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Increasing stroke severity is associated with increased risk of aspiration pneumonia: The risk is higher in medical ward compared to stroke ward

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Increasing stroke severity is associated with increased risk of aspiration pneumonia: The risk is higher in medical ward compared to stroke ward

Running Title: Risk factors associated with aspiration pneumonia

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Abstract

Objective: We examined the incidence, clinical characteristics, and outcomes among ischemic stroke-related aspiration pneumonia patients in Qatar.

Methods: A prospective cohort study was analyzed retrospectively from January 2014 to April 2024. A total of 9,197 patients were included.

Results: Stroke patients who developed aspiration pneumonia tended to be older and of the male sex. Patients who developed aspiration pneumonia were also more likely to present with a higher NIHSS at admission (p<0.001). Patients with large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke of undetermined etiology were more likely to develop aspiration pneumonia. They also stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia (16.0 vs. 5.3 days). Patients admitted to the medicine ward had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward (aOR of 1.56, 95% confidence interval: 1.05–2.31). Patients with aspiration pneumonia had unfavorable outcome (mRS 3-6) at 90 days (74.6% vs. 30.4% for an NIHSS admission score of 5-9 and 79.6% vs. 59.5% for an NIHSS admission >10). They were also more likely to have higher mortality rates at 90 days (16.9% vs. 1.9% for an NIHSS admission score of 5-9 and 22.3% vs. 13.8% for an NIHSS admission score >10) and MACE at 1 year (23.7% vs. 3.8% for an NIHSS admission score of 5-9 and 27.5% vs. 16.2% for NIHSS >10).

Conclusion: Age, sex, admission NIHSS severity, stroke subtypes, and admission location are independent predictors of aspiration pneumonia post-stroke.

Keywords: Aspiration Pneumonia, Stroke, Dysphagia, Stroke-associated pneumonia

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What is already known on this topic: Aspiration pneumonia is a common complication poststroke that increases patient's duration of stay in hospitals and affects their prognosis post-stroke. However, there is very little data on the incidence, causes, and outcomes of aspiration pneumonia from the Middle East and North Africa (MENA) region.

What this study adds: This is the first study to specifically examine the incidence and outcomes of patients who develop aspiration pneumonia post-stroke in the MENA region. Patients with aspiration pneumonia stayed an average of 10 days longer in the hospital compared to patients without. A higher proportion of patients with aspiration pneumonia had an unfavorable outcome at 90 days. They were also more likely to have higher mortality rates at 90 days and MACE at 1 year. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward.

How this study might affect research, practice or policy: Our study demonstrates that admission location is a significant predictor of aspiration pneumonia post-stroke. Healthcare providers should be judicious of the placement of their stroke patients to reduce the incidence of aspiration pneumonia.

Introduction

Stroke is a major cause of death and disability worldwide. Early in the course of the disease, stroke patients are at risk for medical complications including dysphagia and aspiration pneumonia.¹ Dysphagia is characterized by difficulty swallowing due to weakness/reduced coordination between facial, palatal, and pharyngeal muscles (due to reduced cortical connectivity between neural regions post-stroke).² The incidence of dysphagia after stroke ranges from 8.1–80%,^{3–7} it is frequently silent and it is highly associated with aspiration pneumonia.⁸ Dysphagia causes oral or gastric contents to enter the lung, which suppresses the natural defenses of the respiratory system, increasing the risks for opportunistic infections.^{9–11} Several studies have identified multiple risk factors associated with aspiration pneumonia, such as reduced level of consciousness, incorrect postures, and advanced age.^{12–15}

Pneumonia is one of the leading causes of mortality for acute stroke, with a 30-day mortality rate of up to 30%.¹⁶ Aspiration pneumonia also increases the risk of prolonged hospital stay and poor prognosis.¹⁷ Animal and clinical studies have demonstrated that silent aspiration (micro-aspiration due to dysphagia during the night) is the primary cause of aspiration pneumonia.¹⁸ Despite different preventative and therapeutic approaches for managing patients with aspiration pneumonia, its incidence and mortality rates remain high.¹⁹ For example, in a case-control study comprising of 1,112,944 patients, Gupte et al²⁰ reported that aspiration pneumonia due to cerebrovascular disease accounted for 11.7% of deaths in the United States (62,068 deaths per year from 1999 to 2017), with increasing mortality rates since 2009. In countries such as Egypt and Brazil, the incidence of aspiration pneumonia can be as high as 44% and 76%, respectively.^{19,21}

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There are very few studies on the incidence, causes, and outcomes of aspiration pneumonia from the Middle East and North Africa (MENA) region.²² This study aimed to assess the clinical characteristics and treatment outcomes among stroke-related aspiration pneumonia patients in Qatar.

Methods

Data from patients admitted with a stroke to Hamad General Hospital (HGH), Doha, Qatar from January 2014 through April 2024 were analyzed from a hospital based prospective stroke registry. HGH is a Joint Commission International (JCI) accredited 600-bed hospital, with 200 beds reserved for medical patients. It is the only tertiary care medical facility in Qatar where the stroke service is located, 95% of all strokes in Qatar requiring admission to hospital are admitted to HGH.

Ethics Considerations

The studies involving humans were approved by the Institutional Review Board of the Medical Research Centre at Hamad Medical Corporation (MRC-01-18-102). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Patient characteristics

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Patient characteristics including age, sex, ethnicity, medical comorbidities and prior medication were collected in the Stroke Registry. National Institute of Health Stroke Scale (NIHSS) score, neuroimaging data, and post-discharge disposition were entered into the registry as well. Ischemic stroke was diagnosed according to the WHO criteria²³ and stroke subtypes were defined by the TOAST criteria.²⁴ The modified Rankin scale (mRS) measurements were done at discharge and at 90 days following onset of symptoms. The patients were classified as favourable (mRS \leq 0-2) or unfavourable (mRS 3-6) outcome. We used the dichotomized mRS scale to evaluate recovery at 90 days.²⁵

Diabetes was diagnosed according to the American diabetes Association (ADA) and WHO recommendation²⁶ and included patients with a previous diagnosis of diabetes, on medication for diabetes or an HbA1c of more than 6.5%, and the diagnosis of pre-diabetes was based on an HbA1c of 5.7-6.4% as per the 2015 ADA clinical practice recommendations. Hypertension was defined as systolic blood pressure (BP) \geq 140 mm Hg or a diastolic pressure \geq 90 mm Hg, or on current treatment with antihypertensive drugs. Dyslipidemia was defined as low-density lipoprotein-cholesterol level \geq 3.62 mmol/L, high-density lipoprotein cholesterol level \leq 1.03 mmol/L, triglycerides \geq 1.69 mmol/L, or current treatment with a cholesterollowering drug.

Data Collection

Upon identification and confirmation of diagnosis using the International Classification of Disease, 10th edition, definitions (H34.1, 163.x, 164.x, 161.x, 160.x, G45.x), patients' data were collected by trained stroke clinical nurse specialists.

Data Analysis and statistics

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Descriptive results for all continuous variables were reported as mean±standard deviation (SD) for normally distributed data or median with range for data with non-normal distributions. The distribution of continuous variables was assessed before using statistical tools. Mean level comparisons between patients with aspiration pneumonia versus without aspiration pneumonia were assessed using ANOVA test and multiple comparisons were performed using Bonferroni correction. If an assumption of an ANOVA test was failed, then an alternative non-parametric Kruskal Wallis test was performed. Pearson Chi-Square test and Fisher's Exact test were performed whenever appropriate to compare the proportion of all categorical variables between the groups. Multiple logistic regression analysis was performed to assess for risk factors associated with aspiration pneumonia after selecting important and significant variables at univariate analysis. Odds ratio (OR) and the 95% confidence interval for the OR were reported. A p-value of ≤ 0.05 (two-tailed) was considered significant. SPSS statistical package 29.0.1.0 iez was used for the analysis.

Results

Patient Characteristics

A total of 9197 patients were enrolled: 380 developed aspiration pneumonia (4.1%) during hospitalization while 8817 (95.9%) of the patients did not have pneumonia. The mean age of patients was 55.3±13.4 years, with patients with aspiration pneumonia being significantly older than healthy controls (p < 0.001). 80% were male, 57% had diabetes mellitus, 72% had hypertension, 46% had dyslipidemia, and 24% were active smokers. The high proportion of men is reflective of the very high male expatriate population as previously reported.²⁷ A summary of patients' baseline characteristics is outlined in Table 1.

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Since 95.9% of our patients did not have aspiration pneumonia, we performed subanalyses on clinical outcomes based on patients' admission NIHSS scores. Sub-analyses were performed for patients with an NIHSS of 5-9 (moderate stroke) and NIHSS >10 (severe stroke) (Table S1).

Mode of transport

Mode of transport was significantly associated with aspiration pneumonia risks (p<0.001). However, this was only significant for emergency medical services (EMS) versus non-medical services (p<0.001), with a higher proportion of patients developing aspiration pneumonia via EMS (4.5%) versus non-medical services (1.5%). Patients transported with EMS had a significantly higher NIHSS at admission (5.9±6.1 vs. 3.3±3.7, p<0.001). The total sample size for EMS was 6361 versus 2234 for non-medical services.

Onset Duration

Duration of stroke symptoms from the time of onset to evaluation was significantly associated with aspiration pneumonia (p<0.001). This was only significant for <4.5 hours vs. >24 hours (p<0.001) and 4.5-24 hours vs. >24 hours (p<0.001). A stroke onset to emergency evaluation of <4.5 hours had the highest proportion of aspiration pneumonia (5.7%) versus 4.8% for onset duration of 4.5-24 hours and 2.1% for >24 hours (Table S2).

Duration of stay in Emergency Department

Duration of stay in the ED was not significantly associated with aspiration pneumonia (p=0.11) (Table S2). Furthermore, when we analyzed duration of stay in the ED based on NIHSS scores (5-9 and >10), duration of stay in the ED remained non-significant (p=0.052 and 0.09), respectively (Table S1).

Diagnosis

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Stroke diagnosis is shown in Table S2. Overall, type of stroke was significantly associated with aspiration pneumonia (p<0.001). Further analyses revealed that the risk of developing aspiration pneumonia was not significantly different between large vessel disease versus cardioembolic stroke (p=1.00), large vessel disease versus stroke of undetermined aetiology (p=1.00), cardioembolic stroke versus stroke of determined aetiology (p=0.06), cardioembolic stroke versus stroke of undetermined etiology (p=1.00), and stroke of determined aetiology versus stroke of undetermined aetiology (p=0.82).

Patients with small vessel disease had the lowest proportions of aspiration pneumonia (0.8%) compared to large vessel disease (7.4%), cardioembolic stroke (7.3%), stroke of determined etiology (4.8%), and stroke of undetermined etiology (6.8%), p<0.001 (Table 2). *Admission NIHSS Score*

Admission NIHSS score was significantly associated with aspiration pneumonia (p<0.001). Fisher's exact test revealed that there was a significant association between aspiration pneumonia for patients with an NIHSS score of 0-4 (p=0.03), and NIHSS score of >10, p<0.001 (Table S3). Patients with an NIHSS > 10 had the highest proportion of aspiration pneumonia (16.5%). Moreover, patients with an NIHSS >10 and concomitant aspiration pneumonia had higher rates of mortality at 90 days (22.3%) when compared to patients with an NIHSS score of 5-9 and concomitant aspiration pneumonia (16.9%) (p<0.001) (Table S1). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table S1). In patients with aspiration pneumonia, patients with an NIHSS >10 also had higher rates of major adverse cardiovascular events (MACE) at 1 year compared to patients with an NIHSS of 5-9 (27.5% vs. 23.7%, p<0.001).

Length of stay

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Patients with aspiration pneumonia stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia (16.0 days vs. 5.3 days, p=0.00). When analyzed via admission NIHSS severity, patients with aspiration pneumonia stayed significantly longer in the hospital compared to those without aspiration pneumonia (17.1 days vs. 5.9 days, p<0.001 for NIHSS of 5-9, and 16.6 days vs. 9.2 days, p<0.001 for NIHSS > 10).

Admission Location

Overall, 3966 (75.1%) patients were admitted to the stroke ward and 1318 (24.9%) patients were admitted to the medical ward. A higher proportion of patients admitted to the medicine ward developed aspiration pneumonia in contrast to patients admitted to the stroke ward (5.3% vs 3.7%, p=0.01) (Table 2). 2.3% of patients with an NIHSS of 0-4 and admitted to the medicine ward developed aspiration pneumonia compared to 1.2% of patients with an NIHSS of 0-4 and admitted to the stroke ward (p=0.03) (Table S3). Similarly, 19.9% of patients with an NIHSS >10 and admitted to the stroke ward (p<0.001) (Figure 1).

Modified Rankin Scale at 90 days

A higher proportion of patients with aspiration pneumonia had an unfavorable outcome (mRS 3-6) at 90 days compared to patients without aspiration pneumonia (74.6% vs. 30.4% for NIHSS of 5-9), p<0.001 (Table S1). Similar observations were seen for NIHSS > 10 (79.6% vs. 59.5%, p<0.001). Figure 2a and 2b illustrates the proportion of mRS at 90 days based on NIHSS admission scores.

Mortality at 90 days

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For patients with an NIHSS score of 5-9, a higher proportion of patients with aspiration pneumonia died at 90 days (16.9%) compared to patients without aspiration pneumonia (1.9%), p<0.001. Similar observations were seen for NIHSS > 10 (22.3% vs. 13.8%, p=0.003).

Multivariate analysis for risk factors associated with aspiration pneumonia

Table 2 describes a multiple binary logistic regression model to identify significant independent factors associated with the development of aspiration pneumonia after selecting important and significant variables at bivariate analysis. Males were more likely than females to have aspiration pneumonia risks [aOR 1.56, 95% CI: 1.05-2.32, p=0.03]. Age was significantly associated with aspiration pneumonia [aOR 1.02, 95% CI: 1.01-1.03, p=0.002], with patients with aspiration pneumonia being significantly older (p<0.001). Large vessel disease was significantly associated with aspiration pneumonia [aOR 4.11, 95% CI: 2.52-6.69, p<0.001]. Similar observations were seen for cardioembolic stroke (p<0.001), stroke of determined aetiology (p<0.001), and stroke of undetermined aetiology (p<0.001), see Table 2. Patients with an NIHSS score of 5–9 and >10 also had high odds of developing aspiration pneumonia (aOR of 1.87 and 5.98, respectively). Patients admitted to the medicine ward also had 1.56 times the odds of developing aspiration pneumonia compared to the stroke ward (95% CI: 1.05-2.31, p=0.03). A forest plot of the multivariate analysis can be seen in Figure 4.

Discussion

To the best of our knowledge, this is the first study to specifically examine the incidence and outcomes of patients who develop aspiration pneumonia post-stroke in the MENA region. In our cohort, 4.1% of our patients developed aspiration pneumonia post stroke. This low number may be deceiving as the majority of patients admitted had mild symptoms [5626 (61.2%) of patients had an NIHSS of <4]. The odds of aspiration pneumonia was 1.87 in patients with

admission NIHSS of 5-9 (n=1965), increasing to 5.98 in patients with NIHSS of 10 or more (n=1606). Patients with aspiration pneumonia also stayed an average of 10 days longer in the hospital compared to patients without. A higher proportion of patients with aspiration pneumonia had an unfavorable outcome at 90 days. They were also more likely to have higher mortality rates at 90 days and MACE at 1 year. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward.

High NIHSS has also been shown to be correlated with increased rates of dysphagia and aspiration pneumonia due to stroke severity.²⁸ Patients with aspiration pneumonia in the Qatar dataset had comparatively higher NIHSS at presentation as compared to patients without pneumonia (14.7 v 5.1, p<0.001). Garavelli et al²⁹ demonstrated that an NIHSS cut-off of \geq 10.5 was associated with higher rates of dysphagia (p=0.014) and aspiration pneumonia (p=0.006). Similarly, Jeyaseelan et al²⁸ demonstrated NIHSS > 9 as being moderately predictive of clinically relevant dysphagia, with dysphagia rates increasing with greater NIHSS scores (p<0.001). Okubo et al³⁰ also showed an NIHSS cut-off of 12 sensitive for dysphagia detection, with 14 (87.5%) of the 16 patients with dysphagia having NIHSS scores \geq 12 and 2 (12.5%) patients having scores of 10 and 11. NIHSS >12 also has an independent association with persistent dysphagia at hospital discharge in acute ischemic stroke patients with dysphagia at stroke onset, with one of its sub-components–dysarthria–emerging as a significant independent predictor of prolonged dysphagia.³¹ In our current study, the odds of developing aspiration pneumonia increased as NIHSS score increased.

Several studies have reported the adverse outcomes of aspiration pneumonia on stroke patients. In a study comprised of 610,668 stroke patients, Barlas et al³² reported that patients with

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stroke-associated pneumonia (SAP) had significantly higher odds of in-hospital mortality (OR of 2.90, 95% CI: 2.83–2.96), and longer length of stay (OR 13.11, 95% CI: 12.83–13.40). While they analyzed data from both ischemic and hemorrhagic strokes, patients with ischemic stroke were more likely to die in hospital and experience long length of stay (LOS).³² Teh et al³³ had similar observations in his cohort of 9238 patients from the UK. SAP was found in 1083 (11.7%) patients, out of which 60.8% were aspiration pneumonia.³³ After controlling for confounders, SAP was found to be associated with increased mortality up to 1 year (inpatient, 90-day, 1 year), prolonged LOS, and poor functional outcome on discharge.³³ In our current study, patients who developed aspiration pneumonia with an admission NIHSS of 5-9 had a 16.9% mortality rate at 90 days in contrast to 1.9% for patients who did not develop aspiration pneumonia. Similarly, patients who developed aspiration pneumonia with an admission NIHSS >10 had higher mortality rates at 90 days (22.3% vs. 13.8%, p=0.003).

Dysphagia is a common feature of severe stroke and an indicator of poor prognosis. It is implicated in the development of aspiration pneumonia, and it results in longer LOS and increased mortality. In stroke patients with dysphagia, early nutritional support is vital, and the decision to initiate that depends on the outcome of the swallow study.³⁴ Multiple national and international guidelines recommend that people with acute stroke have their swallowing screened by a trained healthcare professional by utilizing a validated screening tool and that the patients remain nothing per oral (NPO) until a swallow screen is performed.¹⁷ Bedside swallow screening tools include the functional bedside aspiration screen (FBAS), GLOBE-3S (the Sapienza GLObal Bedside Evaluation of Swallowing after Stroke), water swallowing test, volume-viscosity swallow test, and the Gugging swallow screen. However, despite these recommendations, in our study 34.6% of patients did not undergo swallow screen prior to PO

intake in the ED and 32.7% patient did not have SLP assessment within 24 hours of admission. Likely explanations for these findings include ED nursing inadvertently giving patients PO medications, or SLPs not being available over the weekend, hence leading to an inability to perform assessment within 24 hours of presentation.

Similar to previous reports, we observed a significantly higher risk of aspiration pneumonia in the patients admitted to the medical ward compared to the stroke ward (5.3% vs. 3.7%, p=0.01). Admission to the stroke ward, by prevention of medical complications, results in reduced length of stay, decreased incidence of complications, improved prognosis at discharge and at 90 days (higher % of mRS scores of 0-2).^{35,36} Similarly, in our current study, fewer patients developed aspiration pneumonia if they were admitted to the stroke ward versus medicine ward (3.7% vs. 5.3%, p=0.01). Multivariable logistic regression identified admission location as an independent predictor of aspiration pneumonia, with patients admitted to the medicine ward having higher risks of developing aspiration pneumonia (aOR 1.56, 95% CI: 1.05-2.31). In our study population, we also observed that 19.9% patients with an NIHSS >10 and admitted to the medicine ward developed aspiration pneumonia in contrast to patients with an NIHSS > 10 and admitted to the stroke ward (9.9%; p<0.001). Thus, healthcare providers should be judicious of the placement of their stroke patients if they would like to reduce the incidence of aspiration pneumonia.

We also observed that patients with small vessel disease or subcortical stroke were less likely to develop aspiration pneumonia in contrast to patients with cardioembolic stroke, large vessel disease, stroke of undetermined etiology, and stroke of determined etiology. This is consistent with Alberts et al's study, who reported a low occurrence of aspiration in small vessel infarcts compared to those with both large- and small vessel infarcts (p=0.002).³⁷ Similarly,

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Jitpratoom et al³⁸ observed that 40.7% of their patients with cardioembolic stroke developed aspiration pneumonia in contrast to 11.1% for small vessel occlusion. Multivariable logistic regression analysis revealed that type of stroke was an independent predictor of aspiration pneumonia, specifically for large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke of undetermined etiology. A potential explanation for this is that patients with small vessel disease have milder stroke symptoms and fewer neurological deficits in contrast to the other stroke subtypes,³⁹ therefore they might have more preserve/control of their facial, palatal, and pharyngal muscles, reducing their risks of developing dysphagia and aspiration pneumonia. However, additional studies are needed to unravel this relationship.

There are several limitations with our study. Our patient sample is comprised of largely Middle Eastern ethnicity (Qatari, Arabs), South Asian and Far Eastern (Asians) (97.7% vs. 2.3% for Caucasians), therefore lacks generalizability. We also had missing data for the mRS score at 90 days for 1846 patients (out of 9197). Since Qatar's population is comprised mainly of expatriate workers, it is not possible to collect data for patients who may have moved back to their home country once their work contract ended.

Conclusion

This large study in prospectively collected patients with acute stroke identified multiple factors associated with an increased risk of aspiration pneumonia. Patients who developed aspiration pneumonia were older, presented with more severe neurological symptoms, and stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia. Patients with large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke of undetermined etiology were more likely to develop aspiration pneumonia. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in

contrast to patients admitted to the stroke ward. Our study showed that aspiration pneumonia was associated with an unfavorable prognosis (mRS 3-6) and increased mortality at 90 days in patients with moderate and severe symptoms.

Data Availability Statement

The Qatar Stroke Registry dataset will be available on reasonable request to the

corresponding author.

Declaration of conflicting interests

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References

- 1. 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. doi:10.3389/fneur.2022.834240
- 2. Teasell R, Foley N, Martino R, et al. Dysphagia and Aspiration Following Stroke.
- 3. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. *Stroke*. 2005;36(12):2756-2763. doi:10.1161/01.STR.0000190056.76543.eb
- 4. Meng PP, Zhang SC, Han C, Wang Q, Bai GT, Yue SW. The Occurrence Rate of Swallowing Disorders After Stroke Patients in Asia: A PRISMA-Compliant Systematic Review and Meta-Analysis. *J Stroke Cerebrovasc Dis*. 2020;29(10):105113. doi:10.1016/j.jstrokecerebrovasdis.2020.105113
- 5. Takizawa C, Gemmell E, Kenworthy J, Speyer R. A Systematic Review of the Prevalence of Oropharyngeal Dysphagia in Stroke, Parkinson's Disease, Alzheimer's Disease, Head Injury, and Pneumonia. *Dysphagia*. 2016;31(3):434-441. doi:10.1007/s00455-016-9695-9
- 6. Avan A, Digaleh H, Di Napoli M, et al. Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: an ecological analysis from the Global Burden of Disease Study 2017. *BMC Med.* 2019;17(1):191. doi:10.1186/s12916-019-1397-3
- Cohen DL, Roffe C, Beavan J, et al. Post-stroke dysphagia: A review and design considerations for future trials. *Int J Stroke*. 2016;11(4):399-411. doi:10.1177/1747493016639057

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 Banda KJ, Chu H, Kang XL, et al. Prevalence of dysphagia and risk of pneumonia and mortality in acute stroke patients: a meta-analysis. <i>BMC Geriatr</i>. 2022;22:420. doi:10.1186/s12877-022-02960-5 Son YG, Shin J, Ryu HG. Pneumonitis and pneumonia after aspiration. <i>J Dent Anesth Patende</i>. 2017;17(1):1-12. doi:10.17245/jdapm.2017.17.1.1 Hu X, Yi ES, Ryu JH. Aspiration-Related Deaths in 57 Consecutive Patients: Autopsy St. <i>PLoS One</i>. 2014;9(7):e103795. doi:10.1371/journal.pone.0103795 Makhnevich A, Feldhamer KH, Kast CL, Sinvani L. Aspiration Pneumonia in Older Adv. <i>J Hosp Med</i>. 2019;14(7):429-435. doi:10.12788/jhm.3154 Schallom M, Dykeman B, Metheny N, Kirby J, Pierce J. Head-of-bed elevation and early outcomes of gastric reflux, aspiration and pressure ulcers: a feasibility study. <i>Am J Crit C</i> 2015;24(1):57-66. doi:10.4037/ajcc2015781 Metheny NA. Risk factors for aspiration. <i>JPENJ Parenter Enteral Nutr</i>. 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605 Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with st in Northeast Nigeria. <i>International Journal of Stroke</i>. 2013;8(4):E16-E16. doi:10.1111/jis.12095 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel)</i>. 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i>. 2003;60(4):620-625. doi:10.1212/01.wnl.000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic for a present
 Son YG, Shin J, Ryu HG. Pneumonitis and pneumonia after aspiration. <i>J Dent Anesth PacMed</i>. 2017;17(1):1-12. doi:10.17245/jdapm.2017.17.1.1 Hu X, Yi ES, Ryu JH. Aspiration-Related Deaths in 57 Consecutive Patients: Autopsy St <i>PLoS One</i>. 2014;9(7):e103795. doi:10.1371/journal.pone.0103795 Makhnevich A, Feldhamer KH, Kast CL, Sinvani L. Aspiration Pneumonia in Older Adu <i>J Hosp Med</i>. 2019;14(7):429-435. doi:10.12788/jhm.3154 Schallom M, Dykeman B, Metheny N, Kirby J, Pierce J. Head-of-bed elevation and early outcomes of gastric reflux, aspiration and pressure ulcers: a feasibility study. <i>Am J Crit C</i> 2015;24(1):57-66. doi:10.4037/ajcc2015781 Metheny NA. Risk factors for aspiration. <i>JPEN J Parenter Enteral Nutr</i>. 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605 Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with st in Northeast Nigeria. <i>International Journal of Stroke</i>. 2013;8(4):E16-E16. doi:10.1111/jij.12095 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel)</i>. 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i>. 2003;60(4):620-625. doi:10.1212/01.wnl.000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutical of a current definition, epidemiology, animal models and a novel therapeutical of a current definition, epidemiology, animal models and a novel therapeutical of a current definition and an angle and a novel therapeutical
 Hu X, Yi ES, Ryu JH. Aspiration-Related Deaths in 57 Consecutive Patients: Autopsy St <i>PLoS One</i>. 2014;9(7):e103795. doi:10.1371/journal.pone.0103795 Makhnevich A, Feldhamer KH, Kast CL, Sinvani L. Aspiration Pneumonia in Older Adu <i>J Hosp Med</i>. 2019;14(7):429-435. doi:10.12788/jhm.3154 Schallom M, Dykeman B, Metheny N, Kirby J, Pierce J. Head-of-bed elevation and early outcomes of gastric reflux, aspiration and pressure ulcers: a feasibility study. <i>Am J Crit C</i> 2015;24(1):57-66. doi:10.4037/ajcc2015781 Metheny NA. Risk factors for aspiration. <i>JPEN J Parenter Enteral Nutr</i>. 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605 Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with st in Northeast Nigeria. <i>International Journal of Stroke</i>. 2013;8(4):E16-E16. doi:10.1111/ijs.12095 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel)</i>. 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i>. 2003;60(4):620-625. doi:10.1212/01.wnl.000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutor of the stroke of the strok
 Makhnevich A, Feldhamer KH, Kast CL, Sinvani L. Aspiration Pneumonia in Older Adu <i>J Hosp Med.</i> 2019;14(7):429-435. doi:10.12788/jhm.3154 Schallom M, Dykeman B, Metheny N, Kirby J, Pierce J. Head-of-bed elevation and early outcomes of gastric reflux, aspiration and pressure ulcers: a feasibility study. <i>Am J Crit C</i> 2015;24(1):57-66. doi:10.4037/ajcc2015781 Metheny NA. Risk factors for aspiration. <i>JPEN J Parenter Enteral Nutr</i>. 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605 Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with st in Northeast Nigeria. <i>International Journal of Stroke</i>. 2013;8(4):E16-E16. doi:10.1111/ijs.12095 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel)</i>. 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i>. 2003;60(4):620-625. doi:10.1212/01.wnl.000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic and the function of the pressociated Pneumonia on and Risk of Stroke-Associated Pneumonia on and store of the pressociated Pneumonia on an order of the pressociated Pneumonia on Pressociated Pneumonia
 Schallom M, Dykeman B, Metheny N, Kirby J, Pierce J. Head-of-bed elevation and early outcomes of gastric reflux, aspiration and pressure ulcers: a feasibility study. <i>Am J Crit C</i> 2015;24(1):57-66. doi:10.4037/ajcc2015781 Metheny NA. Risk factors for aspiration. <i>JPEN J Parenter Enteral Nutr.</i> 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605 Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with st in Northeast Nigeria. <i>International Journal of Stroke.</i> 2013;8(4):E16-E16. doi:10.1111/ijs.12095 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel).</i> 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology.</i> 2003;60(4):620-625. doi:10.1212/01.wnl.0000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis.</i> 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic for the function of the function
 Metheny NA. Risk factors for aspiration. JPEN J Parenter Enteral Nutr. 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605 Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with st in Northeast Nigeria. International Journal of Stroke. 2013;8(4):E16-E16. doi:10.1111/ijs.12095 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. Geriatrics (Basel). 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. Neurology. 2003;60(4):620-625. doi:10.1212/01.wnl.0000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. Cerebrovasc Dis. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic
 Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with st in Northeast Nigeria. <i>International Journal of Stroke</i>. 2013;8(4):E16-E16. doi:10.1111/ijs.12095 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel)</i>. 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i>. 2003;60(4):620-625. doi:10.1212/01.wnl.0000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic doi: 10.1212/01.45.55
 Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel)</i>. 2018;3(4):69. doi:10.3390/geriatrics3040069 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i>. 2003;60(4):620-625. doi:10.1212/01.wnl.0000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeution
 Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i>. 2003;60(4):620-625. doi:10.1212/01.wnl.0000046586.38284.60 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeution.
 Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Manageme on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i>. 2018;46(3-4):99-107. doi:10.1159/000492730 Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic
8. Teramoto S. The current definition, epidemiology, animal models and a novel therapeution
strategy for aspiration pneumonia. <i>Respir Investig.</i> 2022;60(1):45-55. doi:10.1016/j.resinv.2021.09.012
 Lidetu T, Muluneh EK, Wassie GT. Incidence and Predictors of Aspiration Pneumonia Among Stroke Patients in Western Amhara Region, North-West Ethiopia: A Retrospectiv Follow Up Study. <i>IJGM</i>. 2023;16:1303-1315. doi:10.2147/IJGM.S400420
 Gupte T, Knack A, Cramer JD. Mortality from Aspiration Pneumonia: Incidence, Trends and Risk Factors. <i>Dysphagia</i>. 2022;37(6):1493-1500. doi:10.1007/s00455-022-10412-w

21. Pacheco-Castilho AC, Vanin G de M, Dantas RO, Pontes-Neto OM, Martino R. Dysphagia and Associated Pneumonia in Stroke Patients from Brazil: A Systematic Review. *Dysphagia*. 2019;34(4):499-520. doi:10.1007/s00455-019-10021-0

- 22. Imam YZ, Kamran S, Saqqur M, et al. Stroke in the adult Qatari population (Q-stroke) a hospital-based retrospective cohort study. *PLoS One*. 2020;15(9):e0238865. doi:10.1371/journal.pone.0238865
- 23. Hatano S. Experience from a multicentre stroke register: a preliminary report. *Bull World Health Organ*. 1976;54(5):541-553.
- 24. Adams HP, Bendixen BH, Kappelle LJ, et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. *Stroke*. 1993;24(1):35-41. doi:10.1161/01.str.24.1.35
- 25. Touma L, Filion KB, Sterling LH, Atallah R, Windle SB, Eisenberg MJ. Stent Retrievers for the Treatment of Acute Ischemic Stroke: A Systematic Review and Meta-analysis of Randomized Clinical Trials. *JAMA Neurol*. 2016;73(3):275-281. doi:10.1001/jamaneurol.2015.4441
- 26. d'Emden MC, Shaw JE, Jones GR, Cheung NW. Guidance concerning the use of glycated haemoglobin (HbA1c) for the diagnosis of diabetes mellitus. *Med J Aust*. 2015;203(2):89-90. doi:10.5694/mja15.00041
- 27. Akhtar N, Salam A, Kamran S, et al. Ethnic variation in acute cerebrovascular disease: Analysis from the Qatar stroke registry. *Eur Stroke J*. 2016;1(3):231-241. doi:10.1177/2396987316663776
- 28. Jeyaseelan RD, Vargo MM, Chae J. National Institutes of Health Stroke Scale (NIHSS) as An Early Predictor of Poststroke Dysphagia. *PM&R*. 2015;7(6):593-598. doi:10.1016/j.pmrj.2014.12.007
- 29. Garavelli F, Ghelfi AM, Kilstein JG. Usefulness of NIHSS score as a predictor of nonneurological in-hospital complications in stroke. *Medicina Clínica (English Edition)*. 2021;157(9):434-437. doi:10.1016/j.medcle.2020.07.045
- Okubo PCMI, Fábio SRC, Domenis DR, Takayanagui OM. Using the National Institute of Health Stroke Scale to predict dysphagia in acute ischemic stroke. *Cerebrovasc Dis*. 2012;33(6):501-507. doi:10.1159/000336240
- 31. Kumar S, Doughty C, Doros G, et al. Recovery of Swallowing after Dysphagic Stroke: An Analysis of Prognostic Factors. *Journal of Stroke and Cerebrovascular Diseases*. 2014;23(1):56-62. doi:10.1016/j.jstrokecerebrovasdis.2012.09.005
- 32. Barlas RS, Clark AB, Bettencourt-Silva JH, et al. Pneumonia and Risk of Serious Adverse Outcomes in Hospitalized Strokes in Thailand. *J Stroke Cerebrovasc Dis*. 2019;28(6):1448-1454. doi:10.1016/j.jstrokecerebrovasdis.2019.03.024

- 33. Teh WH, Smith CJ, Barlas RS, et al. Impact of stroke-associated pneumonia on mortality, length of hospitalization, and functional outcome. *Acta Neurol Scand*. 2018;138(4):293-300. doi:10.1111/ane.12956
 - 34. Han TS, Lean ME, Fluck D, et al. Impact of delay in early swallow screening on pneumonia, length of stay in hospital, disability and mortality in acute stroke patients. *Eur J Clin Nutr*. 2018;72(11):1548-1554. doi:10.1038/s41430-018-0148-4
 - 35. Akhtar N, Kamran S, Singh R, et al. Beneficial Effects of Implementing Stroke Protocols Require Establishment of a Geographically Distinct Unit. *Stroke*. 2015;46(12):3494-3501. doi:10.1161/STROKEAHA.115.010552
 - 36. Tamm A, Siddiqui M, Shuaib A, et al. Impact of Stroke Care Unit on Patient Outcomes in a Community Hospital. *Stroke*. 2014;45(1):211-216. doi:10.1161/STROKEAHA.113.002504
 - 37. Alberts MJ, Horner J, Gray L, Brazer SR. Aspiration after stroke: Lesion analysis by brain MRI. *Dysphagia*. 1992;7(3):170-173. doi:10.1007/BF02493452
 - Jitpratoom P, Boonyasiri A. Factors associated with an increased risk of developing pneumonia during acute ischemic stroke hospitalization. *PLoS One*. 2024;19(1):e0296938. doi:10.1371/journal.pone.0296938
 - 39. Grau AJ, Weimar C, Buggle F, et al. Risk Factors, Outcome, and Treatment in Subtypes of Ischemic Stroke. *Stroke*. 2001;32(11):2559-2566. doi:10.1161/hs1101.098524

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Characteristic	No Pneumonia (n=8817, 95.9%)	Aspiration Pneumonia (n= 380, 4.1%)	Total (n= 9197)	P-Value
Age	55.1±13.3	59.0±15.6	55.3±13.4	<0.001
Male Gender	7041 (79.9)	303 (79.7)	7344 (79.9)	0.95
Diabetes	5038 (57.1)	229 (60.3)	5267 (57.3)	0.22
Hypertension	6373 (72.3)	246 (64.7)	6619 (72.0)	<0.001
Dyslipidemia	4069 (46.1)	136 (35.8)	4205 (45.7)	<0.001
Prior Stroke or TIA	1156 (13.1)	63 (16.6)	1219 (13.3)	0.05
Coronary Artery Disease	1053 (11.9)	70 (18.4)	1123 (12.2)	<0.001
Atrial Fibrillation	664 (7.5)	73 (19.2)	737 (8.0)	<0.001
Active Smoking	2143 (24.3)	52 (13.7)	2195 (23.9)	<0.001
Ethnicity ^a				
Arab	2962 (33.6)	160 (42.1)	3122 (33.9)	
South Asian	4518 (51.2)	168 (44.2)	4686 (51.0)	
Far Eastern	753 (8.5)	17 (4.5)	770 (8.4)	<0.001
African	382 (4.3)	26 (6.8)	408 (4.4)	
Caucasian	202 (2.3)	9 (2.4)	211 (2.3)	
Mode of Arrival ^a				
EMS	6073 (68.9)	288 (75.8)	6361 (69.2)	<0.001
Non-Medical	2200 (25.0)	34 (8.9)	2234 (24.3)	
From Other Hospitals	372 (4.2)	15 (3.9)	387 (4.2)	
mRS prior to acute stroke ^a				
0	7595 (86.1)	282 (74.2)	7877 (85.6)	
1	132 (1.5)	9 (2.4)	141 (1.5)	-
2	312 (3.5)	12 (3.2)	324 (3.5)	
3	430 (4.9)	33 (8.7)	463 (5.0)	<0.001
4	196 (2.2)	23 (6.1)	219 (2.4)	
5	151 (1.7)	21 (5.5)	172 (1.9)	
NIHSS on admission	5.1 ± 5.54	14.65 ± 8.05	5.5 ± 6.0	<0.001
Oncot Duration?				
Less than 4.5 Hours	2822 (32.0)	169 (44.5)	2991 (32.5)	
Between 4.5 till 24 hours	2890 (32.8)	145 (38.2)	3035 (33.0)	<0.001
More than 24 hours	3105 (35.2)	66 (17.4)	3171 (34.5)	
Thrombolysis Given	962 (10.9)	73 (19.2)	1035 (11.3)	<0.001
Mechanical Thrombectomy done	350 (4.0)	43 (11.3)	393 (4.3)	<0.001
BMI on admission	28 15+42 0	27 5/1+5 2	28 12+42 0	0.0
RBS on admission	9 6+7 5	10 4+5 05	9 6+7 4	0.0
HbA1c	7,51+2 42	7 6+2 4	7.51+2 41	0.64
Serum Cholesterol	4.84+1.52	4,6+1.75	4,83+1.53	0.04
Serum Triglyceride	1.8±1.76	1.45±0.83	1.77±1.73	0.002
Serum HDL	1.1±3.24	1.43±6.34	1.10±3.38	0.12
Serum LDL	3.1±1.8	2.82±1.25	3.1±1.8	0.03
Systolic Blood Pressure	157.8±44.23	149.44±29.15	157.42±43.73	0.00
Diastolic Blood Pressure	91.1±22.4	86.4±19.4	90.9±22.3	0.00
Leveth of Chair	E 2E+9 EE	16 0+14 02	E 70+0 2	0.00

Disposition ^a				
Discharged Home	5726 (64.9)	44 (11.6)	5770 (62.7)	
Rehabilitation	2079 (23.6)	89 (23.4)	2168 (23.6)	
Long term care	151 (1.7)	97 (25.5)	248 (2.7)	<0.001
Transfer to other facility	732 (8.3)	109 (28.7)	841 (9.1)	
Died as in-patient	129 (1.5)	41 (10.8)	170 (1.8)	
TOAST Classification ^a				
Small Vessel Disease	4213 (47.8)	36 (9.5)	4249 (46.2)	
Large Vessel Disease	1772 (20.1)	141 (37.1)	1913 (20.8)	
Cardio-Embolic	1744 (19.8)	137 (36.1)	1881 (20.5)	<0.001
Stroke of Determined Etiology	612 (6.9)	31 (8.2)	643 (7.0)	
Stroke of Undetermined Etiology	476 (5.4)	35 (9.2)	511 (5.6)	
Swallow Screen done before oral intake	5820 (66.0)	197 (51.8)	6017 (65.4)	<0.001
Speech therapy assessment done	6024 (68.3)	161 (42.4)	6185 (67.3)	<0.001
Speech Therapy assessment duration (hours)	31.7±309.7	77.9±694.32	32.85±325.45	0.07
Antibiotics given	626 (7.1)	361 (95.0)	987 (10.7)	<0.001

Abbreviations: BMI, Body Mass Index; ED, emergency department; HDL, High density lipoprotein; ICU,

intensive care unit; LDL, Low density lipoprotein; MACE, major adverse cardiac event; mRS, Modified

Rankin Score; NIHSS, National Institute of Health Stroke Scale; RBS, Random blood sugar

^ap-value reported based on Pearson-Chi Square Test

Values are reported as mean ± standard deviation and n(%)

BMJ Open **Table 2.** Bivariate and Multivariate logistic regression analysis to identify the risk factors associated with as based on the regression analysis to identify the risk factors associated with as based on the regression analysis to identify the risk factors associated with as based on the regression analysis to identify the risk factors associated with as based on the regression analysis to identify the risk factors associated with the risk factors

Determinants			Bivariate	logistic regression and	alysis	Multivariate	logistic regressio	n analysis
	No Pneumonia	Aspiration	Standardized	Odds ratio (95%	p-value	Standardize	Odds ratio	p-value
		Pneumonia	Beta	CI)		Betaging	(95% CI)	
Age	55.3 ± 13.4	59.0 ± 15.6	0.021	1.02 (1.01–1.03)	<.001		1.02 (1.01–	0.002
						atec	1.03)	
Sex				1		l to	1	
Female	1776 (95.8)	202 (4.1)	-		-			-
Mule	7041 (95.9)	505 (4.1)	-0.007	0.99 (0.77-1.28)	0.95	0.446 per an	2 32)	0.05
TOAST						ed fro ieur (/ id dat:	2.32)	
SVD	4213 (99.2)	36 (0.8)	-	1	-	- mir	1	-
LVD	1772 (92.6)	141 (7.4)	2.231	9.31 (6.43–13.48)	<.001	1.41 9 1.41 9 9 •	4.11 (2.52– 6.69)	<.001
CE	1744 (92.7)	137 (7.3)	2.218	9.19 (6.34–13.33)	<.001	1.30 6 jopen ini en	3.69 (2.23– 6.12)	<.001
SDA	612 (95.2)	31 (4.8)	1.780	5.93 (3.64–9.65)	<.001	1.178 by an c	3.25 (1.75– 6.03)	<.001
SUD	476 (93.2)	35 (6.8)	2.152	8.61 (5.35–13.83)	<.001	1.40 👷 👷	4.09 (1.98– 8.46)	<.001
Mode of						۱ Jun lar te		
transport						e 11 chn		
From Other	372 (96.1)	15 (3.9)	-	1	-	, 202	1	-
Hospitals						ies.		
EMS	6073 (95.5)	288 (4.5)	0.162	1.18 (0.69–2.00)	0.55	0.184 Agenc	1.20 (0.55– 2.64)	0.65
Non-Medical	2200 (98.5)	34 (1.5)	-0.959	0.38 (0.21–0.71)	0.00	0.032 B BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB	1.03 (0.43– 2.47)	0.94
Onset Duration						ographique		
		For peer revi	ew only - http://bmj	open.bmj.com/site/abo	ut/guidelines	xhtml		23

12 <	- 0.79 0.43
3 <4.5 hours 2822 (94.3) 169 (5.7) - 1 - <th< td=""><td>- 0.79 0.43</td></th<>	- 0.79 0.43
4.5-24 hours 3890 (96.4) 145 (3.6) -0.177 0.84 (0.67-1.05) <.001 0.136 20 1.06 (0.68-1.65) 7 >24 hours 3105 (97.9) 66 (2.1) -1.036 0.36 (0.27-0.47) <.001 0.066 21 1.15 (0.82-1.61) 9 Duration in ER 1 - 1 - 1 - 1.15 (0.82-1.62) 11 <4 hours 809 (94.2) 50 (5.8) - 1 - <	0.79 0.43
7 >24 hours 3105 (97.9) 66 (2.1) -1.036 0.36 (0.27-0.47) <.001 0.060 1 1.15 (0.82- 9 Duration in ER 1 - - 1.15 (0.82- 11 <4 hours 809 (94.2) 50 (5.8) - 1 - - - - - - - 1.61) - 12 <4 hours 809 (94.2) 50 (5.8) - 1 - <td>0.43</td>	0.43
9 Duration in ER 809 (94.2) 50 (5.8) - 1 - <th< td=""><td></td></th<>	
11 <4 hours 809 (94.2) 50 (5.8) - 1 - - ergin 25 are fine 55 0.41 1 12 4-8 hours 1711 (93.3) 122 (6.7) 0.143 1.15 (0.82–1.62) 0.41 0.346 or provide 50 0.41 1.41 (0.90– 2.20) 14 -<	
12 4-8 hours 1711 (93.3) 122 (6.7) 0.143 1.15 (0.82–1.62) 0.41 0.346 m port (2.20) 1.41 (0.90– 14 -8 hours 2749 (94.8) 151 (5.2) -0.118 0.89 (0.64–1.24) 0.48 0.217 port (2.20) 1.24 (0.80– 16 -1.41 (0.90– 1.41 (0.90– 1.41 (0.90– 1.41 (0.90–	-
15 >8 hours 2749 (94.8) 151 (5.2) -0.118 0.89 (0.64–1.24) 0.48 0.21 \$\$ 5 1.24 (0.80– 16 16 1.24 (0.80– 1.93)	0.13
	0.34
19 Mild Stroke (0- 5570 (99.0) 56 (1.0) - 1 -<	-
21 4) $(\vec{a} \cdot \vec{b})$ $(\vec{a} \cdot \vec{b})$ (20) (20) (20) (21) (41) (62)	0.01
22 Moderate 1900 (97.0) 39 (3.0) 1.123 3.08 (2.13-4.43) <.001 0.024 3 1.87 (1.19- 23 24 Stroke (5-14) 100 2.94) 100 <td< td=""><td>0.01</td></td<>	0.01
25 Severe Stroke 1341 (83.5) 265 (16.5) 2.978 19.66 (14.64– <.001 1.788 5.98 (3.92– 26 26.38) 26.38) 9.11)	<.001
Admission 30 Location	
31 32 Stroke Ward 3819 (96.3) 147 (3.7) - 1	-
32 Medicine Ward 1248 (94.7) 70 (5.3) 0.377 1.46 (1.09–1.95) 0.01 0.442 No.55 No.56 (1.05– 2.31) 36 37 37 36 37 37 37 37 37 37 37 37 37 37 37 37 36 37<	0.03
38 Bibliographique 39 40 40 41 42 43 43 44 45 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml 46	24

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Abbreviations: CE, cardioembolic stro disease; NIHSS, National Institute of H undetermined etiology.	ke; CI, confidence interval; EMS, emergency medical services; ER, er lealth Stroke Scale; SDA, stroke of determined etiology; SVD, small v	pyright rogations nergency rogations essel diagonal 21 Marct Ens
		י 2025. Downloaded from eignement Superieur (AB related to text and data m
Figure 1. Proportion of aspiration p	oneumonia between stroke ward vs. medicine ward	http://b ES) ·
*p ≤ 0.05		Al trair
Figure 2a. Proportion of mRS at 90	days for patients with an NIHSS of 5-9	n.bmj. ning, a
Figure 2b. Proportion of mRS at 90	days for patients with an NIHSS of >10	nd sim
Figure 3. Forest Plot based on the	results of multivariate analysis of the factors associated with a	spiration peeumonia.
Abbreviations: CI, confidence inter	val; OR, odds ratio.	, 11, 2025 at Agence Bibliographique hnologies.
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Table S1. Characteristics and outcome of acute ischemic stroke patients with aspiration

pneumonia based on their NIHSS admission

Characteristic or Investigation	No Pneumonia (n=8817, 95.9%)	Aspiration Pneumonia (n= 380, 4.1%)	Total (n= 9197)	P-Value
NIHSS Severity				
Mild Stroke (NIHSS 0-4)	5570 (63.2)	56 (14.7)	5626 (61.2)	<0.001
Moderate Stroke (NIHSS 5-9)	1906 (21.6)	59 (15.5)	1965(21.4)	
Severe Stroke (NIHSS 10 or more)	1341 (15.2)	265 (69.7)	1606 (17.5)	
NIHSS (5-9)				
90-Days Mortality	36 (1.9)	10 (16.9)	46 (2.3)	<0.001
MACE at 1 year	72 (3.8)	14 (23.7)	86 (4.4)	<0.001
Admission Location				
Stroke Ward	1281 (67.2)	35 (59.3)	1316 (67.0)	
Medicine Ward	250 (13.1)	10 (16.9)	45 (13.2)	0.31
Duration of ED Stay Category ^a				
<4 hours	249 (13.1)	2 (3.4)	251 (12.8)	
4-8 hours	555 (29.1)	23 (39.0)	578 (29.4)	
>8 hours	750 (39.3)	26 (44.1)	776 (39.5)	0.052
Length of Stav	5.89±10.0	17.1+19.4	6.23+10.5	<0.001
Prognosis – At Discharge				
Good (mRS 0–2)	814 (42.7)	4 (6.8)	818 (41.6)	<0.001
Poor (mRS 3-6)	1092 (57.3)	55 (93.2)	1147 (58.4)	
Prognosis – At 90 Davs				
Good (mRS 0–2)	876 (46.0)	6 (10.2)	882 (44.9)	<0.001
Poor (mRS 3-6)	580 (30.4)	44 (74.6)	624 (31.8)	
Mortality at Discharge	9 (0.5)	7 (11.9)	16 (0.8)	<0.001
90 Days Mortality	36 (1.9)	10 (16.9)	46 (2.3)	<0.001
mRS at 90 Days ^a				
0	446 (23.4)	0 (0)	446 (22.7)	
1	212 (11.1)	3 (5.1)	215 (10.4)	
- 2	218 (11.4)	3 (5.1)	221 (11.2)	
	325 (17 1)	6 (10 2)	331 (16.8)	<0.001
4	160 (8.4)	10 (16 9)	170 (8 7)	
	59 (3.1)	18 (30 5)	77 (3.9)	
6	36 (1.9)	10 (16 9)	46 (2 3)	
5	56 (1.5)	10 (10.5)	40 (2:3)	
NIHSS (>10)				
90-Davs Mortality	185 (13.8)	59 (22.3)	244 (15.2)	0.003
MACE at 1 year	217 (16.2)	73 (27.5)	290 (18.1)	<0.001
Admission Location				
Stroke Ward	834 (62.2)	92 (34.7)	926 (57.7)	
Medicine Ward	166 (12.4)	40 (15.1)	206 (12.8)	<0.001
Duration of ED Stay Category ^a	100 (11:1)	10 (1012)	200 (12:0)	
<4 hours	288 (21.5)	41 (15.5)	329 (20.5)	
4-8 hours	446 (33.3)	87 (32.8)	533 (33.2)	0.09
>8 hours	470 (35.0)	103 (38.9)	573 (35.7)	
Length of Stav	9 2+9 8	16 6+14 6	10 4+11 2	<0.001
Prognosis – At Discharge	5. <u></u> 5.0	101011410		
Good (mRS 0_2)	247 (18.4)	5 (1.9)	252 (15.7)	<0.001
Door (mRS 2_6)	1094 (81.6)	260 (98 1)	1354 (84 3)	-0.001
FUUL (IIIK3 5-0)	1034 (01.0)	200 (50.1)	1334 (04.3)	

Prognosis – At 90 Days				
Good (mRS 0–2)	301 (22.4)	18 (6.8)	319 (19.9)	<0.001
Poor (mRS 3-6)	798 (59.5)	211 (79.6)	1009 (62.8)	
Mortality at Discharge	105 (7.8)	30 (11.3)	135 (8.4)	0.07
90 Days Mortality	185 (13.8)	59 (22.3)	244 (15.2)	<0.001
mRS at 90 Days ^a				
0	132 (9.8)	5 (1.9)	137 (8.5)	
1	72 (5.4)	3 (1.1)	75 (4.7)	
2	97 (7.2)	10 (3.8)	107 (6.7)	
3	219 (16.3)	18 (6.8)	237 (14.8)	<0.001
4	223 (16.6)	46 (17.4)	269 (16.7)	
5	171 (12.8)	88 (33.2)	259 (16.1)	
6	185 (13.8)	59 (22.3)	244 (15.2)	

Abbreviations: ED, emergency department; NIHSS, National Institute of Heath Stroke Scale; MACE, major adverse cardiovascular event; mRS, modified Rankin Scale



	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc	SVD v ^{BMJC}	SVD ^{Ope} vs.	SVD vs.	SVD vs.	LVD vs.	ctecLV2D dtv⊑t.	LVD vs.	CE vs.	CE vs. ^{Pag}	SDA Je 3 ¢ s f 35		
				е	LVD ¹	CE ¹	SDA ¹	SUD ¹	CE ¹	SDA¹	SUD ¹	SDA 1	SUD	SUD ¹		
TOAST				<.001	<.001	<.001	<.001	<.001	1.00	Y 0.05	1.00	0.06	1.00	0.82		
² Small vessel ³ disease	4249 (46.2)	4213 (99.2)	36 (0.8)	_	-	-	-	_	_)2/4-09 ight, ii	_	_	-	_		
⁴ Large vessel 5 disease	1913 (20.8)	1772 (92.6)	141 (7.4)	-	-	-	-	-	-	3328 ncludi	-	-	-	-		
⁶ Cardioembolic	1881 (20.5)	1744 (92.7)	137 (7.3)	_	-	-	-	-	-	oŋ 21 ng for	_	_	-	-		
9 Determined 10 etiology	643 (7.0)	612 (95.2)	31 (4.8)	-	-	-	-	-	-	March Ens uses	-	-	-	-		
1 Undetermined	511 (5.6)	476 (93.2)	35 (6.8)	_	-	-	-	-	_	1 2025 eignei relate	_	_	-	-		
12 13 14 15	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	EMS vs. NM ¹	EMS vs. OH ¹	NM vs. OH ¹			. Downlo ment Sup d to text						
1 <mark>Mode of</mark> ₁ŧransport				<.001	<.001	1.00	0.07			aded berieu and d						
18 EMS	6361 (69.2)	6073 (95.5)	288 (4.5)	-	-	-	-	-	-	frøm f r (ABE lata m	-	-	-	-		
20 Non-Medical	2234 (24.3)	2200 (98.5)	34 (1.5)	-	7	-	_	-	_	tttp://t ≘S) . ining,	_	_	-	-		
22 From Other23 Hospitals	387 (4.2)	372 (96.1)	15 (3.9)	-	_	-	-	_	_	onnjop Al tra	_	_	_	_		
24 25 26 27 28 29	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	<4.5 hours vs. 4.5-24 hours ¹	<4.5 hours vs. >24 hours	4.5-24 hours vs. >24 hours ¹	0,		en.bmj.com/ on J ining, and similar						
3Onset				<.001	0.26	<.001	<.001			une						
32 <4.5 hours	2991 (32.5)	2822 (94.3)	169 (5.7)	_	-	-	-	- 4	-	11,,202	-	-	-	-		
34 4.5-24 hours 35	3035 (33.0)	2890 (95.2)	145 (4.8)	-	-	-	-	-	-	ies.	_	-	-	-		
36 >24 hours 37	3171 (34.5)	3105 (97.9)	66 (2.1)	_	-	-	-	-	-	gęnce	-	-	-	-		
38 39 40	Överall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	<4 hours	<4 hours vs. >8	4-8 hours			Bibliogr						
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Vs. 4-8 hours vs. >8 Duration in 0.11 1.00 0.11 1.00 0.11 Construction in 0.11 1.00 0.11 1.00 0.11 1.00 0.11 Construction in (15.4) 1.02 50 (5.8) -	Page	e 35 of 35					BMJ (Dpen				36/bmjopen-20 cted by copyri				
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Operation in R 0.11 1.00 0.01 0.11 0.01 4 hours 859 809 (94.2) 50 (5.8) -	2 3 4						vs. 4-8 hours ¹	hours	vs. >8 hours ¹			24-093: ght, inc				
$ \frac{4 + hours}{16} = \frac{859}{100} = \frac{809}{100} (94.2) = 50 (5.8)$	⁵ Du	ration in				0.11	1.00	1.00	0.11			328 o Iudin				
(15.4) 191 4-8 hours 1833 1711 122 (6.7) -	° ⊏ к 7 ∘	<4 hours	859	809 (94.2)	50 (5.8)	-	_	_	-	_	_	n 21 g for	_	_	_	_
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	9		(15.4)									Mar Er				
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	10	4-8 hours	1833	1711	122 (6.7)	-	-	_	-	-	_	s r	_	-	_	_
$\frac{12}{13} = \frac{12}{51} = \frac{12}{51} = \frac{1}{51} = \frac{1}{5$	11		(32.8)	(93.3)								202 gne elat				
14Overall PreumoniaNo PreumoniaAspiration SignificancOverall 5.14'0.4 vs. 9.5.14'0.4 vs. $v = 15'$ 5.14 vs. $v = 15'$ 15'1618 $v = 0.01$ 191910059 $v = 0.01$ 1919190659 $v = 0.01$ 20 $(0-4)$ (61.2) (99.0) $v = 0.01$ $v = 0.01$ $v = 0.01$ $v = 0.01$ 21Moderate1965190659 (3.0) $v = 0.01$ $v = 0.01$ $v = 0.01$ 22(0-4) (21.4) (97.0) $v = 0.00$ $v = 0.00$ $v = 0.00$ $v = 0.00$ 22Woderate1965190.6134.1265 $v = 0.00$ $v = 0.00$ $v = 0.00$ 23Evere Stroke160.6134.1265 $v = 0.00$ $v = 0.00$ $v = 0.00$ $v = 0.00$ 24Table S2. Clinical characteristics among patients with aspiration pneumonia versus those without spiration pneumonia $v = 0.00$ 24 $v = 0.00$ $v = 0.00$ $v = 0.00$ $v = 0.00$ 25 $v = 0.00$ $v = 0.00$ $v = 0.00$ $v = 0.00$ 26 $v = 0.00$ $v = 0.00$ $v = 0.00$ $v = 0.00$ 27Table S2. Clinical characteristics among patients with aspiration pneumonia $v = 0.00$ 28 $v = 0.00$ v	12 13	>8 hours	2900 (51.9)	2749 (94.8)	151 (5.2)	-	-	-	-	-	-	54 Dov ement ed to	-	-	-	-
$\frac{1}{9}$ Mild Stroke 5626 5570 56 (1.0)	14 15		Overall	No	Aspiration Pneumonia	Overall Significanc	0-4 vs. 5-141	0-4	5-14 vs.			wnloa t Supe text a				
All HISS <.001 <.001 <.001 <.001 Image: constraint of the second seco	16			i neumonia	Theamonia	e	5-14	∨3. >15¹	210			erie				
10/10/10/10/10/10/10/10/10/10/10/10/10/1		HSS				<.001	<.001	<.001	<.001			ur () dat:				
20 (0-4) (61.2) (99.0) 21 Moderate 1965 1906 59 (3.0) - <td>19N</td> <td>1ild Stroke</td> <td>5626</td> <td>5570</td> <td>56 (1.0)</td> <td></td> <td>-</td> <td>_</td> <td>_</td> <td>_</td> <td>_</td> <td></td> <td>_</td> <td>_</td> <td>_</td> <td>_</td>	19N	1ild Stroke	5626	5570	56 (1.0)		-	_	_	_	_		_	_	_	_
21 Moderate 1965 1906 59 (3.0) - <td>20</td> <td>(0-4)</td> <td>(61.2)</td> <td>(99.0)</td> <td></td> <td></td> <td>L</td> <td></td> <td></td> <td></td> <td></td> <td>inin</td> <td></td> <td></td> <td></td> <td></td>	20	(0-4)	(61.2)	(99.0)			L					inin				
2Stroke (5-9) (21.4) (97.0) 23evere Stroke 1606 1341 265 (16.5) -	21	Moderate	1965	1906	59 (3.0)	-	-	_	_	-	_	9. <mark>9</mark>	_	_	_	_
⁴ Severe Stroke <u>1606</u> <u>1341</u> <u>265 (16.5)</u> <u>-</u>	22S1	roke (5-9)	(21.4)	(97.0)												
25 (17.5) (83.5) 26 and the second seco	² Se 24	vere Stroke	1606	1341	265 (16.5)	_	-	-	-	_	-	ainii	_	-	-	_
Table S2. Clinical characteristics among patients with aspiration pneumonia versus those without appiration pneumonia 1 Bonferroni corrections have been applied to the p-values reported Abbreviations: CE, cardioembolic; EMS, emergency medical service; LVD, large vessel disease NRI, non-medical; OH, other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVLF Strategee result For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml Table S2. Clinical characteristics among patients with aspiration pneumonia versus those without approximate approxim	25	(~10)	(17.5)	(83.5)				(ng,				
 ¹ Bonferroni corrections have been applied to the p-values reported Abbreviations: CE, cardioembolic; EMS, emergency medical service; LVD, large vessel disease other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVD, s	26	Та		linical charact	oriation amon	a potiopto with	h oonirati	ion nnoi	imonio ve	vroue the	oo with	and Grain	otion nno	umonio		
¹ Bonferroni corrections have been applied to the p-values reported Abbreviations: CE, cardioembolic; EMS, emergency medical service; LVD, large vessel disease other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVL other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVL For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	27 28	Id				y patients with	n aspirat	ion priet	unionia ve		se with	our teni	alion prie	umonia		
Abbreviations: CE, cardioembolic; EMS, emergency medical service; LVD, large vessel disease there hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVD, similar vessel disease.	20	1 🖬	Ronferroni	corrections ba	wa haan anni	ied to the n-v	aluae rar	orted				on , nila				
Abbreviations: CE, cardioembolic; EMS, emergency medical service; LVD, large vessel disease Nin, non-medical; OH, other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVD, sinal vessel disease.	30	L	Joinchoin				aluesie	Jonea				lune r teo				
other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVD, stroke of	31	Ał	breviation	s. CE cardioe	embolic [.] EMS	emergency	medical	service [.]	I VD larc	ie vessel	diseas	en Nich no	on-medic	al OH		
other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVD, stroke of un	32					, entergeney	ine area i				diebdde			ai, eri,		
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NIHSS	No Pneumonia	Aspiration Pneumonia	Ströke Ward vs. Medici
Mild Stroke (0-4)			
Admission Location			ing
Stroke Ward	1704 (98.8)	20 (1.2)	ốg ≌ 0.03*
Medicine Ward	832 (97.7)	20 (2.3)	us ma
Moderate Stoke (5-9)			ins es
Admission Location			- 20 religi
Stroke Ward	1281 (97.3)	35 (2.7)	
Medicine Ward	250 (96.2)	10 (3.8)	d to
Severe Stroke (>10)			o te
Admission Location			Xt a
Stroke Ward	834 (90.1)	92 (9.9)	and er id <.001*
Medicine Ward	166 (80.1)	40 (19.9)	d fr da
*p≤0.05 Table S3. Comparison of NIF	ISS score and admission loc	ation among patients with aspir	ration gnegimonia versus t
*p≤0.05 Table S3. Comparison of NI⊢ without aspiration pneumonia	ISS score and admission loc using Fisher's Exact Test	cation among patients with aspir	ning, Al training, and similar technologies.

Increasing stroke severity is associated with increased risk of aspiration pneumonia: The risk is higher in medical ward compared to stroke ward

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Increasing stroke severity is associated with increased risk of aspiration pneumonia: The risk is higher in medical ward compared to stroke ward

Running Title: Risk factors associated with aspiration pneumonia

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Abstract

Objective: Aspiration pneumonia is a common complication post-stroke that increases patient's duration of stay in hospital, mortality, and morbidity. We examined the incidence, clinical characteristics, and outcomes among ischemic stroke-related aspiration pneumonia patients in Qatar.

Methods: A retrospective cohort study was analyzed from January 2014 to April 2024. A total of 9,197 patients were included.

Results: Stroke patients who developed aspiration pneumonia tended to be older and of the male sex. Patients who developed aspiration pneumonia were also more likely to present with a higher NIHSS at admission (p<0.001). Patients with large vessel disease, cardioembolic stroke, stroke

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of determined etiology and stroke of undetermined etiology were more likely to develop aspiration pneumonia. They also stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia (16.0 vs. 5.3 days). Patients admitted to the medicine ward had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward (aOR of 1.56, 95% CI: 1.05–2.31). Patients with aspiration pneumonia had unfavorable outcome (mRS 3-6) at 90 days (74.6% vs. 30.4% for an NIHSS admission score of 5-9 and 79.6% vs. 59.5% for an NIHSS admission >10). They were also more likely to have higher mortality rates at 90 days (16.9% vs. 1.9% for an NIHSS admission score of 5-9 and 22.3% vs. 13.8% for an NIHSS admission score >10) and major adverse cardiovascular event at 1 year (23.7% vs. 3.8% for an NIHSS admission score of 5-9 and 27.5% vs. 16.2% for NIHSS >10).

Conclusion: Age, sex, admission NIHSS severity, stroke subtypes, and admission location are independent predictors of aspiration pneumonia post-stroke.

Keywords: Aspiration Pneumonia, Stroke, Dysphagia, Stroke-associated pneumonia

Strengths and limitations of this study:

- This is the first study to specifically examine the incidence and outcomes of patients who develop aspiration pneumonia post-stroke in the Middle East and North Africa (MENA) region.
- This study is based on a large stroke registry with 9197 acute ischemic stroke patients enrolled over a 10-year period.
- 3) This is the first study in the MENA region to demonstrate that patients with aspiration pneumonia stayed an average of 10 days longer in the hospital compared to patients without. A higher proportion of patients with aspiration pneumonia had an unfavorable

outcome at 90 days. They were also more likely to have higher mortality rates at 90 days and MACE at 1 year. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward.

 Our patient sample is comprised of largely Middle Eastern ethnicity, South Asian and Far Eastern, therefore lacks generalizability.

Introduction

Stroke is a major cause of death and disability worldwide. Early in the course of the disease, stroke patients are at risk for medical complications including dysphagia and aspiration pneumonia.¹ Dysphagia is characterized by difficulty swallowing due to weakness/reduced coordination between facial, palatal, and pharyngeal muscles (due to reduced cortical connectivity between neural regions post-stroke).² The incidence of dysphagia after stroke ranges from 8.1–80%,^{3–7} it is frequently silent and it is highly associated with aspiration pneumonia.⁸ Dysphagia causes oral or gastric contents to enter the lung, which suppresses the natural defenses of the respiratory system, increasing the risks for opportunistic infections.^{9–11} Several studies

have identified multiple risk factors associated with aspiration pneumonia, such as reduced level of consciousness, incorrect postures, and advanced age.^{12–15}

Pneumonia is one of the leading causes of mortality for acute stroke, with a 30-day mortality rate of up to 30%.¹⁶ Aspiration pneumonia also increases the risk of prolonged hospital stay and poor prognosis.¹⁷ Animal and clinical studies have demonstrated that silent aspiration (micro-aspiration due to dysphagia during the night) is the primary cause of aspiration pneumonia.¹⁸ Despite different preventative and therapeutic approaches for managing patients with aspiration pneumonia, its incidence and mortality rates remain high.¹⁹ For example, in a case-control study comprising of 1,112,944 patients, Gupte et al²⁰ reported that aspiration pneumonia due to cerebrovascular disease accounted for 11.7% of deaths in the United States (62,068 deaths per year from 1999 to 2017), with increasing mortality rates since 2009. In countries such as Egypt and Brazil, the incidence of aspiration pneumonia can be as high as 44% and 76%, respectively.^{19,21}

There are very few studies on the incidence, causes, and outcomes of aspiration pneumonia from the Middle East and North Africa (MENA) region.²² This study aimed to assess the clinical characteristics and treatment outcomes among stroke-related aspiration pneumonia patients in Qatar.

Methods

Data from patients admitted with a stroke to Hamad General Hospital (HGH), Doha, Qatar from January 2014 through April 2024 were analyzed from a hospital based prospective stroke registry. HGH is a Joint Commission International (JCI) accredited 600-bed hospital, with 200 beds reserved for medical patients. It is the only tertiary care medical facility in Qatar where the stroke service is located, 95% of all strokes in Qatar requiring admission to hospital are admitted

to HGH. The program provides 24-hour thrombolysis and thrombectomy services for acute stroke management. Patients are evaluated by the stroke team in the emergency department (ED), and urgent decisions about treatment are made. Hyperacute stroke patients are admitted to a dedicated 12-bed stroke unit or Medical ICU as necessary. Non-urgent stroke patients are admitted under the medical team, with neurology consultation in the ED. HGH has the required laboratory, neuroradiological, and neurosurgical infrastructure to manage stroke patients effectively. The stroke team is readily available to make immediate treatment decisions for acute stroke cases.

Patient characteristics

Patient characteristics including age, sex, ethnicity, medical comorbidities and prior medication were collected in the HGH Stroke Registry. National Institute of Health Stroke Scale (NIHSS) score, neuroimaging data, and post-discharge disposition were entered into the registry as well. Ischemic stroke was diagnosed according to the WHO criteria²³ and stroke subtypes were defined by the TOAST criteria.²⁴ The modified Rankin scale (mRS) measurements were done at discharge and at 90 days following onset of symptoms. The patients were classified as favourable (mRS \leq 0-2) or unfavourable (mRS 3-6) outcome. We used the dichotomized mRS scale to evaluate recovery at 90 days.²⁵

Diabetes was diagnosed according to the American diabetes Association (ADA) and WHO recommendation²⁶ and included patients with a previous diagnosis of diabetes, on medication for diabetes or an HbA1c of more than 6.5%, and the diagnosis of pre-diabetes was based on an HbA1c of 5.7-6.4% as per the 2015 ADA clinical practice recommendations. Hypertension was defined as systolic blood pressure (BP) \geq 140 mm Hg or a diastolic pressure \geq 90 mm Hg, or on current treatment with antihypertensive drugs. Dyslipidemia was defined as low-density lipoprotein-cholesterol level \geq 3.62 mmol/L, high-density lipoprotein cholesterol level \leq 1.03 mmol/L, triglycerides \geq 1.69 mmol/L, or current treatment with a cholesterol-lowering drug.

Data Collection and inclusion/exclusion criteria

Upon identification and confirmation of diagnosis using the International Classification of Disease, 10th edition, definitions (H34.1, 163.x, 164.x, 161.x, 160.x, G45.x), patients' data were collected by trained stroke clinical nurse specialists. For our study, we only included patients diagnosed with acute ischemic stroke and excluded patients diagnosed with intracerebral hemorrhage, transient ischemic attacks, stroke mimics, and cerebral venous thrombosis. As for the diagnosis of post-stroke aspiration pneumonia, clinical diagnosis was made via assessing symptoms like fever, cough, dyspnea, and purulent sputum. Radiological imagings (CT and chest X-rays) were also performed to identify lung consolidation or infiltrates indicative of pneumonia. Microbiological testing including sputum culture, blood cultures, and bronchoalveolar lavage were also performed.

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Data Analysis and statistics

Descriptive results for all continuous variables were reported as mean±standard deviation (SD) for normally distributed data or median with range for data with non-normal distributions. The distribution of continuous variables was assessed before using statistical tools. Mean level comparisons between patients with aspiration pneumonia versus without aspiration pneumonia were assessed using ANOVA test and multiple comparisons were performed using Bonferroni

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correction. If an assumption of an ANOVA test was failed, then an alternative non-parametric Kruskal Wallis test was performed. Pearson Chi-Square test and Fisher's Exact test were performed whenever appropriate to compare the proportion of all categorical variables between the groups. Multiple logistic regression analysis was performed to assess for risk factors associated with aspiration pneumonia after selecting important and significant variables at univariate analysis. Odds ratio (OR) and the 95% confidence interval for the OR were reported. A p-value of ≤0.05 (two-tailed) was considered significant. SPSS statistical package 29.0.1.0 was used for the analysis.

Results

Patient Characteristics

A total of 9197 patients were enrolled: 380 developed aspiration pneumonia (4.1%) during hospitalization while 8817 (95.9%) of the patients did not have pneumonia. The mean age of patients was 55.3 ± 13.4 years, with patients with aspiration pneumonia being significantly older than healthy controls (p<0.001). 80% were male, 57% had diabetes mellitus, 72% had hypertension, 46% had dyslipidemia, and 24% were active smokers. The high proportion of men is reflective of the very high male expatriate population as previously reported.²⁷ A summary of patients' baseline characteristics is outlined in Table 1.

Since 95.9% of our patients did not have aspiration pneumonia, we performed subanalyses on clinical outcomes based on patients' admission NIHSS scores. Sub-analyses were performed for patients with an NIHSS of 5-9 (moderate stroke) and NIHSS >10 (severe stroke) (Table 2).

Mode of transport

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Mode of transport was significantly associated with aspiration pneumonia risks (p<0.001). However, this was only significant for emergency medical services (EMS) versus non-medical services (p<0.001), with a higher proportion of patients developing aspiration pneumonia via EMS (4.5%) versus non-medical services (1.5%). Patients transported with EMS had a significantly higher NIHSS at admission (5.9 ± 6.1 vs. 3.3 ± 3.7 , p<0.001). The total sample size for EMS was 6361 versus 2234 for non-medical services.

Onset Duration

Duration of stroke symptoms from the time of onset to evaluation was significantly associated with aspiration pneumonia (p<0.001). This was only significant for <4.5 hours vs. >24 hours (p<0.001) and 4.5-24 hours vs. >24 hours (p<0.001). A stroke onset to emergency evaluation of <4.5 hours had the highest proportion of aspiration pneumonia (5.7%) versus 4.8% for onset duration of 4.5-24 hours and 2.1% for >24 hours (Table S1).

Duration of stay in Emergency Department

Duration of stay in the ED was not significantly associated with aspiration pneumonia (p=0.11) (Table S1). Furthermore, when we analyzed duration of stay in the ED based on NIHSS scores (5-9 and >10), duration of stay in the ED remained non-significant (p=0.052 and 0.09), respectively (Table 2).

Stroke Diagnosis

Stroke diagnosis is shown in Table S1. Overall, type of stroke was significantly associated with aspiration pneumonia (p<0.001). Further analyses revealed that the risk of developing aspiration pneumonia was not significantly different between large vessel disease versus cardioembolic stroke (p=1.00), large vessel disease versus stroke of undetermined aetiology (p=1.00), cardioembolic stroke versus stroke of determined aetiology (p=0.06),

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cardioembolic stroke versus stroke of undetermined etiology (p=1.00), and stroke of determined aetiology versus stroke of undetermined aetiology (p=0.82).

Patients with small vessel disease had the lowest proportions of aspiration pneumonia (0.8%) compared to large vessel disease (7.4%), cardioembolic stroke (7.3%), stroke of determined etiology (4.8%), and stroke of undetermined etiology (6.8%), p<0.001 (Table 3). *Admission NIHSS Score*

Admission NIHSS score was significantly associated with aspiration pneumonia (p<0.001). Fisher's exact test revealed that there was a significant association between aspiration pneumonia for patients with an NIHSS score of 0-4 (p=0.03), and NIHSS score of >10, p<0.001 (Table S2). Patients with an NIHSS > 10 had the highest proportion of aspiration pneumonia (16.5%). Moreover, patients with an NIHSS >10 and concomitant aspiration pneumonia had higher rates of mortality at 90 days (22.3%) when compared to patients with an NIHSS score of 5-9 and concomitant aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia, patients with an NIHSS >10 also had higher rates of major adverse cardiovascular events (MACE) at 1 year compared to patients with an NIHSS of 5-9 (27.5% vs. 23.7%, p<0.001).

Length of stay

Patients with aspiration pneumonia stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia (16.0 days vs. 5.3 days, p=0.00). When analyzed via admission NIHSS severity, patients with aspiration pneumonia stayed significantly longer in the hospital compared to those without aspiration pneumonia (17.1 days vs. 5.9 days, p<0.001 for NIHSS of 5-9, and 16.6 days vs. 9.2 days, p<0.001 for NIHSS > 10). *Admission Location*

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Overall, 3966 (75.1%) patients were admitted to the stroke ward and 1318 (24.9%) patients were admitted to the medical ward. A higher proportion of patients admitted to the medicine ward developed aspiration pneumonia in contrast to patients admitted to the stroke ward (5.3% vs 3.7%, p=0.01) (Table 3). 2.3% of patients with an NIHSS of 0-4 and admitted to the medicine ward developed aspiration pneumonia compared to 1.2% of patients with an NIHSS of 0-4 and admitted to the stroke ward (p=0.03) (Table S2). Similarly, 19.9% of patients with an NIHSS >10 and admitted to the stroke ward (p<0.001) (Figure 1).

Modified Rankin Scale at 90 days

A higher proportion of patients with aspiration pneumonia had an unfavorable outcome (mRS 3-6) at 90 days compared to patients without aspiration pneumonia (74.6% vs. 30.4% for NIHSS of 5-9), p<0.001 (Table 2). Similar observations were seen for NIHSS > 10 (79.6% vs. 59.5%, p<0.001). Figure 2 and 3 illustrates the proportion of mRS at 90 days based on NIHSS admission scores.

Mortality at 90 days

For patients with an NIHSS score of 5-9, a higher proportion of patients with aspiration pneumonia died at 90 days (16.9%) compared to patients without aspiration pneumonia (1.9%), p<0.001. Similar observations were seen for NIHSS > 10 (22.3% vs. 13.8%, p=0.003).

Multivariate analysis for risk factors associated with aspiration pneumonia

Table 3 describes a multiple binary logistic regression model to identify significant independent factors associated with the development of aspiration pneumonia after selecting important and significant variables at bivariate analysis. Males were more likely than females to have aspiration pneumonia risks [aOR 1.56, 95% CI: 1.05–2.32, p=0.03]. Age was significantly

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associated with aspiration pneumonia [aOR 1.02, 95% CI: 1.01–1.03, p=0.002], with patients with aspiration pneumonia being significantly older (p<0.001). Large vessel disease was significantly associated with aspiration pneumonia [aOR 4.11, 95% CI: 2.52–6.69, p<0.001]. Similar observations were seen for cardioembolic stroke (p<0.001), stroke of determined aetiology (p<0.001), and stroke of undetermined aetiology (p<0.001), see Table 3. Patients with an NIHSS score of 5–9 and >10 also had high odds of developing aspiration pneumonia (aOR of 1.87 and 5.98, respectively). Patients admitted to the medicine ward also had 1.56 times the odds of developing aspiration pneumonia compared to the stroke ward (95% CI: 1.05–2.31, p=0.03). A forest plot of the multivariate analysis can be seen in Figure 4.

Discussion

To the best of our knowledge, this is the first study to specifically examine the incidence and outcomes of patients who develop aspiration pneumonia post-stroke in the MENA region. In our cohort, 4.1% of our patients developed aspiration pneumonia post stroke. This low number may be deceiving as the majority of patients admitted had mild symptoms [5626 (61.2%) of patients had an NIHSS of <4]. The odds of aspiration pneumonia was 1.87 in patients with admission NIHSS of 5-9 (n=1965), increasing to 5.98 in patients with NIHSS of 10 or more (n=1606). Patients with aspiration pneumonia also stayed an average of 10 days longer in the hospital compared to patients without. A higher proportion of patients with aspiration pneumonia had an unfavorable outcome at 90 days. They were also more likely to have higher mortality rates at 90 days and MACE at 1 year. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward.

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High NIHSS has also been shown to be correlated with increased rates of dysphagia and aspiration pneumonia due to stroke severity.²⁸ Patients with aspiration pneumonia in the Qatar dataset had comparatively higher NIHSS at presentation as compared to patients without pneumonia (14.7 v 5.1, p<0.001). Garavelli et al²⁹ demonstrated that an NIHSS cut-off of \geq 10.5 was associated with higher rates of dysphagia (p=0.014) and aspiration pneumonia (p=0.006). Similarly, Jeyaseelan et al²⁸ demonstrated NIHSS > 9 as being moderately predictive of clinically relevant dysphagia, with dysphagia rates increasing with greater NIHSS scores (p<0.001). Okubo et al³⁰ also showed an NIHSS cut-off of 12 sensitive for dysphagia detection, with 14 (87.5%) of the 16 patients with dysphagia having NIHSS scores \geq 12 and 2 (12.5%) patients having scores of 10 and 11. NIHSS >12 also has an independent association with persistent dysphagia at hospital discharge in acute ischemic stroke patients with dysphagia at stroke onset, with one of its sub-components–dysarthria–emerging as a significant independent predictor of prolonged dysphagia.³¹ In our current study, the odds of developing aspiration pneumonia increased as NIHSS score increased.

Several studies have reported the adverse outcomes of aspiration pneumonia on stroke patients. In a study comprised of 610,668 stroke patients, Barlas et al³² reported that patients with stroke-associated pneumonia (SAP) had significantly higher odds of in-hospital mortality (OR of 2.90, 95% CI: 2.83–2.96), and longer length of stay (OR 13.11, 95% CI: 12.83–13.40). While they analyzed data from both ischemic and hemorrhagic strokes, patients with ischemic stroke were more likely to die in hospital and experience long length of stay (LOS).³² Teh et al³³ had similar observations in his cohort of 9238 patients from the UK. SAP was found in 1083 (11.7%) patients, out of which 60.8% were aspiration pneumonia.³³ After controlling for confounders, SAP was found to be associated with increased mortality up to 1 year (inpatient, 90-day, 1 year),

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prolonged LOS, and poor functional outcome on discharge.³³ In our current study, patients who developed aspiration pneumonia with an admission NIHSS of 5-9 had a 16.9% mortality rate at 90 days in contrast to 1.9% for patients who did not develop aspiration pneumonia. Similarly, patients who developed aspiration pneumonia with an admission NIHSS >10 had higher mortality rates at 90 days (22.3% vs. 13.8%, p=0.003).

Dysphagia is a common feature of severe stroke and an indicator of poor prognosis. It is implicated in the development of aspiration pneumonia, and it results in longer LOS and increased mortality. In stroke patients with dysphagia, early nutritional support is vital, and the decision to initiate that depends on the outcome of the swallow study.³⁴ Multiple national and international guidelines recommend that people with acute stroke have their swallowing screened by a trained healthcare professional by utilizing a validated screening tool and that the patients remain nothing per oral (NPO) until a swallow screen is performed.¹⁷ Bedside swallow screening tools include the functional bedside aspiration screen (FBAS), GLOBE-3S (the Sapienza GLObal Bedside Evaluation of Swallowing after Stroke), water swallowing test, volumeviscosity swallow test, and the Gugging swallow screen. However, despite these recommendations, in our study 34.6% of patients did not undergo swallow screen prior to PO intake in the ED and 32.7% patient did not have SLP assessment within 24 hours of admission. Likely explanations for these findings include ED nursing inadvertently giving patients PO medications, or SLPs not being available over the weekend, hence leading to an inability to perform assessment within 24 hours of presentation.

Similar to previous reports, we observed a significantly higher risk of aspiration pneumonia in the patients admitted to the medical ward compared to the stroke ward (5.3% vs. 3.7%, p=0.01). Admission to the stroke ward, by prevention of medical complications, results in

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reduced length of stay, decreased incidence of complications, improved prognosis at discharge and at 90 days (higher % of mRS scores of 0-2).^{35,36} Similarly, in our current study, fewer patients developed aspiration pneumonia if they were admitted to the stroke ward versus medicine ward (3.7% vs. 5.3%, p=0.01). Multivariable logistic regression identified admission location as an independent predictor of aspiration pneumonia, with patients admitted to the medicine ward having higher risks of developing aspiration pneumonia (aOR 1.56, 95% CI: 1.05-2.31). In our study population, we also observed that 19.9% patients with an NIHSS >10 and admitted to the medicine ward developed aspiration pneumonia in contrast to patients with an NIHSS > 10 and admitted to the stroke ward (9.9%; p<0.001). Thus, healthcare providers should be judicious of the placement of their stroke patients if they would like to reduce the incidence of aspiration pneumonia.

We also observed that patients with small vessel disease or subcortical stroke were less likely to develop aspiration pneumonia in contrast to patients with cardioembolic stroke, large vessel disease, stroke of undetermined etiology, and stroke of determined etiology. This is consistent with Alberts et al's study, who reported a low occurrence of aspiration in small vessel infarcts compared to those with both large- and small vessel infarcts (p=0.002).³⁷ Similarly, Jitpratoom et al³⁸ observed that 40.7% of their patients with cardioembolic stroke developed aspiration pneumonia in contrast to 11.1% for small vessel occlusion. Multivariable logistic regression analysis revealed that type of stroke was an independent predictor of aspiration pneumonia, specifically for large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke of undetermined etiology. A potential explanation for this is that patients with small vessel disease have milder stroke symptoms and fewer neurological deficits in contrast to the other stroke subtypes,³⁹ therefore they might have more preserve/control of their

facial, palatal, and pharyngal muscles, reducing their risks of developing dysphagia and aspiration pneumonia. However, additional studies are needed to unravel this relationship.

There are several limitations with our study. Our patient sample is comprised of largely Middle Eastern ethnicity (Qatari, Arabs), South Asian and Far Eastern (Asians) (97.7% vs. 2.3% for Caucasians), therefore lacks generalizability. We also had missing data for the mRS score at 90 days for 1846 patients (out of 9197). Since Qatar's population is comprised mainly of expatriate workers, it is not possible to collect data for patients who may have moved back to their home country once their work contract ended.

Conclusion

This large study in prospectively collected patients with acute stroke identified multiple factors associated with an increased risk of aspiration pneumonia. Patients who developed aspiration pneumonia were older, presented with more severe neurological symptoms, and stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia. Patients with large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke of undetermined etiology were more likely to develop aspiration pneumonia. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward. Our study showed that aspiration pneumonia was associated with an unfavorable prognosis (mRS 3-6) and increased mortality at 90 days in patients with moderate and severe symptoms.

Data Availability Statement

The Qatar Stroke Registry dataset will be available on reasonable request to the corresponding author.

Ethics Statement

The studies involving humans were approved by the Institutional Review Board of the Medical Research Centre at Hamad Medical Corporation (MRC-01-18-102). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Declaration of conflicting interests

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Authors Contribution

KHT: Writing-original draft, Formal analysis.

NA: Formal analysis, Methodology, Supervision, Reviewing draft.

AA: Writing, Reviewing draft

SJ: Data curation and Validation.

RU: Data curation and Validation.

DM: Data curation and Validation.

BB: Data curation, Methodology.

AS: Conceptualization, reviewing, editing & guarantor.

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	BMJ Open
	References
1.	Chang MC, Choo YJ, Seo KC, Yang S. The Relationship Between Dysphagia and Pneumonia in Acute Stroke Patients: A Systematic Review and Meta-Analysis. <i>Front Neurol.</i> 2022;13. doi:10.3389/fneur.2022.834240
2.	Teasell R, Foley N, Martino R, et al. Dysphagia and Aspiration Following Stroke.
3.	Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. <i>Stroke</i> . 2005;36(12):2756-2763. doi:10.1161/01.STR.0000190056.76543.eb
4.	Meng PP, Zhang SC, Han C, Wang Q, Bai GT, Yue SW. The Occurrence Rate of Swallowing Disorders After Stroke Patients in Asia: A PRISMA-Compliant Systematic Review and Meta-Analysis. <i>J Stroke Cerebrovasc Dis</i> . 2020;29(10):105113. doi:10.1016/j.jstrokecerebrovasdis.2020.105113
5.	Takizawa C, Gemmell E, Kenworthy J, Speyer R. A Systematic Review of the Prevalence of Oropharyngeal Dysphagia in Stroke, Parkinson's Disease, Alzheimer's Disease, Head Injury, and Pneumonia. <i>Dysphagia</i> . 2016;31(3):434-441. doi:10.1007/s00455-016-9695-9
6.	Avan A, Digaleh H, Di Napoli M, et al. Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: an ecological analysis from the Global Burden of Disease Study 2017. <i>BMC Med.</i> 2019;17(1):191. doi:10.1186/s12916-019-1397-3
7.	Cohen DL, Roffe C, Beavan J, et al. Post-stroke dysphagia: A review and design considerations for future trials. <i>Int J Stroke</i> . 2016;11(4):399-411. doi:10.1177/1747493016639057
8.	Banda KJ, Chu H, Kang XL, et al. Prevalence of dysphagia and risk of pneumonia and mortality in acute stroke patients: a meta-analysis. <i>BMC Geriatr</i> . 2022;22:420. doi:10.1186/s12877-022-02960-5
9.	Son YG, Shin J, Ryu HG. Pneumonitis and pneumonia after aspiration. <i>J Dent Anesth Pain Med</i> . 2017;17(1):1-12. doi:10.17245/jdapm.2017.17.1.1
10.	Hu X, Yi ES, Ryu JH. Aspiration-Related Deaths in 57 Consecutive Patients: Autopsy Study. <i>PLoS One</i> . 2014;9(7):e103795. doi:10.1371/journal.pone.0103795
11.	Makhnevich A, Feldhamer KH, Kast CL, Sinvani L. Aspiration Pneumonia in Older Adults. <i>J Hosp Med.</i> 2019;14(7):429-435. doi:10.12788/jhm.3154
12.	Schallom M, Dykeman B, Metheny N, Kirby J, Pierce J. Head-of-bed elevation and early outcomes of gastric reflux, aspiration and pressure ulcers: a feasibility study. <i>Am J Crit Care</i> . 2015;24(1):57-66. doi:10.4037/ajcc2015781

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

13. Metheny NA. Risk factors for aspiration. *JPEN J Parenter Enteral Nutr*. 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605

- Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with stroke in Northeast Nigeria. *International Journal of Stroke*. 2013;8(4):E16-E16. doi:10.1111/ijs.12095
- Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration, Choking Risk, Modified Food Texture and Autonomy of Choice. *Geriatrics (Basel)*. 2018;3(4):69. doi:10.3390/geriatrics3040069
- Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. *Neurology*. 2003;60(4):620-625. doi:10.1212/01.wnl.0000046586.38284.60
- 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(3-4):99-107. doi:10.1159/000492730
- 18. Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic strategy for aspiration pneumonia. *Respir Investig.* 2022;60(1):45-55. doi:10.1016/j.resinv.2021.09.012
- 19. 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. *IJGM*. 2023;16:1303-1315. doi:10.2147/IJGM.S400420
- 20. Gupte T, Knack A, Cramer JD. Mortality from Aspiration Pneumonia: Incidence, Trends, and Risk Factors. *Dysphagia*. 2022;37(6):1493-1500. doi:10.1007/s00455-022-10412-w
- 21. Pacheco-Castilho AC, Vanin G de M, Dantas RO, Pontes-Neto OM, Martino R. Dysphagia and Associated Pneumonia in Stroke Patients from Brazil: A Systematic Review. *Dysphagia*. 2019;34(4):499-520. doi:10.1007/s00455-019-10021-0
- Imam YZ, Kamran S, Saqqur M, et al. Stroke in the adult Qatari population (Q-stroke) a hospital-based retrospective cohort study. *PLoS One*. 2020;15(9):e0238865. doi:10.1371/journal.pone.0238865
- 23. Hatano S. Experience from a multicentre stroke register: a preliminary report. *Bull World Health Organ*. 1976;54(5):541-553.
- 24. Adams HP, Bendixen BH, Kappelle LJ, et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. *Stroke*. 1993;24(1):35-41. doi:10.1161/01.str.24.1.35
- 25. Touma L, Filion KB, Sterling LH, Atallah R, Windle SB, Eisenberg MJ. Stent Retrievers for the Treatment of Acute Ischemic Stroke: A Systematic Review and Meta-analysis of

BMJ Open

	Randomized Clinical Trials. <i>JAMA Neurol</i> . 2016;73(3):275-281. doi:10.1001/jamaneurol.2015.4441
26.	d'Emden MC, Shaw JE, Jones GR, Cheung NW. Guidance concerning the use of glycated haemoglobin (HbA1c) for the diagnosis of diabetes mellitus. <i>Med J Aust.</i> 2015;203(2):89-90. doi:10.5694/mja15.00041
27.	Akhtar N, Salam A, Kamran S, et al. Ethnic variation in acute cerebrovascular disease: Analysis from the Qatar stroke registry. <i>Eur Stroke J</i> . 2016;1(3):231-241. doi:10.1177/2396987316663776
28.	Jeyaseelan RD, Vargo MM, Chae J. National Institutes of Health Stroke Scale (NIHSS) as An Early Predictor of Poststroke Dysphagia. <i>PM&R</i> . 2015;7(6):593-598. doi:10.1016/j.pmrj.2014.12.007
29.	Garavelli F, Ghelfi AM, Kilstein JG. Usefulness of NIHSS score as a predictor of non- neurological in-hospital complications in stroke. <i>Medicina Clínica (English Edition)</i> . 2021;157(9):434-437. doi:10.1016/j.medcle.2020.07.045
30.	Okubo PCMI, Fábio SRC, Domenis DR, Takayanagui OM. Using the National Institute of Health Stroke Scale to predict dysphagia in acute ischemic stroke. <i>Cerebrovasc Dis</i> . 2012;33(6):501-507. doi:10.1159/000336240
31.	Kumar S, Doughty C, Doros G, et al. Recovery of Swallowing after Dysphagic Stroke: An Analysis of Prognostic Factors. <i>Journal of Stroke and Cerebrovascular Diseases</i> . 2014;23(1):56-62. doi:10.1016/j.jstrokecerebrovasdis.2012.09.005
32.	Barlas RS, Clark AB, Bettencourt-Silva JH, et al. Pneumonia and Risk of Serious Adverse Outcomes in Hospitalized Strokes in Thailand. <i>J Stroke Cerebrovasc Dis</i> . 2019;28(6):1448- 1454. doi:10.1016/j.jstrokecerebrovasdis.2019.03.024
33.	Teh WH, Smith CJ, Barlas RS, et al. Impact of stroke-associated pneumonia on mortality, length of hospitalization, and functional outcome. <i>Acta Neurol Scand</i> . 2018;138(4):293-300. doi:10.1111/ane.12956
34.	Han TS, Lean ME, Fluck D, et al. Impact of delay in early swallow screening on pneumonia, length of stay in hospital, disability and mortality in acute stroke patients. <i>Eur J Clin Nutr</i> . 2018;72(11):1548-1554. doi:10.1038/s41430-018-0148-4
35.	Akhtar N, Kamran S, Singh R, et al. Beneficial Effects of Implementing Stroke Protocols Require Establishment of a Geographically Distinct Unit. <i>Stroke</i> . 2015;46(12):3494-3501. doi:10.1161/STROKEAHA.115.010552
36.	Tamm A, Siddiqui M, Shuaib A, et al. Impact of Stroke Care Unit on Patient Outcomes in a Community Hospital. <i>Stroke</i> . 2014;45(1):211-216. doi:10.1161/STROKEAHA.113.002504
37.	Alberts MJ, Horner J, Gray L, Brazer SR. Aspiration after stroke: Lesion analysis by brain MRI. <i>Dysphagia</i> . 1992;7(3):170-173. doi:10.1007/BF02493452
	20 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

- Jitpratoom P, Boonyasiri A. Factors associated with an increased risk of developing pneumonia during acute ischemic stroke hospitalization. *PLoS One*. 2024;19(1):e0296938. doi:10.1371/journal.pone.0296938
- 39. Grau AJ, Weimar C, Buggle F, et al. Risk Factors, Outcome, and Treatment in Subtypes of Ischemic Stroke. *Stroke*. 2001;32(11):2559-2566. doi:10.1161/hs1101.098524

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Table 1. Characteristics and outcome of acute ischemic stroke patients with aspiration pneumonia

	(m. 0047, 05, 00/)			
	(n=8817, 95.9%)	Pneumonia	(n= 9197)	
		(n= 380, 4.1%)		
Age	55.1±13.3	59.0±15.6	55.3±13.4	<0.001
Male Gender	7041 (79.9)	303 (79.7)	7344 (79.9)	0.95
Diabetes	5038 (57.1)	229 (60.3)	5267 (57.3)	0.22
Hypertension	6373 (72.3)	246 (64.7)	6619 (72.0)	<0.001
Dyslipidemia	4069 (46.1)	136 (35.8)	4205 (45.7)	<0.001
Prior Stroke or TIA	1156 (13.1)	63 (16.6)	1219 (13.3)	0.05
Coronary Artery Disease	1053 (11.9)	70 (18.4)	1123 (12.2)	<0.001
Atrial Fibrillation	664 (7.5)	73 (19.2)	737 (8.0)	<0.001
Active Smoking	2143 (24.3)	52 (13.7)	2195 (23.9)	<0.001
Ethnicitya				
Etimicity-	2062 (33 6)	160 (42 1)	2122 (22.0)	
Aldu South Asian	2502 (55.0) AE19 (E1.2)	169 (42.1)	3122 (33.3) 4696 (E1.0)	_
For Fostorn	4510 (51.2)	17 (4 5)	4000 (51.0)	<0.001
Far Eastern	755 (8.5) 282 (4.2)	17 (4.5)	//0 (8.4)	<0.001
Allical	302 (4.3)	20 (0.8)	400 (4.4)	_
Caucasian	202 (2.3)	9 (2.4)	211 (2.3)	
Mode of Arrival ^a				
FMS	6073 (68.9)	288 (75.8)	6361 (69.2)	<0.001
Non-Medical	2200 (25 0)	34 (8 9)	2234 (24 3)	
From Other Hospitals	372 (4.2)	15 (3.9)	387 (4.2)	_
mRS prior to acute stroke ^a				
0	7595 (86.1)	282 (74.2)	7877 (85.6)	
1	132 (1.5)	9 (2.4)	141 (1.5)	
2	312 (3.5)	12 (3.2)	324 (3.5)	
3	430 (4.9)	33 (8.7)	463 (5.0)	<0.001
4	196 (2.2)	23 (6.1)	219 (2.4)	
5	151 (1.7)	21 (5.5)	172 (1.9)	
NIHSS on admission	5.1 ± 5.54	14.65 ± 8.05	5.5 ± 6.0	<0.001
Onset Duration ^a				
Less than 4.5 Hours	2822 (32.0)	169 (44.5)	2991 (32.5)	
Between 4.5 till 24 hours	2890 (32.8)	145 (38.2)	3035 (33.0)	<0.001
More than 24 hours	3105 (35.2)	66 (17.4)	3171 (34.5)	
	0_00 (00.2)		0=1=(0.10)	
Thrombolysis Given	962 (10.9)	73 (19.2)	1035 (11.3)	<0.001
Mechanical Thrombectomy done	350 (4.0)	43 (11.3)	393 (4.3)	<0.001
BMI on admission	28.15±43.9	27.54±5.3	28.13±43.0	0.8
RBS on admission	9.6±7.5	10.4±5.05	9.6±7.4	0.04
HbA1c	7.51±2.42	7.6±2.4	7.51±2.41	0.64
Serum Cholesterol	4.84±1.52	4.6±1.75	4.83±1.53	0.01
Serum Triglyceride	1.8±1.76	1.45±0.83	1.77±1.73	0.002
Serum HDL	1.1±3.24	1.43±6.34	1.10±3.38	0.12
Serum LDL	3.1±1.8	2.82±1.25	3.1±1.8	0.03
Systolic Blood Pressure	157.8±44.23	149.44±29.15	157.42±43.73	0.00
Diastolic Blood Pressure	91.1±22.4	86.4±19.4	90.9±22.3	0.00
		16 0+14 93	5 70+9 2	0.00

Disposition ^a				
Discharged Home	5726 (64.9)	44 (11.6)	5770 (62.7)	
Rehabilitation	2079 (23.6)	89 (23.4)	2168 (23.6)	
Long term care	151 (1.7)	97 (25.5)	248 (2.7)	<0.001
Transfer to other facility	732 (8.3)	109 (28.7)	841 (9.1)	
Died as in-patient	129 (1.5)	41 (10.8)	170 (1.8)	
TOAST Classification ^a				
Small Vessel Disease	4213 (47.8)	36 (9.5)	4249 (46.2)	
Large Vessel Disease	1772 (20.1)	141 (37.1)	1913 (20.8)	<0.001
Cardio-Embolic	1744 (19.8)	137 (36.1)	1881 (20.5)	
Stroke of Determined Etiology	612 (6.9)	31 (8.2)	643 (7.0)	
Stroke of Undetermined Etiology	476 (5.4)	35 (9.2)	511 (5.6)	
Swallow Screen done before oral intake	5820 (66.0)	197 (51.8)	6017 (65.4)	<0.001
Speech therapy assessment done	6024 (68.3)	161 (42.4)	6185 (67.3)	<0.001
Speech Therapy assessment duration (hours)	31.7±309.7	77.9±694.32	32.85±325.45	0.07
Antibiotics given	626 (7.1)	361 (95.0)	987 (10.7)	<0.001

Abbreviations: BMI, Body Mass Index; ED, emergency department; HDL, High density lipoprotein; ICU,

intensive care unit; LDL, Low density lipoprotein; MACE, major adverse cardiac event; mRS, Modified

Rankin Score; NIHSS, National Institute of Health Stroke Scale; RBS, Random blood sugar

^ap-value reported based on Pearson-Chi Square Test

Values are reported as mean ± standard deviation and n(%)

Table 2. Characteristics and outcome of acute ischemic stroke patients with aspiration

pneumonia based on their NIHSS admission

Characteristic or Investigation	No Pneumonia	Aspiration	Total	P-Value
	(n=8817, 95.9%)	Pneumonia	(n= 9197)	
		(n= 380, 4.1%)		
NIHSS Severity				
Mild Stroke (NIHSS 0-4)	5570 (63.2)	56 (14.7)	5626 (61.2)	<0.001
Moderate Stroke (NIHSS 5-9)	1906 (21.6)	59 (15.5)	1965(21.4)	
Severe Stroke (NIHSS 10 or more)	1341 (15.2)	265 (69.7)	1606 (17.5)	
NIHSS (5-9)				
90-Days Mortality	36 (1.9)	10 (16.9)	46 (2.3)	<0.001
MACE at 1 year	72 (3.8)	14 (23.7)	86 (4.4)	<0.001
Admission Location				
Stroke Ward	1281 (67.2)	35 (59.3)	1316 (67.0)	
Medicine Ward	250 (13.1)	10 (16.9)	45 (13.2)	0.31
Duration of ED Stay Category ^a				
<4 hours	249 (13.1)	2 (3.4)	251 (12.8)	
4-8 hours	555 (29.1)	23 (39.0)	578 (29.4)	
>8 hours	750 (39.3)	26 (44.1)	776 (39.5)	0.052
Length of Stay	5.89±10.0	17.1±19.4	6.23±10.5	<0.001
Prognosis – At Discharge				
Good (mRS 0–2)	814 (42.7)	4 (6.8)	818 (41.6)	<0.001
Poor (mRS 3-6)	1092 (57.3)	55 (93.2)	1147 (58.4)	
Prognosis – At 90 Days				
Good (mRS 0–2)	876 (46.0)	6 (10.2)	882 (44.9)	<0.001
Poor (mRS 3-6)	580 (30.4)	44 (74.6)	624 (31.8)	
Mortality at Discharge	9 (0.5)	7 (11.9)	16 (0.8)	<0.001
90 Days Mortality	36 (1.9)	10 (16.9)	46 (2.3)	<0.001
mRS at 90 Days ^a				
0	446 (23.4)	0 (0)	446 (22.7)	
1	212 (11.1)	3 (5.1)	215 (10.4)	
2	218 (11.4)	3 (5.1)	221 (11.2)	
3	325 (17.1)	6 (10.2)	331 (16.8)	<0.001
4	160 (8.4)	10 (16.9)	170 (8.7)	
5	59 (3.1)	18 (30.5)	77 (3.9)	
6	36 (1.9)	10 (16.9)	46 (2.3)	
NIHSS (>10)				
90-Days Mortality	185 (13.8)	59 (22.3)	244 (15.2)	0.003
MACE at 1 year	217 (16.2)	73 (27.5)	290 (18.1)	<0.001
Admission Location				
Stroke Ward	834 (62.2)	92 (34.7)	926 (57.7)	
Medicine Ward	166 (12.4)	40 (15.1)	206 (12.8)	<0.001
Duration of ED Stay Category ^a				
<4 hours	288 (21.5)	41 (15.5)	329 (20.5)	
4-8 hours	446 (33.3)	87 (32.8)	533 (33.2)	0.09
>8 hours	470 (35.0)	103 (38.9)	573 (35.7)	
Length of Stay	9.2±9.8	16.6±14.6	10.4±11.2	<0.001
Prognosis – At Discharge				
Good (mRS 0–2)	247 (18.4)	5 (1.9)	252 (15.7)	<0.001
Poor (mRS 3-6)	1094 (81.6)	260 (98.1)	1354 (84.3)	
			•	

Prognosis – At 90 Days				
Good (mRS 0–2)	301 (22.4)	18 (6.8)	319 (19.9)	<0.001
Poor (mRS 3-6)	798 (59.5)	211 (79.6)	1009 (62.8)	
Mortality at Discharge	105 (7.8)	30 (11.3)	135 (8.4)	0.07
90 Days Mortality	185 (13.8)	59 (22.3)	244 (15.2)	<0.001
mRS at 90 Days ^a				
0	132 (9.8)	5 (1.9)	137 (8.5)	
1	72 (5.4)	3 (1.1)	75 (4.7)	
2	97 (7.2)	10 (3.8)	107 (6.7)	
3	219 (16.3)	18 (6.8)	237 (14.8)	<0.001
4	223 (16.6)	46 (17.4)	269 (16.7)	
5	171 (12.8)	88 (33.2)	259 (16.1)	
6	185 (13.8)	59 (22.3)	244 (15.2)	

Abbreviations: ED, emergency department; NIHSS, National Institute of Heath Stroke Scale; MACE, major adverse cardiovascular event; mRS, modified Rankin Scale.

Determinants			Bivariate l	ogistic regression and	n Multivasiate	رج ع Multivațiate logistic regression analysis			
	No Pneumonia	Aspiration Pneumonia	Standardized Beta	Odds ratio (95% CI)	p-value	Standazdized Began 7	Odds ratio (95% CI)	p-value	
Age	55.3 ± 13.4	59.0 ± 15.6	0.021	1.02 (1.01–1.03)	<.001	0.0 0.0 0.0 0.0 0.0	1.02 (1.01– 1.03)	0.002	
Sex						d to			
Female	1776 (95.8)	77 (4.2)	-	1	-	o tex	1	-	
Male	7041 (95.9)	303 (4.1)	-0.007	0.99 (0.77–1.28)	0.95	0.44 and	1.56 (1.05– 2.32)	0.03	
TOAST						d fro dat			
SVD	4213 (99.2)	36 (0.8)	-	1	-	a mi	1	-	
LVD	1772 (92.6)	141 (7.4)	2.231	9.31 (6.43–13.48)	<.001	ning. 1.4ng, A	4.11 (2.52– 6.69)	<.001	
CE	1744 (92.7)	137 (7.3)	2.218	9.19 (6.34–13.33)	<.001	1.3966 jopen	3.69 (2.23– 6.12)	<.001	
SDA	612 (95.2)	31 (4.8)	1.780	5.93 (3.64–9.65)	<.001	1.1.039 mi.o	3.25 (1.75– 6.03)	<.001	
SUD	476 (93.2)	35 (6.8)	2.152	8.61 (5.35–13.83)	<.001	1.4058 000 000	4.09 (1.98– 8.46)	<.001	
Mode of						ı Jun lar te			
transport						ichn			
From Other Hospitals	372 (96.1)	15 (3.9)	-	1	-	, 2025 at olpgies.	1	-	
EMS	6073 (95.5)	288 (4.5)	0.162	1.18 (0.69–2.00)	0.55	0.184 Agen	1.20 (0.55– 2.64)	0.65	
Non-Medical	2200 (98.5)	34 (1.5)	-0.959	0.38 (0.21–0.71)	0.00	0.032 B	1.03 (0.43– 2.47)	0.94	
Onset Duration		For poor route	woody http://kmia	non hmi com (site (shaw	t/auidaliaaa	ographique de		26	
		For peer revie	w only - nttp://bmJo	pen.pmj.com/site/abou	i/guidelines.x				

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1 2							1-202 byrigl			
3 4	<4.5 hours	2822 (94.3)	169 (5.7)	-	1	-	4-09; ht, in	1	-	
5 6	4.5-24 hours	3890 (96.4)	145 (3.6)	-0.177	0.84 (0.67–1.05)	<.001	0.106 or	1.06 (0.68– 1.65)	0.79	
7 8	>24 hours	3105 (97.9)	66 (2.1)	-1.036	0.36 (0.27–0.47)	<.001		1.15 (0.82– 1.61)	0.43	
9 10	Duration in ER						arch ≘nse ses r			
11 12	<4 hours	809 (94.2)	50 (5.8)	-	1	-	2025 elate	1	-	
12 13 14	4-8 hours	1711 (93.3)	122 (6.7)	0.143	1.15 (0.82–1.62)	0.41	0.3 to te	1.41 (0.90– 2.20)	0.13	
15 16	>8 hours	2749 (94.8)	151 (5.2)	-0.118	0.89 (0.64–1.24)	0.48	0.2 and	1.24 (0.80– 1.93)	0.34	
17 18	NIHSS						d fro data			
19	Mild Stroke (0-	5570 (99.0)	56 (1.0)	-	1	-	a min	1	-	
20 21	4)						ing,			
22 23	Moderate Stroke (5-14)	1906 (97.0)	59 (3.0)	1.125	3.08 (2.13–4.45)	<.001	0.6 ⊉ 5 mjoper	1.87 (1.19– 2.94)	0.01	
24 25 26	Severe Stroke	1341 (83.5)	265 (16.5)	2.978	19.66 (14.64– 26.38)	<.001	1.7488 and	5.98 (3.92– 9.11)	<.001	
27 28	(>10)						d sim			
29	Admission						n Ju Nilar 1			
30 31		3819 (96.3)	147 (3.7)	-	1	_	ne 1, echņ	1	-	
32 33	Stroke ward	1248 (94 7)	70 (5 2)	0 277	1 46 (1 00-1 05)	0.01		1 56 (1 05-	0.03	
33 34 35 36 37 38 39 40 41 42 43	Medicine Ward	1240 (34.7)	, (3.3)	0.577	1.40 (1.05 1.55)	0.01	25 at Agence Bibliographiqu µes. 5	2.31)	0.03	
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1 2 3	copyriging Iginitiana CE, cardioambalia stroko. CL confidence interval: EMS, emergency medical convises. ED, emergency	pen-2024
4	Abbreviations: CE, cardioembolic stroke; CI, confidence interval; EMS, emergency medical services; ER, emergency	රුළුm; LVD, large vessel
6	disease; NIHSS, National Institute of Health Stroke Scale; SDA, stroke of determined etiology; SVD, small vessel di	ase; SUD, stroke of
7 8	undetermined etiology.	21 N
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19	Figure 1 Broportion of aspiration photomonia between stroke ward vs. modicine ward	
20 21	rigure 1. Proportion of aspiration pheumonia between stroke ward vs. medicine ward	
22	*p ≤ 0.05	omjo
23 24	Figure 2 Proportion of mBS at 90 days for patients with an NIHSS of 5-9	pen.
25 26		bmj.c
27 28	Figure 3. Proportion of mRS at 90 days for patients with an NIHSS of >10 Image: Comparison of mRS at 90 days for patients with an NIHSS of >10	on/ or
29 30 31	Figure 4. Forest Plot based on the results of multivariate analysis of the factors associated with aspiration	p h eumonia.
32	Abbreviations: CI, confidence interval; OR, odds ratio.	11, 2
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	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc	SVD v ^{BMJC}	SVD ^{Ope} vs.	SVD vs.	SVD vs.	LVD vs.	ctecLV2D dtv⊑t.	LVD vs.	CE vs.	CE vs. ^{Pag}	SDA Je 3 ¢ s f 35
				е	LVD ¹	CE ¹	SDA ¹	SUD ¹	CE ¹	SDA¹	SUD ¹	SDA 1	SUD	SUD ¹
TOAST				<.001	<.001	<.001	<.001	<.001	1.00	Y 0.05	1.00	0.06	1.00	0.82
² Small vessel ³ disease	4249 (46.2)	4213 (99.2)	36 (0.8)	_	-	-	-	_	_)2/4-09 ight, ii	_	_	-	_
⁴ Large vessel 5 disease	1913 (20.8)	1772 (92.6)	141 (7.4)	-	-	-	-	-	-	3328 ncludi	-	-	-	-
⁶ Cardioembolic	1881 (20.5)	1744 (92.7)	137 (7.3)	_	-	-	-	-	-	oŋ 21 ng for	-	_	-	-
9 Determined 10 etiology	643 (7.0)	612 (95.2)	31 (4.8)	-	-	-	-	-	-	March Ens uses	-	-	-	-
1 Undetermined 12 etiology	511 (5.6)	476 (93.2)	35 (6.8)	_	-	-	-	-	_	1 2025 eignei relate	_	_	-	-
12 13 14 15	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	EMS vs. NM ¹	EMS vs. OH ¹	NM vs. OH ¹			. Downlo ment Sup d to text				
1 <mark>Mode of</mark> ₁ŧransport				<.001	<.001	1.00	0.07			aded berieu and d				
18 EMS	6361 (69.2)	6073 (95.5)	288 (4.5)	-	-	-	-	-	-	frøm f r (ABE lata m	-	-	-	-
20 Non-Medical	2234 (24.3)	2200 (98.5)	34 (1.5)	-	7	-	_	_	_	tttp://t ≘S) . ining,	_	_	-	-
22 From Other23 Hospitals	387 (4.2)	372 (96.1)	15 (3.9)	-	_	-	-	-	-	onpjop Al tra	-	-	-	-
24 25 26 27 28 29	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	<4.5 hours vs. 4.5-24 hours ¹	<4.5 hours vs. >24 hours	4.5-24 hours vs. >24 hours ¹	0,		en.bmj.com/ on J ining, and similar				
3Onset				<.001	0.26	<.001	<.001			une				
32 <4.5 hours	2991 (32.5)	2822 (94.3)	169 (5.7)	_	-	-	-	- 4	-	11,,202	-	-	-	-
34 4.5-24 hours 35	3035 (33.0)	2890 (95.2)	145 (4.8)	-	-	-	-	-	-	ies.	_	-	-	-
36 >24 hours 37	3171 (34.5)	3105 (97.9)	66 (2.1)	_	-	-	-	-	-	gęnce	_	-	-	-
38 39 40	Överall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	<4 hours	<4 hours vs. >8	4-8 hours			Bibliogr				
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Pag 1	e 35 of 35					BMJ (Open				36/bmjopen-20 cted by copyri				
2 3 4						vs. 4-8 hours ¹	hours	vs. >8 hours ¹			24-093: ght, inc				
⁵ Du	ration in				0.11	1.00	1.00	0.11			328 o				
7 7 8	<4 hours	859	809 (94.2)	50 (5.8)	-	-	-	-	-	-	n 21 N g for u	-	-	-	-
9 10	4-8 hours	(15.4) 1833	1711	122 (6.7)	_	_	_	_	_	_	larch : Ensei uses r	_	_	_	_
11		(32.8)	(93.3)								202: elat				
12 13	>8 hours	2900 (51.9)	2749 (94.8)	151 (5.2)	-	_	-	_	-	-	54 Dov ement ed to t	-	-	-	-
14 15 16		Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	0-4 vs. 5-14 ¹	0-4 vs. >15 ¹	5-14 vs. >15 ¹			nloadec Superie text and				
	HSS				<.001	<.001	<.001	<.001			data				
19	lild Stroke	5626	5570	56 (1.0)	- 6		_	-	_	—		_	-	_	_
20	(0-4)	(61.2)	(99.0)			6					nin(S)				
21 22c	Moderate	1965	1906	59 (3.0)	-	-	—	-	-	-	g, Al	-	-	-	-
23e	vere Stroke	1606	1341	265 (16 5)	_	_		_	_	_	traii	_	_	_	_
24 25	(>10)	(17.5)	(83.5)	200 (1010)							ning				
26 27 28 29 30	T a ¹ E	i ble S1. C Bonferroni	linical characte	eristics amonę ave been appl	g patients witl ied to the p-v	h aspirat alues rep	ion pnet ported	umonia ve	ersus tho	se with	nj.com/on June , and similar teo	ation pne	umonia		
31 32	Ab	breviatior	ns: CE, cardioe	embolic; EMS	, emergency	medical	service;	LVD, larg	e vessel	diseas	eg NAM, no	on-medic	al; OH,		
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	В	MJ Open	√bmjopen ed by cop
NIHSS	No Pneumonia	Aspiration Pneumonia	Ströke Ward vs. Medici
Mild Stroke (0-4)			
Admission Location			ng
Stroke Ward	1704 (98.8)	20 (1.2)	f 2 0.03*
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Moderate Stoke (5-9)			es rch
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Medicine Ward	250 (96.2)	10 (3.8)	d to
Severe Stroke (>10)			o te
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Stroke Ward	834 (90.1)	92 (9.9)	nd e g
Medicine Ward	166 (80.1)	40 (19.9)	da ^{úr} fr
Table S2. Comparison of NI⊦	ISS score and admission loc	cation among patients with aspi	يق . ک ration gneaimonia versus t
Table S2. Comparison of NI⊦ without aspiration pneumonia	ISS score and admission loc using Fisher's Exact Test	cation among patients with aspir	ration faining, and similar technologies.

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Impact of Stroke Severity on Aspiration Pneumonia Risks in the Medical Ward versus the Stroke Unit: A 10-Year Retrospective Cohort Study

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Impact of Stroke Severity on Aspiration Pneumonia Risks in the Medical Ward versus the Stroke Unit: A 10-Year Retrospective Cohort Study

Running Title: Risk factors associated with aspiration pneumonia

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Abstract

Objective: Aspiration pneumonia is a common complication post-stroke that increases patient's duration of stay in hospital, mortality, and morbidity. We examined the incidence, clinical characteristics, and outcomes among ischemic stroke-related aspiration pneumonia patients in Qatar.

Settings and participants: The Qatar Stroke database was reviewed for acute ischemic stroke patients admitted to Hamad General Hospital, a tertiary care medical facility, between January 2014 to April 2024.

Outcomes: Patients were prospectively assessed for mortality at 90 days, modified Rankin Score at 90 days, and length of stay. Several clinical characteristics were also compared between acute ischemic stroke patients who developed aspiration pneumonia versus those without.

Results: Stroke patients who developed aspiration pneumonia tended to be older and of the male sex. Patients who developed aspiration pneumonia were also more likely to present with a higher NIHSS at admission (p<0.001). Patients with large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke of undetermined etiology were more likely to develop aspiration pneumonia. They also stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia (16.0 vs. 5.3 days). Patients admitted to the medicine ward had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward (aOR of 1.56, 95% CI: 1.05-2.31). Patients with aspiration pneumonia had unfavorable outcome (mRS 3-6) at 90 days (74.6% vs. 30.4% for an NIHSS admission score of 5-9 and 79.6% vs. 59.5% for an NIHSS admission >10). They were also more likely to have higher mortality rates at 90 days (16.9% vs. 1.9% for an NIHSS admission score of 5-9 and 22.3% vs. 13.8% for an NIHSS admission score >10) and major adverse cardiovascular event at

1 year (23.7% vs. 3.8% for an NIHSS admission score of 5-9 and 27.5% vs. 16.2% for NIHSS >10).

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Conclusion: Age, sex, admission NIHSS severity, stroke subtypes, and admission location are independent predictors of aspiration pneumonia post-stroke.

Keywords: Aspiration Pneumonia, Stroke, Dysphagia, Stroke-associated pneumonia

Strengths and limitations of this study:

- This study is based on a large stroke registry with 9197 acute ischemic stroke patients enrolled over a 10-year period.
- Our patient sample is comprised of largely Middle Eastern ethnicity, South Asian and Far Eastern, therefore lacks generalizability.

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Introduction

Stroke is a major cause of death and disability worldwide. Early in the course of the disease, stroke patients are at risk for medical complications including dysphagia and aspiration pneumonia.¹ Dysphagia is characterized by difficulty swallowing due to weakness/reduced coordination between facial, palatal, and pharyngeal muscles (due to reduced cortical connectivity between neural regions post-stroke).² The incidence of dysphagia after stroke ranges from 8.1–80%,^{3–7} it is frequently silent and it is highly associated with aspiration pneumonia.⁸ Dysphagia causes oral or gastric contents to enter the lung, which suppresses the natural defenses of the respiratory system, increasing the risks for opportunistic infections.^{9–11} Several studies have identified multiple risk factors associated with aspiration pneumonia, such as reduced level of consciousness, incorrect postures, and advanced age.^{12–15}

Pneumonia is one of the leading causes of mortality for acute stroke, with a 30-day mortality rate of up to 30%.¹⁶ Aspiration pneumonia also increases the risk of prolonged hospital stay and poor prognosis.¹⁷ Animal and clinical studies have demonstrated that silent aspiration (micro-aspiration due to dysphagia during the night) is the primary cause of aspiration pneumonia.¹⁸ Despite different preventative and therapeutic approaches for managing patients with aspiration pneumonia, its incidence and mortality rates remain high.¹⁹ For example, in a case-control study comprising of 1,112,944 patients, Gupte et al²⁰ reported that aspiration pneumonia due to cerebrovascular disease accounted for 11.7% of deaths in the United States (62,068 deaths per year from 1999 to 2017), with increasing mortality rates since 2009. In countries such as Egypt and Brazil, the incidence of aspiration pneumonia can be as high as 44% and 76%, respectively.^{19,21}

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There are very few studies on the incidence, causes, and outcomes of aspiration pneumonia from the Middle East and North Africa (MENA) region.²² This study aimed to assess the clinical characteristics and treatment outcomes among stroke-related aspiration pneumonia patients in Qatar.

Methods

Data from patients admitted with a stroke to Hamad General Hospital (HGH), Doha, Qatar from January 2014 through April 2024 were analyzed from a hospital based prospective stroke registry. HGH is a Joint Commission International (JCI) accredited 600-bed hospital, with 200 beds reserved for medical patients. It is the only tertiary care medical facility in Qatar where the stroke service is located, 95% of all strokes in Qatar requiring admission to hospital are admitted to HGH. The program provides 24-hour thrombolysis and thrombectomy services for acute stroke management. Patients are evaluated by the stroke team in the emergency department (ED), and urgent decisions about treatment are made. Hyperacute stroke patients are admitted to a dedicated 12-bed stroke unit or Medical ICU as necessary. Non-urgent stroke patients are admitted under the medical team, with neurology consultation in the ED. HGH has the required laboratory, neuroradiological, and neurosurgical infrastructure to manage stroke patients effectively. The stroke team is readily available to make immediate treatment decisions for acute stroke cases.

Study Variables

The primary outcome variables were duration of stay in the emergency department, length of stay, modified Rankin Score at 90 days, and mortality at 90 days.

The independent variables were age, sex, development of post-stroke pneumonia, and admission location (stroke ward versus medical ward).

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Patient characteristics including age, sex, ethnicity, medical comorbidities and prior medication were collected in the HGH Stroke Registry. National Institute of Health Stroke Scale (NIHSS) score, neuroimaging data, and post-discharge disposition were entered into the registry as well. Ischemic stroke was diagnosed according to the WHO criteria²³ and stroke subtypes were defined by the TOAST criteria.²⁴ The modified Rankin scale (mRS) measurements were done at discharge and at 90 days following onset of symptoms. The patients were classified as favourable (mRS \leq 0-2) or unfavourable (mRS 3-6) outcome. We used the dichotomized mRS scale to evaluate recovery at 90 days.²⁵ NIHSS score was developed by the National Institutes of Health and is widely referenced in clinical settings for stroke assessment. The tool is highly regarded for its reliability and ability to track neurological changes over time.²⁶ The Modified Rankin Scale (mRS) is a widely used tool to assess the degree of disability or dependence in individuals who have suffered a stroke or other neurological events. It measures the functional outcome of a patient after a neurological injury, such as a stroke, and evaluates the level of independence in daily activities.²⁷

Diabetes was diagnosed according to the American diabetes Association (ADA) and WHO recommendation²⁸ and included patients with a previous diagnosis of diabetes, on medication for diabetes or an HbA1c of more than 6.5%, and the diagnosis of pre-diabetes was based on an HbA1c of 5.7-6.4% as per the 2015 ADA clinical practice recommendations. Hypertension was defined as systolic blood pressure (BP) \geq 140 mm Hg or a diastolic pressure \geq 90 mm Hg, or on current treatment with antihypertensive drugs. Dyslipidemia was defined as low-density lipoprotein-cholesterol level \geq 3.62 mmol/L, high-density lipoprotein cholesterol level ≤ 1.03 mmol/L, triglycerides ≥ 1.69 mmol/L, or current treatment with a cholesterollowering drug.

Data Collection and inclusion/exclusion criteria

Upon identification and confirmation of diagnosis using the International Classification of Disease, 10th edition, definitions (H34.1, 163.x, 164.x, 161.x, 160.x, G45.x), patients' data were collected by trained stroke clinical nurse specialists. For our study, we only included patients diagnosed with acute ischemic stroke and excluded patients diagnosed with intracerebral hemorrhage, transient ischemic attacks, stroke mimics, and cerebral venous thrombosis. Clinical diagnosis (via assessing symptoms like fever, cough, dyspnea, and purulent sputum) and/or radiological imaging (CT and chest X-rays to identify lung consolidation or infiltrates indicative of pneumonia) were used to confirm the diagnosis of post-stroke aspiration pneumonia. Microbiological testing including sputum culture, blood cultures, and bronchoalveolar lavage were also performed when clinical or imaging diagnoses were inconclusive. The methods used are consistent with current guidelines.^{29,30}

Patient and Public Involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Data Quality Control

Data quality control in the HGH Stroke Registry was ensured through several key practices. Stroke coordinators received training on data collection and International Classification of Diseases (ICD)-10 coding, and standardized procedures are followed to maintain consistency. Diagnoses were confirmed using ICD-10 codes, and registry entries are cross-checked with patient records to ensure accuracy. Automated tools flag errors, and manual

reviews ensure corrections are made when necessary. Routine audits and continuous monitoring of data help identify and correct errors, maintaining the integrity of the registry. These measures help ensure high-quality, reliable data for stroke care analysis and improvement.

Data Analysis and statistics

Descriptive results for all continuous variables were reported as mean±standard deviation (SD) for normally distributed data or median with range for data with non-normal distributions. The distribution of continuous variables was assessed before using statistical tools. Mean level comparisons between patients with aspiration pneumonia versus without aspiration pneumonia were assessed using ANOVA test and multiple comparisons were performed using Bonferroni correction. If an assumption of an ANOVA test was failed, then an alternative non-parametric Kruskal Wallis test was performed. Pearson Chi-Square test and Fisher's Exact test were performed whenever appropriate to compare the proportion of all categorical variables between the groups. Multiple logistic regression analysis was performed to assess for risk factors associated with aspiration pneumonia after selecting important and significant variables at univariate analysis. Odds ratio (OR) and the 95% confidence interval for the OR were reported. A p-value of ≤0.05 (two-tailed) was considered significant. SPSS statistical package 29.0.1.0 was used for the analysis.

Results

Patient Characteristics

A total of 9197 patients were enrolled: 380 developed aspiration pneumonia (4.1%) during hospitalization while 8817 (95.9%) of the patients did not have pneumonia. The mean age of patients was 55.3 ± 13.4 years, with patients with aspiration pneumonia being significantly older than healthy controls (p<0.001). 80% were male, 57% had diabetes mellitus, 72% had

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hypertension, 46% had dyslipidemia, and 24% were active smokers. The high proportion of men is reflective of the very high male expatriate population as previously reported.³¹ A summary of patients' baseline characteristics is outlined in Table 1.

Since 95.9% of our patients did not have aspiration pneumonia, we performed subanalyses on clinical outcomes based on patients' admission NIHSS scores. Sub-analyses were performed for patients with an NIHSS of 5-9 (moderate stroke) and NIHSS >10 (severe stroke)

(Table 2).

Mode of transport

Mode of transport was significantly associated with aspiration pneumonia risks (p<0.001). However, this was only significant for emergency medical services (EMS) versus non-medical services (p<0.001), with a higher proportion of patients developing aspiration pneumonia via EMS (4.5%) versus non-medical services (1.5%). Patients transported with EMS had a significantly higher NIHSS at admission (5.9±6.1 vs. 3.3±3.7, p<0.001). The total sample size for EMS was 6361 versus 2234 for non-medical services.

Onset Duration

Duration of stroke symptoms from the time of onset to evaluation was significantly associated with aspiration pneumonia (p<0.001). This was only significant for <4.5 hours vs. >24 hours (p<0.001) and 4.5-24 hours vs. >24 hours (p<0.001). A stroke onset to emergency evaluation of <4.5 hours had the highest proportion of aspiration pneumonia (5.7%) versus 4.8% for onset duration of 4.5-24 hours and 2.1% for >24 hours (Table S1).

Duration of stay in Emergency Department

Duration of stay in the ED was not significantly associated with aspiration pneumonia (p=0.11) (Table S1). Furthermore, when we analyzed duration of stay in the ED based on NIHSS

scores (5-9 and >10), duration of stay in the ED remained non-significant (p=0.052 and 0.09), respectively (Table 2).

Stroke Diagnosis

Stroke diagnosis is shown in Table S1. Overall, type of stroke was significantly associated with aspiration pneumonia (p<0.001). Further analyses revealed that the risk of developing aspiration pneumonia was not significantly different between large vessel disease versus cardioembolic stroke (p=1.00), large vessel disease versus stroke of undetermined aetiology (p=1.00), cardioembolic stroke versus stroke of determined aetiology (p=0.06), cardioembolic stroke versus stroke of undetermined etiology (p=1.00), and stroke of determined aetiology versus stroke of undetermined aetiology (p=0.82).

Patients with small vessel disease had the lowest proportions of aspiration pneumonia (0.8%) compared to large vessel disease (7.4%), cardioembolic stroke (7.3%), stroke of determined etiology (4.8%), and stroke of undetermined etiology (6.8%), p<0.001 (Table 3). *Admission NIHSS Score*

Admission NIHSS score was significantly associated with aspiration pneumonia (p<0.001). Fisher's exact test revealed that there was a significant association between aspiration pneumonia for patients with an NIHSS score of 0-4 (p=0.03), and NIHSS score of >10, p<0.001 (Table S2). Patients with an NIHSS > 10 had the highest proportion of aspiration pneumonia (16.5%). Moreover, patients with an NIHSS >10 and concomitant aspiration pneumonia had higher rates of mortality at 90 days (22.3%) when compared to patients with an NIHSS score of 5-9 and concomitant aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2). In patients with aspiration pneumonia (16.9%) (p<0.001) (Table 2).

cardiovascular events (MACE) at 1 year compared to patients with an NIHSS of 5-9 (27.5% vs. 23.7%, p<0.001).

Length of stay

Patients with aspiration pneumonia stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia (16.0 days vs. 5.3 days, p=0.00). When analyzed via admission NIHSS severity, patients with aspiration pneumonia stayed significantly longer in the hospital compared to those without aspiration pneumonia (17.1 days vs. 5.9 days, p<0.001 for NIHSS of 5-9, and 16.6 days vs. 9.2 days, p<0.001 for NIHSS > 10).

Admission Location

Overall, 3966 (75.1%) patients were admitted to the stroke ward and 1318 (24.9%) patients were admitted to the medical ward. A higher proportion of patients admitted to the medicine ward developed aspiration pneumonia in contrast to patients admitted to the stroke ward (5.3% vs 3.7%, p=0.01) (Table 3). 2.3% of patients with an NIHSS of 0-4 and admitted to the medicine ward developed aspiration pneumonia compared to 1.2% of patients with an NIHSS of 0-4 and admitted to the stroke ward (p=0.03) (Table S2). Similarly, 19.9% of patients with an NIHSS >10 and admitted to the stroke ward developed aspiration pneumonia compared to 9.9% of patients with an NIHSS >10 and admitted to the stroke ward (p<0.001) (Figure 1).

Modified Rankin Scale at 90 days

A higher proportion of patients with aspiration pneumonia had an unfavorable outcome (mRS 3-6) at 90 days compared to patients without aspiration pneumonia (74.6% vs. 30.4% for NIHSS of 5-9), p<0.001 (Table 2). Similar observations were seen for NIHSS > 10 (79.6% vs. 59.5%, p<0.001). Figure 2 and 3 illustrates the proportion of mRS at 90 days based on NIHSS admission scores.

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Mortality at 90 days

For patients with an NIHSS score of 5-9, a higher proportion of patients with aspiration pneumonia died at 90 days (16.9%) compared to patients without aspiration pneumonia (1.9%), p<0.001. Similar observations were seen for NIHSS > 10 (22.3% vs. 13.8%, p=0.003). *Multivariate analysis for risk factors associated with aspiration pneumonia*

Table 3 describes a multiple binary logistic regression model to identify significant independent factors associated with the development of aspiration pneumonia after selecting important and significant variables at bivariate analysis. Males were more likely than females to have aspiration pneumonia risks [aOR 1.56, 95% CI: 1.05-2.32, p=0.03]. Age was significantly associated with aspiration pneumonia [aOR 1.02, 95% CI: 1.01-1.03, p=0.002], with patients with aspiration pneumonia being significantly older (p<0.001). Large vessel disease was significantly associated with aspiration pneumonia [aOR 4.11, 95% CI: 2.52-6.69, p<0.001]. Similar observations were seen for cardioembolic stroke (p<0.001), stroke of determined aetiology (p<0.001), and stroke of undetermined aetiology (p<0.001), see Table 3. Patients with an NIHSS score of 5–9 and >10 also had high odds of developing aspiration pneumonia (aOR of 1.87 and 5.98, respectively). Patients admitted to the medicine ward also had 1.56 times the odds of developing aspiration pneumonia compared to the stroke ward (95% CI: 1.05-2.31, p=0.03). A forest plot of the multivariate analysis can be seen in Figure 4.

Discussion

To the best of our knowledge, this is the first study to specifically examine the incidence and outcomes of patients who develop aspiration pneumonia post-stroke in the MENA region. In our cohort, 4.1% of our patients developed aspiration pneumonia post stroke. This low number may be deceiving as the majority of patients admitted had mild symptoms [5626 (61.2%) of

patients had an NIHSS of <4]. The odds of aspiration pneumonia was 1.87 in patients with admission NIHSS of 5-9 (n=1965), increasing to 5.98 in patients with NIHSS of 10 or more (n=1606). Patients with aspiration pneumonia also stayed an average of 10 days longer in the hospital compared to patients without. A higher proportion of patients with aspiration pneumonia had an unfavorable outcome at 90 days. They were also more likely to have higher mortality rates at 90 days and MACE at 1 year. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward.

High NIHSS has also been shown to be correlated with increased rates of dysphagia and aspiration pneumonia due to stroke severity.³² Patients with aspiration pneumonia in the Qatar dataset had comparatively higher NIHSS at presentation as compared to patients without pneumonia (14.7 v 5.1, p<0.001). Garavelli et al³³ demonstrated that an NIHSS cut-off of \geq 10.5 was associated with higher rates of dysphagia (p=0.014) and aspiration pneumonia (p=0.006). Similarly, Jeyaseelan et al³² demonstrated NIHSS > 9 as being moderately predictive of clinically relevant dysphagia, with dysphagia rates increasing with greater NIHSS scores (p<0.001). Okubo et al³⁴ also showed an NIHSS cut-off of 12 sensitive for dysphagia detection, with 14 (87.5%) of the 16 patients with dysphagia having NIHSS scores \geq 12 and 2 (12.5%) patients having scores of 10 and 11. NIHSS >12 also has an independent association with persistent dysphagia at hospital discharge in acute ischemic stroke patients with dysphagia at stroke onset, with one of its sub-components–dysarthria–emerging as a significant independent predictor of prolonged dysphagia.³⁵ In our current study, the odds of developing aspiration pneumonia increased as NIHSS score increased.

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Several studies have reported the adverse outcomes of aspiration pneumonia on stroke patients. In a study comprised of 610,668 stroke patients, Barlas et al³⁶ reported that patients with stroke-associated pneumonia (SAP) had significantly higher odds of in-hospital mortality (OR of 2.90, 95% CI: 2.83–2.96), and longer length of stay (OR 13.11, 95% CI: 12.83–13.40). While they analyzed data from both ischemic and hemorrhagic strokes, patients with ischemic stroke were more likely to die in hospital and experience long length of stay (LOS).³⁶ Teh et al³⁷ had similar observations in his cohort of 9238 patients from the UK. SAP was found in 1083 (11.7%) patients, out of which 60.8% were aspiration pneumonia.³⁷ After controlling for confounders, SAP was found to be associated with increased mortality up to 1 year (inpatient, 90-day, 1 year), prolonged LOS, and poor functional outcome on discharge.³⁷ In our current study, patients who developed aspiration pneumonia with an admission NIHSS of 5-9 had a 16.9% mortality rate at 90 days in contrast to 1.9% for patients who did not develop aspiration pneumonia. Similarly, patients who developed aspiration pneumonia with an admission NIHSS >10 had higher mortality rates at 90 days (22.3% vs. 13.8%, p=0.003).

Dysphagia is a common feature of severe stroke and an indicator of poor prognosis. It is implicated in the development of aspiration pneumonia, and it results in longer LOS and increased mortality. In stroke patients with dysphagia, early nutritional support is vital, and the decision to initiate that depends on the outcome of the swallow study.³⁸ Multiple national and international guidelines recommend that people with acute stroke have their swallowing screened by a trained healthcare professional by utilizing a validated screening tool and that the patients remain nothing per oral (NPO) until a swallow screen is performed.¹⁷ Bedside swallow screening tools include the functional bedside aspiration screen (FBAS), GLOBE-3S (the Sapienza GLObal Bedside Evaluation of Swallowing after Stroke), water swallowing test, volume-

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viscosity swallow test, and the Gugging swallow screen. However, despite these recommendations, in our study 34.6% of patients did not undergo swallow screen prior to PO intake in the ED and 32.7% patient did not have SLP assessment within 24 hours of admission. Likely explanations for these findings include ED nursing inadvertently giving patients PO medications, or SLPs not being available over the weekend, hence leading to an inability to perform assessment within 24 hours of presentation.

Similar to previous reports, we observed a significantly higher risk of aspiration pneumonia in the patients admitted to the medical ward compared to the stroke ward (5.3% vs. 3.7%, p=0.01). Admission to the stroke ward, by prevention of medical complications, results in reduced length of stay, decreased incidence of complications, improved prognosis at discharge and at 90 days (higher % of mRS scores of 0-2).^{39,40} Similarly, in our current study, fewer patients developed aspiration pneumonia if they were admitted to the stroke ward versus medicine ward (3.7% vs. 5.3%, p=0.01). Multivariable logistic regression identified admission location as an independent predictor of aspiration pneumonia, with patients admitted to the medicine ward having higher risks of developing aspiration pneumonia (aOR 1.56, 95% CI: 1.05-2.31). In our study population, we also observed that 19.9% patients with an NIHSS >10 and admitted to the medicine ward developed aspiration pneumonia in contrast to patients with an NIHSS > 10 and admitted to the stroke ward (9.9%; p<0.001). Thus, healthcare providers should be judicious of the placement of their stroke patients if they would like to reduce the incidence of aspiration pneumonia.

We also observed that patients with small vessel disease or subcortical stroke were less likely to develop aspiration pneumonia in contrast to patients with cardioembolic stroke, large vessel disease, stroke of undetermined etiology, and stroke of determined etiology. This is

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consistent with Alberts et al's study, who reported a low occurrence of aspiration in small vessel infarcts compared to those with both large- and small vessel infarcts (p=0.002).⁴¹ Similarly, Jitpratoom et al⁴² observed that 40.7% of their patients with cardioembolic stroke developed aspiration pneumonia in contrast to 11.1% for small vessel occlusion. Multivariable logistic regression analysis revealed that type of stroke was an independent predictor of aspiration pneumonia, specifically for large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke of undetermined etiology. A potential explanation for this is that patients with small vessel disease have milder stroke symptoms and fewer neurological deficits in contrast to the other stroke subtypes,⁴³ therefore they might have more preserve/control of their facial, palatal, and pharyngal muscles, reducing their risks of developing dysphagia and aspiration pneumonia. However, additional studies are needed to unravel this relationship.

There are several limitations with our study. Our patient sample is comprised of largely Middle Eastern ethnicity (Qatari, Arabs), South Asian and Far Eastern (Asians) (97.7% vs. 2.3% for Caucasians), therefore lacks generalizability. We also had missing data for the mRS score at 90 days for 1846 patients (out of 9197). Since Qatar's population is comprised mainly of expatriate workers, it is not possible to collect data for patients who may have moved back to their home country once their work contract ended.

Conclusion

This large study in prospectively collected patients with acute stroke identified multiple factors associated with an increased risk of aspiration pneumonia. Patients who developed aspiration pneumonia were older, presented with more severe neurological symptoms, and stayed an average of 10 days longer in the hospital compared to patients without aspiration pneumonia. Patients with large vessel disease, cardioembolic stroke, stroke of determined etiology and stroke

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of undetermined etiology were more likely to develop aspiration pneumonia. Patients who were admitted to the medicine ward also had higher odds of developing aspiration pneumonia in contrast to patients admitted to the stroke ward. Our study showed that aspiration pneumonia was associated with an unfavorable prognosis (mRS 3-6) and increased mortality at 90 days in

patients with moderate and severe symptoms.

Data Availability Statement

The Qatar Stroke Registry dataset will be available on reasonable request to the corresponding author.

Ethics Statement

The studies involving humans were approved by the Institutional Review Board of the Medical Research Centre at Hamad Medical Corporation (MRC-01-20-1135). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Declaration of conflicting interests

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Authors contribution:

KHT: Writing-original draft, Formal analysis.

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- NA: Formal analysis, Methodology, Supervision, Reviewing draft.
- AA: Writing, Reviewing draft
- SJ: Data curation and Validation.
- RU: Data curation and Validation.
- DM: Data curation and Validation.
- BB: Data curation, Methodology.
- AS: Conceptualization, reviewing, editing & guarantor.

References

1. 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. doi:10.3389/fneur.2022.834240

- 2. Teasell R, Foley N, Martino R, et al. Dysphagia and Aspiration Following Stroke.
- 3. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. *Stroke*. 2005;36(12):2756-2763. doi:10.1161/01.STR.0000190056.76543.eb
- 4. Meng PP, Zhang SC, Han C, Wang Q, Bai GT, Yue SW. The Occurrence Rate of Swallowing Disorders After Stroke Patients in Asia: A PRISMA-Compliant Systematic Review and Meta-Analysis. *J Stroke Cerebrovasc Dis*. 2020;29(10):105113. doi:10.1016/j.jstrokecerebrovasdis.2020.105113
- 5. Takizawa C, Gemmell E, Kenworthy J, Speyer R. A Systematic Review of the Prevalence of Oropharyngeal Dysphagia in Stroke, Parkinson's Disease, Alzheimer's Disease, Head Injury, and Pneumonia. *Dysphagia*. 2016;31(3):434-441. doi:10.1007/s00455-016-9695-9
- 6. Avan A, Digaleh H, Di Napoli M, et al. Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: an ecological analysis from the Global Burden of Disease Study 2017. *BMC Med.* 2019;17(1):191. doi:10.1186/s12916-019-1397-3
- Cohen DL, Roffe C, Beavan J, et al. Post-stroke dysphagia: A review and design considerations for future trials. *Int J Stroke*. 2016;11(4):399-411. doi:10.1177/1747493016639057
- 8. 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. doi:10.1186/s12877-022-02960-5
- 9. Son YG, Shin J, Ryu HG. Pneumonitis and pneumonia after aspiration. *J Dent Anesth Pain Med*. 2017;17(1):1-12. doi:10.17245/jdapm.2017.17.1.1
- 10. Hu X, Yi ES, Ryu JH. Aspiration-Related Deaths in 57 Consecutive Patients: Autopsy Study. *PLoS One*. 2014;9(7):e103795. doi:10.1371/journal.pone.0103795
- 11. Makhnevich A, Feldhamer KH, Kast CL, Sinvani L. Aspiration Pneumonia in Older Adults. *J Hosp Med.* 2019;14(7):429-435. doi:10.12788/jhm.3154
- 12. Schallom M, Dykeman B, Metheny N, Kirby J, Pierce J. Head-of-bed elevation and early outcomes of gastric reflux, aspiration and pressure ulcers: a feasibility study. *Am J Crit Care*. 2015;24(1):57-66. doi:10.4037/ajcc2015781

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13	. Metheny NA. Risk factors for aspiration. <i>JPEN J Parenter Enteral Nutr</i> . 2002;26(6 Suppl):S26-31; discussion S32-33. doi:10.1177/014860710202600605
14	. Watila MM, Nyandaiti YW, Balarabe SA, et al. Aspiration pneumonia in patients with stroke in Northeast Nigeria. <i>International Journal of Stroke</i> . 2013;8(4):E16-E16. doi:10.1111/ijs.12095
15	. Cichero JAY. Age-Related Changes to Eating and Swallowing Impact Frailty: Aspiration, Choking Risk, Modified Food Texture and Autonomy of Choice. <i>Geriatrics (Basel)</i> . 2018;3(4):69. doi:10.3390/geriatrics3040069
16	. Katzan IL, Cebul RD, Husak SH, Dawson NV, Baker DW. The effect of pneumonia on mortality among patients hospitalized for acute stroke. <i>Neurology</i> . 2003;60(4):620-625. doi:10.1212/01.wnl.0000046586.38284.60
17	. Eltringham SA, Kilner K, Gee M, et al. Impact of Dysphagia Assessment and Management on Risk of Stroke-Associated Pneumonia: A Systematic Review. <i>Cerebrovasc Dis</i> . 2018;46(3-4):99-107. doi:10.1159/000492730
18	. Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic strategy for aspiration pneumonia. <i>Respir Investig.</i> 2022;60(1):45-55. doi:10.1016/j.resinv.2021.09.012
19	. 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. <i>IJGM</i> . 2023;16:1303-1315. doi:10.2147/IJGM.S400420
20	. Gupte T, Knack A, Cramer JD. Mortality from Aspiration Pneumonia: Incidence, Trends, and Risk Factors. <i>Dysphagia</i> . 2022;37(6):1493-1500. doi:10.1007/s00455-022-10412-w
21	. Pacheco-Castilho AC, Vanin G de M, Dantas RO, Pontes-Neto OM, Martino R. Dysphagia and Associated Pneumonia in Stroke Patients from Brazil: A Systematic Review. <i>Dysphagia</i> . 2019;34(4):499-520. doi:10.1007/s00455-019-10021-0
22.	. Imam YZ, Kamran S, Saqqur M, et al. Stroke in the adult Qatari population (Q-stroke) a hospital-based retrospective cohort study. <i>PLoS One</i> . 2020;15(9):e0238865. doi:10.1371/journal.pone.0238865
23	. Hatano S. Experience from a multicentre stroke register: a preliminary report. <i>Bull World Health Organ</i> . 1976;54(5):541-553.
24	. Adams HP, Bendixen BH, Kappelle LJ, et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. <i>Stroke</i> . 1993;24(1):35-41. doi:10.1161/01.str.24.1.35
25	. Touma L, Filion KB, Sterling LH, Atallah R, Windle SB, Eisenberg MJ. Stent Retrievers for the Treatment of Acute Ischemic Stroke: A Systematic Review and Meta-analysis of
	20 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Randomized Clinical Trials. JAMA Neurol. 2016;73(3):275-281. doi:10.1001/jamaneurol.2015.4441 26. Brott T, Adams HP, Olinger CP, et al. Measurements of acute cerebral infarction: a clinical examination scale. Stroke. 1989;20(7):864-870. doi:10.1161/01.STR.20.7.864 27. van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. Stroke. 1988;19(5):604-607. doi:10.1161/01.str.19.5.604 28. d'Emden MC, Shaw JE, Jones GR, Cheung NW. Guidance concerning the use of glycated haemoglobin (HbA1c) for the diagnosis of diabetes mellitus. Med J Aust. 2015;203(2):89-90. doi:10.5694/mja15.00041 29. Warusevitane A, Karunatilake D, Sim J, Smith C, Roffe C. Early Diagnosis of Pneumonia in Severe Stroke: Clinical Features and the Diagnostic Role of C-Reactive Protein. PLoS One. 2016;11(3):e0150269. doi:10.1371/journal.pone.0150269 30. Green TL, McNair ND, Hinkle JL, et al. Care of the Patient With Acute Ischemic Stroke (Posthyperacute and Prehospital Discharge): Update to 2009 Comprehensive Nursing Care Scientific Statement: A Scientific Statement From the American Heart Association. Stroke. 2021;52(5):e179-e197. doi:10.1161/STR.000000000000357 31. Akhtar N, Salam A, Kamran S, et al. Ethnic variation in acute cerebrovascular disease: Analysis from the Qatar stroke registry. Eur Stroke J. 2016;1(3):231-241. doi:10.1177/2396987316663776 32. Jeyaseelan RD, Vargo MM, Chae J. National Institutes of Health Stroke Scale (NIHSS) as An Early Predictor of Poststroke Dysphagia. PM&R. 2015;7(6):593-598. doi:10.1016/j.pmrj.2014.12.007 33. Garavelli F, Ghelfi AM, Kilstein JG. Usefulness of NIHSS score as a predictor of nonneurological in-hospital complications in stroke. Medicina Clínica (English Edition). 2021;157(9):434-437. doi:10.1016/j.medcle.2020.07.045 34. Okubo PCMI, Fábio SRC, Domenis DR, Takayanagui OM, Using the National Institute of Health Stroke Scale to predict dysphagia in acute ischemic stroke. Cerebrovasc Dis. 2012;33(6):501-507. doi:10.1159/000336240 35. Kumar S, Doughty C, Doros G, et al. Recovery of Swallowing after Dysphagic Stroke: An Analysis of Prognostic Factors. Journal of Stroke and Cerebrovascular Diseases. 2014;23(1):56-62. doi:10.1016/j.jstrokecerebrovasdis.2012.09.005 36. Barlas RS, Clark AB, Bettencourt-Silva JH, et al. Pneumonia and Risk of Serious Adverse Outcomes in Hospitalized Strokes in Thailand. J Stroke Cerebrovasc Dis. 2019;28(6):1448-1454. doi:10.1016/j.jstrokecerebrovasdis.2019.03.024 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

- Teh WH, Smith CJ, Barlas RS, et al. Impact of stroke-associated pneumonia on mortality, length of hospitalization, and functional outcome. *Acta Neurol Scand*. 2018;138(4):293-300. doi:10.1111/ane.12956
 - 38. Han TS, Lean ME, Fluck D, et al. Impact of delay in early swallow screening on pneumonia, length of stay in hospital, disability and mortality in acute stroke patients. *Eur J Clin Nutr*. 2018;72(11):1548-1554. doi:10.1038/s41430-018-0148-4
 - 39. Akhtar N, Kamran S, Singh R, et al. Beneficial Effects of Implementing Stroke Protocols Require Establishment of a Geographically Distinct Unit. *Stroke*. 2015;46(12):3494-3501. doi:10.1161/STROKEAHA.115.010552
- 40. Tamm A, Siddiqui M, Shuaib A, et al. Impact of Stroke Care Unit on Patient Outcomes in a Community Hospital. *Stroke*. 2014;45(1):211-216. doi:10.1161/STROKEAHA.113.002504
- 41. Alberts MJ, Horner J, Gray L, Brazer SR. Aspiration after stroke: Lesion analysis by brain MRI. *Dysphagia*. 1992;7(3):170-173. doi:10.1007/BF02493452
- 42. Jitpratoom P, Boonyasiri A. Factors associated with an increased risk of developing pneumonia during acute ischemic stroke hospitalization. *PLoS One*. 2024;19(1):e0296938. doi:10.1371/journal.pone.0296938
- 43. Grau AJ, Weimar C, Buggle F, et al. Risk Factors, Outcome, and Treatment in Subtypes of Ischemic Stroke. *Stroke*. 2001;32(11):2559-2566. doi:10.1161/hs1101.098524

Characteristic	No Pneumonia (n=8817. 95.9%)	Aspiration Pneumonia	Total (n= 9197)	P-Value
	((n= 380, 4.1%)		
ge	55.1±13.3	59.0±15.6	55.3±13.4	< 0.001
lale Gender	7041 (79.9)	303 (79.7)	7344 (79.9)	0.95
abetes	5038 (57.1)	229 (60.3)	5267 (57.3)	0.22
ypertension	63/3 (/2.3)	246 (64.7)	6619 (72.0)	<0.001
vsiipidemia	4069 (46.1)	130 (35.8)	4205 (45.7)	<0.001
nor Stroke of TIA	1052 (13.1)	70 (18.4)	1219 (13.3)	0.05
trial Fibrillation	664 (7 5)	70 (10.4)	727 (2 0)	<0.001
tive Smoking	2142 (24 2)	52 (12 7)	2105 (22 0)	<0.001
	2173 (24.3)	52 (13.7)	2133 (23.3)	\0.001
hnicity ^a				
, Arab	2962 (33.6)	160 (42.1)	3122 (33.9)	
South Asian	4518 (51.2)	168 (44.2)	4686 (51.0)	
Far Eastern	753 (8.5)	17 (4.5)	770 (8.4)	<0.001
African	382 (4.3)	26 (6.8)	408 (4.4)	
Caucasian	202 (2.3)	9 (2.4)	211 (2.3)	
ode of Arrival ^a				
EMS	6073 (68.9)	288 (75.8)	6361 (69.2)	<0.001
Non-Medical	2200 (25.0)	34 (8.9)	2234 (24.3)	
From Other Hospitals	372 (4.2)	15 (3.9)	387 (4.2)	
RS prior to acute stroke ^a			()	
0	7595 (86.1)	282 (74.2)	7877 (85.6)	_
1	132 (1.5)	9 (2.4)	141 (1.5)	-
2	312 (3.5)	12 (3.2)	324 (3.5)	<0.001
3	430 (4.9)	33 (8.7)	463 (5.0)	<0.001
4	196 (2.2)	23 (6.1)	219 (2.4)	-
3	151 (1.7)	21 (5.5)	172 (1.5)	
HSS on admission	5.1 + 5.54	14.65 + 8.05	5.5 + 6.0	<0.001
	512 2 515 1	11100 - 0100	0.0 2 0.0	
nset Duration ^a				
Less than 4.5 Hours	2822 (32.0)	169 (44.5)	2991 (32.5)	
Between 4.5 till 24 hours	2890 (32.8)	145 (38.2)	3035 (33.0)	<0.001
More than 24 hours	3105 (35.2)	66 (17.4)	3171 (34.5)	
nrombolysis Given	962 (10.9)	73 (19.2)	1035 (11.3)	< 0.001
echanical Thrombectomy done	350 (4.0)	43 (11.3)	393 (4.3)	<0.001
Monadmission	20 15+42 0	27 5445 2	20 12112 0	0.0
vii oli admission	20.15143.9	27.54I5.3	28.13143.0	0.8
	5.01/.5 7 51+2 /2	10.415.05 7 6+2 A	9.017.4 7 51+7 41	0.04
	/.3112.42	7.012.4 A 6+1 75	/ J 23+1 52	0.04
	4.0411.32	4.011.75	4.0311.33	0.01
	1 1+2 2/	1.4310.63	1 10+2 20	0.002
	2 1+1 0	1.45±0.34	2 1+1 0	0.12
stalic Blood Pressure	3.111.8 157 8+44 22	2.8211.25	3.111.8 157 //2+/2 72	0.03
istolic Blood Pressure	137.0144.23 01 1+22 /	143.44123.13 86 /+10 /	137.42143./3	0.00
ascolic blood Pressure	51.1122.4	00.4119.4	50.9122.3	0.00

Disposition ^a				
Discharged Home	5726 (64.9)	44 (11.6)	5770 (62.7)	
Rehabilitation	2079 (23.6)	89 (23.4)	2168 (23.6)	
Long term care	151 (1.7)	97 (25.5)	248 (2.7)	< 0.001
Transfer to other facility	732 (8.3)	109 (28.7)	841 (9.1)	
Died as in-patient	129 (1.5)	41 (10.8)	170 (1.8)	
TOAST Classification ^a				
Small Vessel Disease	4213 (47.8)	36 (9.5)	4249 (46.2)	
Large Vessel Disease	1772 (20.1)	141 (37.1)	1913 (20.8)	
Cardio-Embolic	1744 (19.8)	137 (36.1)	1881 (20.5)	<0.001
Stroke of Determined Etiology	612 (6.9)	31 (8.2)	643 (7.0)	
Stroke of Undetermined Etiology	476 (5.4)	35 (9.2)	511 (5.6)	
Swallow Screen done before oral intake	5820 (66.0)	197 (51.8)	6017 (65.4)	<0.001
Speech therapy assessment done	6024 (68.3)	161 (42.4)	6185 (67.3)	<0.001
Speech Therapy assessment duration (hours)	31.7±309.7	77.9±694.32	32.85±325.45	0.07
Antibiotics given	626 (7.1)	361 (95.0)	987 (10.7)	<0.001

Abbreviations: BMI, Body Mass Index; ED, emergency department; HDL, High density lipoprotein; ICU,

intensive care unit; LDL, Low density lipoprotein; MACE, major adverse cardiac event; mRS, Modified

Rankin Score; NIHSS, National Institute of Health Stroke Scale; RBS, Random blood sugar

^ap-value reported based on Pearson-Chi Square Test

Values are reported as mean ± standard deviation and n(%)

Table 2. Characteristics and outcome of acute ischemic stroke patients with aspiration

pneumonia based on their NIHSS admission

Characteristic or Investigation	No Pneumonia (n=8817, 95.9%)	Aspiration Pneumonia (n= 380, 4.1%)	Total (n= 9197)	P-Value
NIHSS Severity				
Mild Stroke (NIHSS 0-4)	5570 (63.2)	56 (14.7)	5626 (61.2)	<0.001
Moderate Stroke (NIHSS 5-9)	1906 (21.6)	59 (15.5)	1965(21.4)	
Severe Stroke (NIHSS 10 or more)	1341 (15.2)	265 (69.7)	1606 (17.5)	
NIHSS (5-9)				
90-Days Mortality	36 (1.9)	10 (16.9)	46 (2.3)	<0.001
MACE at 1 year	72 (3.8)	14 (23.7)	86 (4.4)	<0.001
Admission Location				
Stroke Ward	1281 (67.2)	35 (59.3)	1316 (67.0)	
Medicine Ward	250 (13.1)	10 (16.9)	45 (13.2)	0.31
Duration of ED Stay Category ^a				
<4 hours	249 (13.1)	2 (3.4)	251 (12.8)	
4-8 hours	555 (29.1)	23 (39.0)	578 (29.4)	
>8 hours	750 (39.3)	26 (44.1)	776 (39.5)	0.052
Length of Stay	5.89±10.0	17.1±19.4	6.23±10.5	<0.001
Prognosis – At Discharge				
Good (mRS 0–2)	814 (42.7)	4 (6.8)	818 (41.6)	<0.001
Poor (mRS 3-6)	1092 (57.3)	55 (93.2)	1147 (58.4)	
Prognosis – At 90 Davs				
Good (mRS 0–2)	876 (46.0)	6 (10.2)	882 (44.9)	<0.001
Poor (mRS 3-6)	580 (30.4)	44 (74.6)	624 (31.8)	
Mortality at Discharge	9 (0.5)	7 (11.9)	16 (0.8)	<0.001
90 Days Mortality	36 (1.9)	10 (16.9)	46 (2.3)	<0.001
mRS at 90 Davs ^a				
0	446 (23.4)	0 (0)	446 (22.7)	
1	212 (11.1)	3 (5.1)	215 (10.4)	
2	218 (11.4)	3 (5.1)	221 (11.2)	-
3	325 (17.1)	6 (10.2)	331 (16.8)	<0.001
4	160 (8.4)	10 (16.9)	170 (8.7)	_
5	59 (3.1)	18 (30.5)	77 (3.9)	
6	36 (1.9)	10 (16.9)	46 (2.3)	_
		, <i>,</i>		
NIHSS (>10)				
90-Days Mortality	185 (13.8)	59 (22.3)	244 (15.2)	0.003
MACE at 1 year	217 (16.2)	73 (27.5)	290 (18.1)	<0.001
Admission Location				
Stroke Ward	834 (62.2)	92 (34.7)	926 (57.7)	
Medicine Ward	166 (12.4)	40 (15.1)	206 (12.8)	<0.001
Duration of ED Stay Category ^a				
<4 hours	288 (21.5)	41 (15.5)	329 (20.5)	
4-8 hours	446 (33.3)	87 (32.8)	533 (33.2)	0.09
>8 hours	470 (35.0)	103 (38.9)	573 (35.7)	
Length of Stay	9.2±9.8	16.6±14.6	10.4±11.2	<0.001
Prognosis – At Discharge				
Good (mRS 0–2)	247 (18.4)	5 (1.9)	252 (15.7)	<0.001
Poor (mRS 3-6)	1094 (81.6)	260 (98.1)	1354 (84.3)	

Prognosis - At 90 Days				
Good (mRS 0-2)	301 (22 4)	18 (6.8)	319 (19 9)	<0.001
Poor (mRS 3-6)	798 (59.5)	211 (79.6)	1009 (62.8)	40.001
Mortality at Discharge	105 (7.8)	30 (11.3)	135 (8.4)	0.07
90 Days Mortality	185 (13.8)	59 (22.3)	244 (15.2)	<0.001
mRS at 90 Davs ^a		,	()	
0	132 (9.8)	5 (1.9)	137 (8.5)	
1	72 (5.4)	3 (1.1)	75 (4.7)	
2	97 (7.2)	10 (3.8)	107 (6.7)	
3	219 (16.3)	18 (6.8)	237 (14.8)	<0.001
4	223 (16.6)	46 (17.4)	269 (16.7)	
5	171 (12.8)	88 (33.2)	259 (16.1)	
6	185 (13.8)	59 (22.3)	244 (15.2)	

Abbrevi MACE, r

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Table 3. Biv	variate and Multiva	ariate logistic reg	ression analysis t	o identify the risk far	ctors associa	ated with asperat	ion pneumonia. 2 logistic regressio	n analysis
	No Pneumonia	Aspiration Pneumonia	Standardized Beta	Odds ratio (95% CI)	p-value	Standazdized	Odds ratio (95% CI)	p-value
Age	55.3 ± 13.4	59.0 ± 15.6	0.021	1.02 (1.01–1.03)	<.001	sreigne 0.028 0.028	1.02 (1.01- 1.03)	0.002
Sex Female Male	1776 (95.8) 7041 (95.9)	77 (4.2) 303 (4.1)	-0.007	1 0.99 (0.77–1.28)	- 0.95	5. Downloade ment Superie ed to text and 0.4	1 1.56 (1.05– 2.32)	- 0.03
TOAST	1212 (22.2)	25 (0.0)		4		d fron 9ur (A I data	4	
SVD LVD	4213 (99.2) 1772 (92.6)	36 (0.8) 141 (7.4)	- 2.231	9.31 (6.43–13.48)	- <.001	nining, /	1 4.11 (2.52– 6.69)	- <.001
CE	1744 (92.7)	137 (7.3)	2.218	9.19 (6.34–13.33)	<.001	1.300 1.300	3.69 (2.23– 6.12)	<.001
SDA	612 (95.2)	31 (4.8)	1.780	5.93 (3.64–9.65)	<.001	1.1439 an	3.25 (1.75– 6.03)	<.001
SUD	476 (93.2)	35 (6.8)	2.152	8.61 (5.35–13.83)	<.001	1.4078 00 <u>1</u> .4078 00	4.09 (1.98– 8.46)	<.001
Mode of transport						۱ June 11 Iar techn		
From Other Hospitals	372 (96.1)	15 (3.9)	-	1	-	, 2025 at olpgies.	1	-
EMS	6073 (95.5)	288 (4.5)	0.162	1.18 (0.69–2.00)	0.55	0.184 Agenc	1.20 (0.55– 2.64)	0.65
Non-Medical	2200 (98.5)	34 (1.5)	-0.959	0.38 (0.21–0.71)	0.00	0.032 BB	1.03 (0.43– 2.47)	0.94
Onset Duration		For peer revie	w only - http://bmio	pen.bmi.com/site/abou	t/quidelines.x	iographique de		27

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1 2							n-2024 pyrigh		
3 4	<4.5 hours	2822 (94.3)	169 (5.7)	-	1	-	-093 t,,in	1	-
5 6	4.5-24 hours	3890 (96.4)	145 (3.6)	-0.177	0.84 (0.67–1.05)	<.001	0.1006 328 on	1.06 (0.68– 1.65)	0.79
7 8	>24 hours	3105 (97.9)	66 (2.1)	-1.036	0.36 (0.27–0.47)	<.001		1.15 (0.82– 1.61)	0.43
9 10	Duration in ER						arch Ense ses i		
11	<4 hours	809 (94.2)	50 (5.8)	-	1	-	202) Pigne relat	1	-
12 13 14	4-8 hours	1711 (93.3)	122 (6.7)	0.143	1.15 (0.82–1.62)	0.41	0.3to to	1.41 (0.90– 2.20)	0.13
15 16	>8 hours	2749 (94.8)	151 (5.2)	-0.118	0.89 (0.64–1.24)	0.48	0.24 and	1.24 (0.80– 1.93)	0.34
17	NIHSS						d fro eur (I dat		
18 19 20	Mild Stroke (0-	5570 (99.0)	56 (1.0)	-	1	-	om http ABES) a minir	1	-
21	4)	1000 (07 0)		1 1 2 5		< 001	jų.	1 07 /1 10	0.01
22 23 24	Moderate Stroke (5-14)	1906 (97.0)	59 (3.0)	1.125	3.08 (2.13-4.45)	<.001	0.045 njopen	2.94)	0.01
25 26	Severe Stroke	1341 (83.5)	265 (16.5)	2.978	19.66 (14.64– 26.38)	<.001	1.74888 <u>m</u> ic	5.98 (3.92– 9.11)	<.001
27 29	(>10)						d sir		
28 29	Admission						on J nilar		
30 21	Location						une tecl		
32	Stroke Ward	3819 (96.3)	147 (3.7)	-	1	-	11, 1 hņol	1	-
 33 34 35 36 37 38 39 40 41 42 43 	Medicine Ward	1248 (94.7)	70 (5.3)	0.377	1.46 (1.09–1.95)	0.01	2025 at Agence Bibliographiqu 20 0. 0.	1.56 (1.05– 2.31)	0.03
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Abbreviations: CE, cardioembolic stroke; CI, confidence interval; EMS, emergency medical services; ER, eme disease; NIHSS, National Institute of Health Stroke Scale; SDA, stroke of determined etiology; SVD, small vess undetermined etiology.	sel digging for us for
	ch 2025. Downloaded frou nseignement Superieur (<i>μ</i> es related to text and data
Figure 1. Proportion of aspiration pneumonia between stroke ward vs. medicine ward	m http: VBES) - 1 mining
*p ≤ 0.05	//bmjop ,, Al tra
Figure 2. Proportion of mRS at 90 days for patients with an NIHSS of 5-9	en.bmj
Figure 3. Proportion of mRS at 90 days for patients with an NIHSS of >10	.com/ o Ind sim
Figure 4. Forest Plot based on the results of multivariate analysis of the factors associated with aspi	iration pecumonia.
Abbreviations: CI, confidence interval; OR, odds ratio.	11, 20; hnolog
	25 at Ay
	gence E
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Page 35 of 36	Overall	No	Aspiration	Overall Significanc	SVD	SVD	SVD	SVD		G L¥Ð		CE	CE	SDA
5		Filedinoma	Filedinoma	e	LVD ¹	CE ¹	SDA ¹	SUD ¹	CE ¹	by SDA1 co	SUD ¹	SDA 1	SUD 1	SUD ¹
TOAST				<.001	<.001	<.001	<.001	<.001	1.00	¥ 0.05	1.00	0.06	1.00	0.82
² Small vessel ³ disease	4249 (46.2)	4213 (99.2)	36 (0.8)	_	_	-	-	_	_	02/4-09 ight, ii	_	-	_	-
⁴ Large vessel 5 disease	1913 (20.8)	1772 (92.6)	141 (7.4)	-	-	-	-	-	-	3328 . ncludi	-	-	-	-
^o Cardioembolic	1881 (20.5)	1744 (92.7)	137 (7.3)	_	_	-	-	_	_	oŋ 21 ng for	_	-	_	_
^o Determined 10 etiology	643 (7.0)	612 (95.2)	31 (4.8)	_	-	-	-	-	_	March Ens uses	-	-	-	-
1Undetermined 12 etiology	511 (5.6)	476 (93.2)	35 (6.8)	_	-	-	_	_	-	, 2025, eigner relate	_	_	_	-
13 14 15	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	EMS vs. NM ¹	EMS vs. OH ¹	NM vs. OH ¹			. Downlo nent Sul d to text				
1 1∯ode of 1transport				<.001	<.001	1.00	0.07			perieu and d				
18 EMS	6361 (69.2)	6073 (95.5)	288 (4.5)	_	-	-	-	-	-	frøm h r (ABE lata m	-	-	-	-
20 Non-Medical	2234 (24.3)	2200 (98.5)	34 (1.5)	-	7	-	_	_	-	tt <mark>lp://k</mark> ES) . ining,	-	-	_	-
22 From Other23 Hospitals	387 (4.2)	372 (96.1)	15 (3.9)	-	-	-	-	-	-	onpjop Al trai	-	-	-	-
24 25 26 27 28 29	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	<4.5 hours vs. 4.5-24 hours ¹	<4.5 hours vs. >24 hours	4.5-24 hours vs. >24 hours ¹	0		en.bmj.com/ on J ning, and similar				
3Onset				<.001	0.26	<.001	<.001			une tecl				
32 <4.5 hours	2991	2822 (94.3)	169 (5.7)	-	-	-	-	- 4	-	11, ₁ 20; 1nolog	-	-	-	-
34 4.5-24 hours 35	3035 (33.0)	2890 (95.2)	145 (4.8)	-	-	-	-	-	-	25 pt A ies.	-	-	-	-
36 >24 hours 37	3171 (34.5)	3105 (97.9)	66 (2.1)	_	-	-	-	-	-	g¢nce	-	-	-	-
38 39 40	Overall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	<4 hours	<4 hours vs. >8	4-8 hours			Bibliogr				
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3 4						vs. 4-8 hours ¹	hours	vs. >8 hours ¹			24-0933 ht, inc				
⁵ D ⁶ F	uration in				0.11	1.00	1.00	0.11			328 or Iudin				
7 8	<4 hours	859 (15.4)	809 (94.2)	50 (5.8)	-	-	-	-	-	-	1 21 Ma g for u	-	-	-	-
9 10 11	4-8 hours	1833	1711 (93.3)	122 (6.7)	-	-	-	-	-	-	arch 20 Enseigr Ses rela	-	-	-	-
12 13	>8 hours	2900 (51.9)	2749 (94.8)	151 (5.2)	-	-	-	-	-	-	254 Dov nement ated to	-	-	-	-
14 15 16		Överall	No Pneumonia	Aspiration Pneumonia	Overall Significanc e	0-4 vs. 5-14 ¹	0-4 vs. >15 ¹	5-14 vs. >15 ¹			vnloade Superie text and				
17 ₁N	IHSS				<.001	<.001	<.001	<.001			d fro dat				
18 19 20	Mild Stroke (0-4)	5626 (61.2)	5570 (99.0)	56 (1.0)	-6	1-	_	_	_	-	a minii	_	_	-	_
21 22	Moderate Stroke (5-9)	1965 (21.4)	1906 (97.0)	59 (3.0)	-	-	-	-	-	-	://þmjo 1g, Al t	-	-	-	-
23 24 25	evere Stroke (>10)	1606 (17.5)	1341 (83.5)	265 (16.5)	_	-	4	0,	-	_	<mark>ppęn.b</mark> raining	-	_	-	_
Table S1. Clinical characteristics among patients with aspiration pneumonia versus those without appiration pneumonia ²⁸ ²⁹ ¹ Bonferroni corrections have been applied to the p-values reported ²⁹ ¹ Bonferroni corrections have been applied to the p-values reported															
31 32	At	breviation	s: CE, cardioe	embolic; EMS	, emergency	medical	service;	LVD, larg	je vessel	diseas	sege N∯A, r	non-medic	al; OH,		
other hospitals; SDA, stroke of determined etiology; SUD, stroke of undetermined etiology; SVD, stroke of un															
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2 3 4	NIHSS	No Pneumonia	Aspiration Pneumonia	ଙ୍କୁ ରୁ Stroke Ward vs. Medicine Wଙ୍କୁ ଜ
5	Mild Stroke (0-4)			
6	Admission Location			ling
7	Stroke Ward	1704 (98.8)	20 (1 2)	5 2 0.03*
8	Medicine Ward	832 (97 7)	20 (2.3)	
9	Moderate Stoke (5-9)	002 (01.1)	20 (2.0)	sea
10	Admission Location			s rei
11	Stroke Ward	1281 (07 3)	35 (2 7)	at a c 31
12	Medicine Ward	250 (96.2)	10 (3.8)	ed 6.51
13	Severe Stroke (>10)	230 (90.2)	10 (3:8)	to
14 15	Admission Location			ext
15	Aumission Location Stroke Ward	834 (00 1)	02 (0 0)	ar < 001*
10	Modicine Ward	166 (80.1)	40 (10 0)	nd c
17		100 (80.1)	40 (19.9)	dati
10	Abbrevietiener NULICO Natione		-1-	a AB
20	Abbreviations: NIHSS, Nationa	II Institute of Health Stroke Sca	ale.	vini.
20	*p≤0.05			ng.//
27				
23	Table S2. Comparison of NIH	SS score and admission locati	on among patients with aspirat	tion gnaimonia versus those
24				ni. en
25	without aspiration pneumonia u	using Fisher's Exact Test		ng,
26	······			an j.c
27				d ôn
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