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**Aspiration pneumonia in stroke survivors:
prevalence and clinical associations at Bolan Medical Complex**

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Abstract

Aspiration pneumonia is a prevalent and severe complication in stroke survivors, substantially affecting morbidity and mortality rates. Early identification of risk factors is crucial for implementing timely prevention and management strategies. We aimed to determine the prevalence and clinical associations of aspiration pneumonia in stroke patients admitted to Bolan Medical Complex Hospital, Quetta. This descriptive cross-sectional study looked at 201 stroke patients who were admitted over 6 months. Clinical, demographic, and radiological data were gathered utilizing a systematic proforma. Aspiration pneumonia occurred in 36.3% of patients. Hemiplegia was identified as the most significant independent association (odds ratio = 1.19, 95% confidence interval: 1.01-1.41, $p=0.04$). Nasogastric tube feeding was present in 77.1% of aspiration pneumonia cases. Dysphagia and dysarthria showed associations in univariate analysis but lost significance in multivariate modeling. Hospital-acquired cases exhibited elevated rates of fever, positive chest X-rays, and significant neurological impairments. Aspiration pneumonia is common among stroke patients, with motor impairments and mechanical feeding being major risk factors. Early screening and comprehensive management are crucial for decreasing its prevalence, particularly in resource-constrained environments.

Key words: aspiration pneumonia, stroke, dysphagia, hemiplegia, nasogastric tube, risk factors.

Introduction

Stroke is a leading cause of death and long-term disability worldwide [1,2]. While we know that aspiration pneumonia frequently complicates stroke recovery, the true prevalence and specific clinical patterns in resource-limited settings like Balochistan remain poorly understood. This study addresses this knowledge gap by determining the prevalence and clinical factors associated with aspiration pneumonia in stroke patients at our facility. Pneumonia is a significant concern among the numerous complications associated with stroke, affects approximately one-third of stroke patients, and significantly increases morbidity and mortality [3-5]. Studies indicate that aspiration pneumonia may be responsible for 60% of the fatalities caused by stroke, making it a serious consequence [6-8].

Post-stroke aspiration pneumonia is a condition that typically develops within seven days of a stroke and is characterized by an infection of the lower respiratory tract as a result of the aspiration of oropharyngeal or gastric contents into the airways [9,10]. Patients with stroke are at increased risk of aspiration due to a complicated pathophysiology that includes decreased swallowing and cough reflexes, endotracheal tubes, and dysfunctional cholinergic pathways [11,12].

The clinical significance of this complication in post-stroke care is underscored by recent meta-analytical data, which indicates that the global aggregated prevalence of aspiration pneumonia in individuals who have suffered a stroke is approximately 14.03% (95% CI: 12.1%–16.5%) [13]. A tertiary care center in Pakistan conducted a hospital-based study that reported a slightly higher prevalence of 15.56%, underscoring the significant regional impact. This study revealed that 28 of the 180 stroke patients developed aspiration pneumonia, underscoring the necessity of early identification and prevention strategies in local healthcare settings [6].

Effective preventative strategies against aspiration pneumonia can only be implemented once patients at high risk have been identified. Significant risk factors encompass female gender, age over 65 years, sizable stroke diameter, decreased Glasgow Coma Scale (GCS) score, dysarthria, aphasia, impaired cognition, inadequate oral hygiene, and seizures [14-16]. Moreover, conditions including hemorrhagic stroke, ischemic heart disease, diabetes mellitus, congestive heart failure, hypertension, low oxygen saturation, and pre-existing pulmonary diseases further amplify the risk by undermining the immune system and increasing the risk of aspiration [17-20].

Given the significant impact on stroke outcomes, understanding its prevalence and clinical associations is essential for developing targeted prevention strategies. This study examines these factors in stroke patients at Bolan Medical Complex Hospital, thereby enhancing evidence for clinical practice in this region.

Materials and Methods

Study design and setting

This descriptive cross-sectional study was carried out during six months from April 2024 to October 2024 in the Neurology Department of the Bolan Medical Complex (BMC) Hospital, Quetta. BMC Hospital is a tertiary care teaching facility that functions as Balochistan's principal referral centre for neurological diseases. The Bolan University of Medical and Health Sciences, Quetta, Pakistan, Institutional Review Board approved this study. All participants or their legally designated representatives provided written informed permission before inclusion.

Study population

All stroke patients of any age admitted with neuroimaging-confirmed acute stroke (ischemic or hemorrhagic) were eligible. We consecutively enrolled all stroke patients admitted to the Neurology Department during the study period.

Inclusion and exclusion criteria

Inclusion criteria:

- Patients of all ages.
- Confirmed diagnosis of acute ischemic or hemorrhagic stroke based on neuroimaging.
- Admission within 72 hours of stroke onset.

Exclusion criteria:

- Patients with pre-existing pneumonia other than Aspiration pneumonia on admission.
- History of chronic pulmonary disease (COPD, interstitial lung disease).
- Incomplete clinical or radiological records.

Data collection

A structured proforma collected demographic data (age, sex), clinical features (stroke type, Glasgow Coma Scale level, neurological impairments), and comorbidities (diabetes, hypertension). Dysphagia was assessed using standardized bedside swallowing assessment, including evaluation of cough reflex, gag reflex, and safe swallowing of test substances. Signs of aspiration pneumonia including fever, cough, sputum production, elevated total leukocyte count, and new pulmonary infiltrates on chest X-ray were documented.

Diagnostic criteria for aspiration pneumonia

Aspiration pneumonia was diagnosed based on the following criteria:

1. Clinical indicators: fever ($>37.5^{\circ}\text{C}$), cough, sputum production, or shortness of breath

2. Radiological findings: new infiltrates on chest X-ray in dependent lung zones (typically lower lobes)
3. Clinical history: documented aspiration event (witnessed, dysphagia-related, or altered consciousness)
4. Supporting laboratory findings: leukocytosis (WBC >11,000/ μ L)

While bronchoalveolar lavage (BAL) was not performed due to clinical constraints, when available, sputum cultures were obtained; organisms isolated were consistent with aspiration flora.

Statistical analysis

Data were analyzed using IBM SPSS Statistics 23.0. Categorical variables are presented as frequencies and percentages. Continuous variables are summarized as mean \pm standard deviation. Comparative analyses used chi-square tests (categorical) and t-tests (continuous variables). Multivariate logistic regression identified independent associations with variables showing $p < 0.05$ in univariate analysis. Results are presented as adjusted odds ratios with 95% confidence intervals. Statistical significance was set at $p < 0.05$.

Results

Demographic characteristics and frequency of aspiration pneumonia

The study cohort consisted of 201 stroke patients, exhibiting significant age stratification that reflects the epidemiology of stroke-related comorbidities. The majority of patients, 68.7%, were aged between 37 and 72 years, a demographic strongly linked to acute stroke incidents and comorbidities such as hypertension and diabetes. Notably, 19.4% of the population were elderly (>72 years), a demographic predisposed to aspiration due to age-related deterioration in cough reflex and swallowing coordination. A smaller subset of patients were younger (12–36 years, 11.9%), which probably included cases of uncommon early-onset stroke or predisposing factors (Table 1, *Supplementary Figure 1*).

The incidence of aspiration pneumonia in home settings was 36.3%, which is significantly higher than the 63.7% incidence in hospital settings. This contrast highlights the increased risk associated with hospitalisation, perhaps due to extended immobility, intrusive interventions (intubation), or contact with hospital-acquired microorganisms.

Clinical characteristics associated with aspiration pneumonia

Table 2 presents clinical characteristics that are categorised according to the presence of aspiration pneumonia. Dysphagia was present in the majority of aspiration pneumonia cases, highlighting poor swallowing mechanics as a key feature, consistent with its known function

in predisposing to pulmonary aspiration. Dysarthria, noted in 71.1% of affected individuals, highlights the relationship between motor speech impairments and diminished airway protection. In 77.1% of aspiration pneumonia patients, nasogastric (NG) tube feeding is employed. This method may paradoxically increase the risk by circumventing natural swallowing mechanisms, thereby reducing pharyngeal sensitivity over time. Systemic and inflammatory indicators were common, with leukocytosis (74.1%) and chest X-ray positive (53.2%) confirming the infectious consequences of aspiration. Obesity (52.2%) was identified as a significant comorbidity, presumably increasing the risk of aspiration due to diaphragmatic constriction and delayed stomach emptying. Vomiting (41.3%) and seizures (34.3%) exhibited a moderate correlation, indicating that episodic mechanisms (postictal stupor) may temporarily compromise airway protection. A smaller proportion of cases (28.4%) had fever, which in some cases indicated systemic infection.

Setting comparison: hospital vs. home acquisition

Hospital-acquired aspiration pneumonia demonstrated unique risk profiles in contrast to home-acquired patients (Table 3). Dysphagia had the most significant correlation with hospital environments (RR = 3.98, 95% CI: 2.45–6.12, $p = 0.001$), presumably indicating that the concentration of high-risk patients needs intense care. Among hospitalised cohorts, fever was disproportionately common (57.9% vs. 42.1%), with a risk ratio of 3.57 ($p = 0.001$), suggesting nosocomial pathogens or delayed diagnosis. With a power of 0-3, severe hemiplegia was associated with a higher risk of elevation (RR = 4.42, $p < 0.001$), highlighting the importance of motor impairments in affecting the role of postural modifications and coughing. The increased clinical surveillance and diagnostic rigour in hospitals likely contributed to the considerable rates of chest X-ray positivity (RR = 3.28, $p = 0.01$) and cough (RR = 2.71, $p = 0.001$). In contrast, obesity (RR = 1.52, $p = 0.15$) and seizures (RR = 1.59, $p = 0.12$) did not achieve statistical significance in this context, indicating that their effects are less dependent on the setting. Vomiting, although notable (RR = 2.62, $p = 0.001$), may indicate iatrogenic reasons (drug side effects) in hospitalised patients (*Supplementary Figures 2 and 3*).

Independent associations with aspiration pneumonia

The strongest independent predictor of aspiration pneumonia was hemiplegia, according to a multivariate logistic regression model that controlled for confounding variables ($\beta = 0.17$, SE = 0.08, $p = 0.04$) (Table 4, *Supplementary Figure 4*). Every unit increase in hemiplegia severity (on a 0–5 scale) increased aspiration risk by 18% (OR = 1.19, 95% CI: 1.01–1.41), highlighting the significant impact of motor impairment on respiratory mechanics. Dysarthria demonstrated

an unexpected inverse association ($\beta = -0.17$, $SE = 0.08$, $p = 0.04$), with a 16% lower risk compared to controls ($OR = 0.85$, 95% CI: 0.73–0.99).

The adjusted model showed that dysphagia lost significance ($\beta = 0.09$, $SE = 0.09$, $p = 0.31$), while having a substantial univariate correlation ($OR = 2.98$, 95% CI: 1.82–4.87). This was probably because of collinearity with NG tube feeding. Nasogastric tube feeding similarly did not achieve independent significance ($p = 0.90$), suggesting overlapping effects with dysphagia. Fever ($\beta = 0.16$, $SE = 0.09$, $p = 0.07$) and chest X-ray positive ($\beta = 0.13$, $SE = 0.09$, $p = 0.17$) neared significance, indicating their function as secondary markers rather than primary determinants. Insignificant predictors encompassed seizures ($\beta = 0.07$, $p = 0.40$), vomiting ($\beta = 0.02$, $p = 0.76$), and oral feeding ($\beta = -0.07$, $p = 0.37$), suggesting their influences are mediated by other variables.

Discussion

The objective of this study was to ascertain the prevalence and association of aspiration pneumonia in stroke patients who were admitted to the Bolan Medical Complex Hospital in Quetta. Our findings enhance the comprehension of this significant issue within a regional framework, providing insights that can guide local clinical practices and preventive measures. The study comprised 201 patients diagnosed with acute stroke. Of the total, 24 patients (11.9%) were between 18 to 36 years, 138 patients (68.7%) were between 37 and 72 years, and 39 patients (19.4%) were above 72 years old. Aspiration pneumonia appeared in 36.3% of patients in a home setting, while 63.7% of cases arose in a hospital context. The higher incidence in hospital settings (63.7% vs. 36.3%) likely reflects multiple hospital-specific factors. Prolonged immobility, sedating medications (e.g., antiepileptics, analgesics), and continuous NG tube feeding without periodic oral intake create an environment conducive to aspiration. Additionally, delayed consciousness recovery in hospitalized patients and increased duration of stay may compound risk. These factors are distinct from home settings where mobilization typically occurs earlier.

Our research showed that 36.3% of stroke patients developed aspiration pneumonia, which is much higher than the global average of 14.03% found in a previous meta-analysis by Kishore et al. [21]. The elevated incidence underscores both the clinical burden of aspiration pneumonia in resource-constrained environments and the pressing need for effective preventative measures in post-stroke management. Notable correlations were found between aspiration pneumonia and a number of clinical predictors. Hemiplegia was identified as the most significant independent risk factor ($OR = 1.19$, 95% CI: 1.01–1.41, $p = 0.04$). The interrelationship between these clinical variables is illustrated in *Supplementary Figure 5*. This

is consistent with prior research indicating that motor dysfunction is directly associated with diminished mobility, inadequate cough reflex, and reduced airway clearance, hence elevating the risk of aspiration [22,23]. In accordance with our findings, Hanan Farag et al. also identified immobility and poor functional status as critical contributors to pneumonia in dysphagic stroke patients [24].

Dysphagia was found in 68.2% of stroke patients in our study, indicating a close relationship between aspiration and dysphagia in stroke patients. Previous studies showed that dysphagia leads to prolonged hospital stay, poor functional outcome, and increased mortality due to its association with aspiration pneumonia [25]. The most common signs and symptoms of dysphagia include choking on food, a wet voice, and a cough after food intake. Interestingly, dysphagia was substantially linked with aspiration pneumonia in univariate analysis (OR = 2.98) but lost statistical significance in the multivariate model. This may be due to its collinearity with nasogastric (NG) tube nutrition, which was present in more than 77% of the aspiration pneumonia cohort. To address potential collinearity between dysphagia and NG tube feeding, we examined their relationship. The loss of dysphagia significance in multivariate analysis, while NG feeding remained non-significant, suggests that dysphagia's protective mechanisms (swallowing rehabilitation, oral care) may be bypassed when feeding is entirely via NG tube. Previous research has documented a contradictory association between the risk of aspiration pneumonia and the usage of NG tubes. Although NG tubes are employed to circumvent compromised swallowing, they may diminish pharyngeal reflexes, encourage pathogen colonization, and elevate reflux, therefore increasing the risk of aspiration [26-28]. Since the NGT bypasses the small amount of gastric contents through to the oropharynx, the materials can be easily aspirated into the lower airways in dysphagic patients with stroke. The mechanism is not related to the percutaneous endoscopic gastrostomy (PEG). This evidence supports the fact that NGT feeding, but not PEG, is a significant cause of aspiration pneumonia in critically ill patients. Tube feeding is the recommended safe method of feeding in stroke patients with impaired swallowing reflexes. Although the medical, social, and psychological effects of dysphagia are significant, dysphagia is often poorly diagnosed and managed. The early detection and proper management of dysphagia, including adequate nutritional management and successful swallowing rehabilitation, may help prevent malnutrition and pneumonia in stroke patients [29].

Dysarthria was noted in 77.1% of patients in our study. Contrary to predictions, dysarthria seems to have a protective impact (OR = 0.85, $p = 0.04$). This unfavorable connection may indicate sample bias or overlap with other preventative care practices in dysarthric patients, including earlier clinical intervention and adjustments in feeding methods. This conclusion, however, contradicts the results of Myszel et al., who discovered that dysarthria frequently

coexists with bulbar dysfunction and elevates the risk of aspiration [30]. The inverse association with dysarthria may reflect selection bias or unmeasured confounding. Dysarthria serves as a visible clinical marker that triggers higher nursing vigilance and more frequent swallowing precautions compared to silent aspirators who may appear clinically well. This paradoxical finding suggests that overt neurological signs may prompt earlier clinical intervention than subtle symptoms.

Fever, leukocytosis, and chest radiographic infiltrates were prevalent in patients with aspiration pneumonia, but they were not significant predictors in the adjusted model. Fever was disproportionately common (57.9% vs. 42.1%), and Systemic and inflammatory indicators were common, with leukocytosis (74.1%) and chest X-ray positive (53.2%) confirming the infectious consequences of aspiration. Aspiration is characterized in the early phase as an acute pneumonitis [31]. This inflammatory episode is often characterized by fever and leukocytosis. These findings align with prior research indicating that these indicators represent the effects rather than the origins of aspiration pneumonia [29,32,33].

Obesity was reported in 52.2% of patients with aspiration pneumonia in our study. Obesity could lead to worse outcomes in those who develop infections, perhaps as a result of dysregulation of the inflammatory cascade involving increased levels of cytokines, adiponectin, and leptin, and exaggerated macrovascular and microvascular responses. Given that obesity is associated with both an increased risk of developing pneumonia and an increased risk of total mortality, it could be assumed that obese individuals would have worse pneumonia-related outcomes. However, a few studies indicate that obesity may have a protective effect against pneumonia-related mortality. This so-called 'obesity paradox' [34-36]. Vomiting (41.3%) and seizures (34.3%) exhibited a moderate correlation with aspiration pneumonia and are very common in patients with impaired consciousness and prolonged seizures, and status epilepticus [37]. This may indicate that these factors function as secondary or interacting variables rather than primary determinants. The most important step is to control seizures early.

Our findings highlight the significance of early and focused screening for aspiration risk, especially in patients with motor deficits such as hemiplegia and those dependent on NG tube feeding. The application of structured dysphagia screening tools, prompt engagement of speech-language pathologists, rigorous oral hygiene protocols, and the evaluation of postural feeding adjustments may mitigate the incidence of aspiration pneumonia in stroke survivors, particularly in resource-limited environments.

Clinical implications

These findings translate into specific clinical actions for stroke care teams: Early Screening: Assess dysphagia and dysarthria on a regular basis within 24 hours of admission to prevent aspiration issues.

Nasogastric Tube Monitoring: For patients receiving nasogastric feeding, implement strict monitoring, including careful oral hygiene protocols, regular suctioning of oropharyngeal secretions, and head-of-bed elevation during feeding.

Patient Positioning: During feeding and for at least two hours following, keep the patient upright (30°). To avoid atelectasis, promote frequent posture changes.

Rehabilitation Integration: Assess and treat dysphagia and dysarthria by involving speech-language pathologists early on. To strengthen protective techniques, work with nursing staff to coordinate swallowing rehabilitation.

Strengths and limitations

Strengths include prospective data collection, comprehensive clinical characterization, and real-world tertiary care setting. The lack of bronchoalveolar lavage for microbiological confirmation (although sputum culture was utilized when possible) and the possibility of residual confounding inherent in observational cross-sectional design are among the limitations, which limit generalizability.

Conclusions

This research identified a significant prevalence of aspiration pneumonia in stroke survivors at Bolan Medical Complex, with hemiplegia and nasogastric tube feeding recognized as principal independent risk factors. While dysphagia demonstrated a robust association in univariate analysis, its significance decreased following adjustment, likely because of the presence of overlapping clinical variables.

In order to decrease aspiration-related consequences, these results emphasize the necessity of early risk assessment and focused interventions, such as standardized swallowing examinations and better feeding habits. In resource-constrained environments, such preventive measures can significantly enhance results and reduce the burden on healthcare systems.

Additional multicenter studies are advised to validate these findings and facilitate the development of treatment procedures customized for local healthcare settings.

References

1. Feigin VL, Brainin M, Norrving B, et al. World stroke organization: global stroke fact sheet 2025. *Int J Stroke* 2025;20:132-44.
2. GBD 2021 Forecasting Collaborators. Burden of disease scenarios for 204 countries and territories, 2022-2050: a forecasting analysis for the Global Burden of Disease Study 2021. *Lancet* 2024;403:2204-56.
3. Septianingrum Y, Sari RY, Wardani EM, et al. Stroke-associated pneumonia: risk factors and discharge status. *Nurse Media J Nurs* 2024;14:344-55.
4. Aboufotouh AM, Aziz HSA, Zein MM, et al. Bacterial stroke-associated pneumonia: microbiological analysis and mortality outcome. *BMC Neurol* 2024;24:265.
5. Getie A, Ayalneh M, Bimerew M, Wondmieneh A. Aspiration pneumonia among stroke patients in Ethiopia: systematic review and meta-analysis. *Clin Epidemiol Global Health* 2024;28:101707.
6. Khalid M, Kakar IA, Khan H, et al. Prevalence of aspiration pneumonia in stroke patients at tertiary care hospital. *Pakistan J Med Health Sci* 2022;16:569.
7. Naemullah S, Ahmad A, Saqib M, Mahmood S. A silent threat: the aspiration pneumonia in hospitalized stroke patients. *Proceedings* 2025;39:86-90.
8. Nigus MD, Sendek EM, Ewunetu MB, et al. Post stroke aspiration pneumonia, associated factors, and treatment outcome among stroke patients admitted to Tibebe Ghion Specialized Hospital, Bahir Dar, Ethiopia. *Front Stroke* 2024;3:1410657.
9. Grossmann I, Rodriguez K, Soni M, et al. Stroke and pneumonia: mechanisms, risk factors, management, and prevention. *Cureus* 2021;13:e19912.
10. Lidetu T, Muluneh EK, Wassie GT. Incidence and predictors of aspiration pneumonia among stroke patients in Western Amhara Region, North-West Ethiopia: a retrospective follow up study. *Int J Gen Med* 2023;16:1303-15.
11. Labeit B, Michou E, Hamdy S, et al. The assessment of dysphagia after stroke: state of the art and future directions. *Lancet Neurol* 2023;22:858-70.
12. Yang C, Pan Y. Risk factors of dysphagia in patients with ischemic stroke: a meta-analysis and systematic review. *PLoS One* 2022;17:e0270096.
13. Chen Y, Yang H, Wei H, et al. Stroke-associated pneumonia: a bibliometric analysis of worldwide trends from 2003 to 2020. *Medicine* 2021;100:e27321.
14. Yuan M, Li Q, Zhang R, et al. Risk factors for and impact of poststroke pneumonia in patients with acute ischemic stroke. *Medicine* 2021;100:e25213.
15. Liu ZY, Wei L, Ye RC, et al. Reducing the incidence of stroke-associated pneumonia: an evidence-based practice. *BMC Neurol* 2022;22:297.

16. Armstrong JR, Mosher BD. Aspiration pneumonia after stroke: intervention and prevention. *Neurohospitalist* 2011;1:85-93.
17. Banda KJ, Chu H, Kang XL, et al. Prevalence of dysphagia and risk of pneumonia and mortality in acute stroke patients: a meta-analysis. *BMC Geriatr* 2022;22:420.
18. Ahmad M, Ayaz Z, Sinha T, et al. Risk factors for the development of pneumonia in stroke patients: a systematic review and meta-analysis. *Cureus* 2024;16:e57077.
19. Chang MC, Choo YJ, Seo KC, Yang S. The relationship between dysphagia and pneumonia in acute stroke patients: a systematic review and meta-analysis. *Front Neurol* 2022;13:834240.
20. Essa M, Kakar A, Gulandam D, et al. Risk factors for stroke in, Bolan Medical Complex Hospital Quetta. *Pak J Neurol Sci* 2021;16:3-8.
21. Kishore AK, Vail A, Chamorro A, et al. How is pneumonia diagnosed in clinical stroke research? A systematic review and meta-analysis. *Stroke* 2015;46:1202-9.
22. Teasell R, Foley N, Martino R, et al. Dysphagia and aspiration following stroke. 2013. Available from: <http://www.ebrsr.com/sites/default/files/v18-SREBR-CH15-NET.pdf>.
23. Racca F, Vianello A, Mongini T, et al. Practical approach to respiratory emergencies in neurological diseases. *Neurol Sci* 2020;41:497-508.
24. Mohamed HF, Mohamed NT, Beshay BN, Morsy HHM. Risk factors of post stroke pulmonary infection in the critically ill patients. *Alexandria Sci Nurs J* 2025;27:159-69.
25. Marin S, Serra-Prat M, Ortega O, Clavé P. Healthcare-related cost of oropharyngeal dysphagia and its complications pneumonia and malnutrition after stroke: a systematic review. *BMJ Open* 2020;10:e031629.
26. Elmahdi A, Eisa M, Omer E. Aspiration pneumonia in enteral feeding: a review on risks and prevention. *Nutr Clin Pract* 2023;38:1247-52.
27. Rabaut J, Thirugnanachandran T, Singhal S, et al. Clinical outcomes and patient safety of nasogastric tube in acute stroke patients. *Dysphagia* 2022;37:1732-9.
28. Wang HH, Wu MT, Lee CL, et al. Pneumonia in elderly patients with nasogastric tubes: factors to consider. *Int J Gerontol* 2025;19:39-44.
29. Eltringham SA, Kilner K, Gee M, et al. Impact of dysphagia assessment and management on risk of stroke-associated pneumonia: a systematic review. *Cerebrovasc Dis* 2018;46:97-105.
30. Myszel K, Skarzynski PH. Medical conditions associated with concurrent dysphagia and dysphonia. In: *Navigating swallowing disorders - from symptoms to solutions*. Singh Gendeh H (ed.). London, UK: IntechOpen.
31. Sanivarapu RR, Vaqar S, Gibson J, Overmeyer KA. *Aspiration pneumonia (nursing)*. Treasure Island, FL, USA: StatPearls Publishing; 2024.

32. Son YG, Shin J, Ryu HG. Pneumonitis and pneumonia after aspiration. *J Dent Anesth Pain Med* 2017;17:1-12.
33. Wang J, Wang P, Shen Z, et al. Innovative nomogram for predictive risk stratification of aspiration pneumonia in post-stroke dysphagia patients. *Front Neurol* 2025;16:1556541.
34. Kahlon S, Eurich D, Padwal R, et al. Obesity and outcomes in patients hospitalized with pneumonia. *Clin Microbiol Infect* 2013;19:709-16.
35. Gacouin A, Maamar A, Terzi N, Tadié J-M. Association of obesity on short-and long-term survival in patients with moderate to severe pneumonia-related ARDS: a retrospective cohort study. *BMC Pulm Med* 2025;25:153.
36. Nie W, Zhang Y, Jee SH, et al. Obesity survival paradox in pneumonia: a meta-analysis. *BMC Med* 2014;12:61.
37. DiBardino DM, Wunderink RG. Aspiration pneumonia: a review of modern trends. *J Crit Care* 2015;30:40-8.

Online supplementary material

Supplementary Figure 1. Age distribution of stroke patients and frequency of aspiration pneumonia by clinical setting.

Supplementary Figure 2. Comparison of clinical characteristics and distribution of aspiration pneumonia by setting.

Supplementary Figure 3. Univariate analysis of factors associated with aspiration pneumonia (risk ratios with 95% confidence intervals).

Supplementary Figure 4. Impact of comorbidities or preventive interventions on aspiration pneumonia risk in stroke patients.

Supplementary Figure 5. Relationship between clinical variables and aspiration pneumonia (chord diagram).

Table 1. Demographic characteristics and aspiration pneumonia frequency.

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	12–36	24	11.9
	37–72	138	68.7
	>72	39	19.4
Aspiration pneumonia setting	At Home	73	36.3
	At Hospital	128	63.7

Table 2. Clinical characteristics and statistical associations with aspiration pneumonia.

Clinical Characteristic	With AP (%)	Without AP (%)	P-Value	Significance
Dysphagia	137 (68.2)	64 (31.8)	<0.001	***
Dysarthria	143 (71.1)	58 (28.9)	0.002	**
NG Tube Feeding	155 (77.1)	47 (22.9)	<0.001	***
Leukocytosis	149 (74.1)	52 (25.9)	<0.001	***
Shortness of Breath	109 (54.2)	92 (45.8)	0.003	**
Cough	104 (51.7)	97 (48.3)	0.001	**
Chest X-ray Positive	107 (53.2)	94 (46.8)	0.006	**
Vomiting	83 (41.3)	118 (58.7)	0.07	ns
Seizures	69 (34.3)	132 (65.7)	0.15	ns
Obesity	105 (52.2)	96 (47.8)	0.18	ns
Fever (37.5°C)	57 (28.4)	144 (71.6)	0.08	ns
Oral Feeding	141 (70.1)	60 (29.9)	0.09	ns

Bold rows indicate statistically significant associations ($p < 0.05$). AP, Aspiration Pneumonia; ns, not significant; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 3. Setting comparison – hospital vs. home acquisition of aspiration pneumonia.

Variable	Home (%)	Hospital (%)	RR (95% CI)	P-Value
Dysphagia	62 (45.3)	75 (54.7)	3.98	<0.001
Fever (37.5°C)	33 (57.9)	24 (42.1)	3.57	0.001
Severe Hemiplegia (Power 0-3)	51 (53.7)	44 (46.3)	4.42	<0.001
Cough	49 (47.1)	55 (52.9)	2.71	0.001
Chest X-ray Positive	52 (48.6)	55 (51.4)	3.28	0.01
Vomiting	41 (49.4)	42 (50.6)	2.62	0.001
Seizures	30 (43.5)	39 (56.5)	1.59	0.12
Obesity	43 (41.0)	62 (59.0)	1.52	0.15

RR, Risk Ratio; CI, Confidence Interval

Table 4. Multivariate logistic regression analysis – independent associations with aspiration pneumonia.

Variable	Coef (B)	SE	OR (95% CI)	P-Value	Significance
Hemiplegia (per unit)	0.17	0.08	1.19 (1.01–1.41)	0.04	*
Dysarthria	-0.17	0.08	0.85 (0.73–0.99)	0.04	*
Dysphagia	0.09	0.09	1.09 (0.92–1.31)	0.31	ns
NG Tube Feeding	0.01	0.09	1.01 (0.85–1.20)	0.90	ns
Fever	0.16	0.09	1.17 (0.98–1.41)	0.07	ns
Chest X-ray Positive	0.13	0.09	1.14 (0.96–1.35)	0.17	ns
Seizures	0.07	0.08	1.07 (0.91–1.26)	0.40	ns
Vomiting	0.02	0.08	1.02 (0.88–1.19)	0.76	ns
GCS Score	0.02	0.05	1.02 (0.93–1.12)	0.63	ns

Coef, Coefficient; SE, Standard Error; OR, Odds Ratio; CI, Confidence Interval; ns, not significant; * $p < 0.05$