, Hankey GJ, Cameron D. Swallowing function after stroke: prognosis and prognostic factors at 6 months. Stroke 1999; 30:744-8.

12. Rojer AG, Kruizenga HM, Trappenburg MC, Reijnierse EM, Sipilä S, Narici MV, Hogrel JY, Butler-Browne G, Mcphee JS, Pääsuke M, Meskers CG. The prevalence of malnutrition according to the new ESPEN definition in four diverse populations. Clinical Nutrition. 2016 Jun 1;35(3):758-62.)

13. Morris, J.C. (1993). The Clinical Dementia Rating (CDR): current version and scoring rules. Neurology, 43, 2412–4.

14. Sitoh YY, Lee A, Phua SY, Lieu PK, Chan SP. Bedside assessment of swallowing: a useful screening tool for dysphagia in an acute geriatric ward. Singapore medical journal. 2000 Aug 1;41(8):376-81.

15. Langmore SE, Schatz K, Olsen N. Fiberoptic endoscopic examination

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of swallowing safety: a new procedure. Dysphagia. 1988; 2:216–9.

16. Rosenbek JC, Robbins JA, Roecker EB, Coyle JL, Wood JL. A penetration-aspiration scale. Dysphagia 1996; 11:93-8.

17. Crary MA, Carnaby Mann GD, Groher ME. Initial psychometric assessment of a functional oral intake scale for dysphagia in stroke patients. Arch Phys Med Rehabil. 2005; 86:1516–20.

18. Naruishi K, Nishikawa Y, Kido JI, Fukunaga A, Nagata T. Relationship of aspiration pneumonia to cognitive impairment and oral condition: a cross-sectional study. Clinical oral investigations. 2018 Sep 1;22(7):2575-80.

19. Miarons M, Clavé P, Wijngaard R, Ortega O, Arreola V, Nascimento W, Rofes L. Pathophysiology of oropharyngeal dysphagia assessed by videofluoroscopy in patients with dementia taking antipsychotics. Journal of the American Medical Directors Association. 2018 Sep 1;19(9):812-e1.

20. Komiya K, Kadota JI. The Relationship Between the Risk of Aspiration Pneumonia and the Risk of Aspiration: Aspiration Risk and Aspiration Pneumonia Risk Are Not the Same? InAspiration Pneumonia 2020 (pp. 87-95). Springer, Singapore.

21. Muder RR (1998) Pneumonia in residents of long-term care facilities: epidemiology, etiology, management, and prevention. Am J Med 105(4):319–30. PMID: 9809694

22. Langmore SE, Olney RK, Lomen-Hoerth C, Miller BL. Dysphagia in patients with frontotemporal lobar dementia. Arch Neurol 2007; 64:58-62.

23. Goff D, Patterson J. Eating and drinking with an inflated tracheostomy cuff: a systematic review of the aspiration risk. International journal of language & communication disorders. 2019 Jan;54(1):30-40.

24. Abe M, Tanaka A, Otomo A, Yoshimura N, Kurosawa E, Nakamura Y, Ohno I, Ohrui T. Diagnosis of Aspiration Pneumonia: What Is the Definition of Aspiration Pneumonia in Clinical Practices? In Aspiration Pneumonia 2020 (pp. 27-34). Springer, Singapore.

25. Leibovitz A, Plotnikov G, Habot B, et al. Pathogenic colonization of oral flora in frail elderly patients fed by nasogastric tube or percutaneous enterogastric tube. *J Gerontol A Biol Sci Med*. 2003;58(1):52-5.

26. Van der Maarel-Wierink CD, Vanobbergen JN, Bronkhorst EM, Schols JM, de Baat C. Oral health care and aspiration pneumonia in frail older people: a systematic literature review. Gerodontology. 2013 Mar;30(1):3-9.

27. Moran C, O'Mahony S. When is feeding via a percutaneous endoscopic gastrostomy indicated? Curr. Opin. Gastroenterol. 2015, 31, 137–142.

28. Chang WK, Huang HH, Lin HH, Tsai CL. Percutaneous Endoscopic Gastrostomy versus Nasogastric Tube Feeding: Oropharyngeal Dysphagia Increases Risk for Pneumonia Requiring Hospital Admission. Nutrients. 2019 Dec;11(12):2969. doi:10.3390/nu11122969.

29. Youssef GY, Alnajjar A, Elsherbiny M. A comparison of percutaneous endoscopic gastrostomy and nasogastric tube feeding in prolonged dysphagic stroke patients. Advanced Arab

Academy of Audio-Vestibulogy Journal. 2015 Jan 1;2(1):14.

30. Castagna A, Ferrara L, Asnaghi E, Colombo V, Rega V, Fiorini G. Post-stroke dysphagia rehabilitation in the old and oldest old: outcome and relevance for discharge home. International Journal of Rehabilitation Research. 2020 Mar 1;43(1):55-61.

31. Jaafar, M.H.; Mahadeva, S.; Morgan, K.; Tan, M.P. Percutaneous endoscopic gastrostomy versus nasogastric feeding in older individuals with non-stroke dysphagia: A systematic review. J. Nutr. Health Aging 2015, 19, 190–7.

32. Ortega O, Clavé P. Oral Hygiene, Aspiration, and Aspiration Pneumonia: From Pathophysiology to Therapeutic Strategies. Curr. Phys. Med. Rehabil. Rep. 2013, 1, 292–95.

33. Manabe T, Fujikura Y, Mizukami K, Akatsu H, Kudo K. Pneumonia-associated death in patients with dementia: A systematic review and meta-analysis. PloS one. 2019 Mar 14;14(3):e0213825.

Appendix (1)
The Clinical Dementia Rating (CDR)

	e 0	Questionable 0.5	Mild 1	Moderate 2	Severe 3
Memory	No memory loss or slight; inconsistent forgetfulness	Consistent slight forgetfulness; partial recollection of events; "benign" forgetfulness	Moderate memory loss: more marked for recent events; defect interferes with everyday activity	Severe memory loss only high learned material retained new material rapidly lost	Severe memory loss only fragments remain
Orientation	Fully oriented	Fully oriented but with slight difficulty with time relationships	Moderate difficulty with time relationships; oriented for place at examination; may have Severe difficulty with time relationships; usually disoriented to time, often to place Oriented to person only geographic disorientation elsewhere	Severe difficulty with time relationships; usually disoriented to time, often to place	Oriented to person only
Judgment and problem solving	Solves everyday problems and handles business and financial affairs well; judgment good in relation to past performance	Slight impairment in solving problems, similarities and differences	Moderate difficulty in handling problems, similarities and differences; social judgment usually maintained	Severely impaired in handling problems, similarities and differences; social judgment usually impaired	Unable to make judgments or solve problems
Community affairs	Independent function as usual in job, shopping, volunteer, and social groups	Slight impairment in these activities	Unable to function independently at these activities though may still be engaged in some; appears normal to casual inspection	No pretense of independent function outside the home; appears well enough to be taken to functions outside the family home	Appears too ill to be taken to functions outside the family home
Home and hobbies	Life at home, hobbies and intellectual interests well maintained	Life at home, hobbies and intellectual interests slightly impaired	Mild but definite impairment of functions at home; more difficult chores, and complicated hobbies and interests abandoned	Only simple chores preserved; very restricted interests, poorly maintained	No significant function in the home
Personal care	Fully capable of self-care	Fully capable of self-care	Needs prompting	Requires assistance in dressing, hygiene and keeping of personal effects	Requires much help with personal care; frequent incontinence

CDR-0: no cognitive impairment
CDR-0.5: questionable or very mild dementia
CDR-1: mild
CDR-2: moderate
CDR-3: severe