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Overview of Risk Factors for Pneumonia Incidence in Acute Stroke Patients

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Background: Stroke is a cerebrovascular emergency with neurological deficits due to cerebral hemorrhage or impaired blood flow to the brain, ranking second as a cause of global death and leading disability. Stroke-associated pneumonia (SAP) is a common complication in the first 7 days after stroke, affecting recovery, mortality, and treatment costs.
Purpose of the Study: To identify which risk factors have the highest prevalence in the incidence of pneumonia in stroke patients so that preventive measures can be taken as early as possible.

Research Methods: A retrospective descriptive study with a cross-sectional design using secondary data from medical records of 31 patients at Chasbullah Abdulmadjid Hospital in the 2023 period. The variables evaluated included demographics (age, gender), type of stroke, GCS, dysphagia, use of NGT, diabetes mellitus, and hypertension.

Results of the Study: The main risk factors for pneumonia in stroke patients at Chasbullah Abdulmadjid Hospital in the 2023 period were age 60-69 years in 13 patients (41.9%), female gender in 21 patients (67.7%), ischemic stroke in 29 patients (93.5%), GCS score 13-15 in 17 patients (54.8%), not using NGT in 19 patients (61.3%), experiencing dysphagia in 19 patients (61.3%), experiencing diabetes mellitus in 21 patients (67.7%), and hypertension in 23 patients. (74.2%).

Conclusion: Pneumonia in stroke patients occurs more frequently at the age of 60-69 years, female gender, ischemic stroke type, GCS 13-15, dysphagia, not using NGT, diabetes mellitus, and hypertension

1. INTRODUCTION

Stroke is a cerebrovascular emergency with neurological deficits caused by bleeding in the brain tissue or impaired blood flow to the brain and is the second leading cause of death in the world and a major cause of disability (Tadi and Lui, 2023). Based on data from Riskesdas, 2018, the prevalence of stroke in 34 provinces in Indonesia averaged 10.9 per mil, the highest in East Kalimantan at 14.7 per mil and the lowest in Papua at 4.1 per mil (Ministry of Health of the Republic of Indonesia 2018). Mortality in stroke patients 40% -96% is due to complications (InformedHealth.org 2008).

Stroke is a disease that has a high risk of experiencing complications that often occur in the first week of a stroke attack (Ritonga et al., 2019). In general, post-stroke patients have comorbidities that can increase the risk of medical complications during stroke recovery. This has a major impact on the patient's health status where the recovery process will be hampered, increased mortality, and also the impact on the patient's finances due to longer hospitalization times and increased treatment costs (Mutiarasari, 2019). Based on data from BPJS, the number of stroke treatments in 2016 reached 1.43 trillion rupiahs and increased to 2.57 trillion rupiahs in 2018 (Venketasubramanian et al., 2022). The average length of hospitalization for stroke patients without complications is 5 to 6 days and with complications is 11 to 12 days (Mazidah et al., 2019). Medical complications of acute stroke events include damage to central nervous system tissue causing decreased neurological status such as functional cognitive disorders and sensory and motor deficits, as well as various other complications such as recurrent strokes, epileptic seizures, urinary tract infections, pneumonia, cardiac dysfunction, hypertension, decubitus ulcers, deep vein thrombosis, and depression where these things are related to the length of immobilization and hospitalization (Khaku and Tadi, 2022). These acute and subacute complications tend to be avoidable, and the right time of treatment will result in good clinical outcomes (Verma, 2019).

Stroke-associated pneumonia (SAP) is a spectrum of lower respiratory tract infections in the first 7 days of stroke which is the most common stroke complication, which is around one third of acute stroke patients and results in a high mortality rate with a three-fold increase in mortality within one month (Grossmann et al., 2021, Verma, 2019). The incidence of pneumonia in stroke patients in Indonesia in 2016 was 22.9% (Ministry of Health of the Republic of Indonesia, 2017). Long-term prognosis and mortality rates were found to be worse in patients with SAP compared to stroke patients without pneumonia complications. Research by Ritonga, et al at the Neuro ICU RSPON in 2019 showed that the number of stroke patients during 2016 to 2017 with pneumonia complications was 130 people (65.98%) out of 197 stroke patients with a mortality rate of 77.7% (Ritonga et al., 2019). The prevalence of SAP can be reduced by identifying high-risk patients early and treating them well. For high-risk patients, namely acute stroke patients who experience dysphagia, poor stroke severity, elderly, or with comorbidities such as diabetes mellitus or hypertension (Hashim et al., 2022).

In diagnosing SAP is a challenge in itself due to various things. Clinical presentation may be non-specific, cough that can be a sign of aspiration can be disturbed by neurological disorders. Fever and leukocytosis can arise as a response to the acute phase of stroke without any etiology of an infection and hypoxia can be caused by other comorbidities such as heart or other lung diseases. The quality of chest radiography also tends to be less than optimal due to diaphragm disorders and reduced ability to inspire deeply. Sputum sampling is also more difficult in patients who do not use ventilation (Zawiah et al., 2023) This study aims to evaluate each risk factor or stroke unit procedure that predisposes and to determine the prevalence of risk factors for pneumonia in patients with acute stroke with the hope that early prevention and intervention efforts can be carried out to reduce the incidence of pneumonia complications and good clinical outcomes.

Research problem is what risk factors have the highest prevalence in increasing the incidence of pneumonia in acute stroke patients?

2. MATERIALS AND METHODS

2.1 Research Design

This research is a retrospective descriptive study with a cross-sectional design, namely each research variable is observed or data collection is carried out simultaneously and measurements are carried out on the independent variables and dependent variables.

2.2 Place and Time of Research

This research was conducted at Chasbullah Abdulmadjid Regional Hospital for the period from November 2023 to February 2024.

2.3 Target Population, Population Reach and Sample

The target population of this study was patients with acute stroke who were treated at Chasbullah Abdulmadjid Hospital for the period 2023 - 2024. The accessible population was patients with acute stroke who were confirmed by CT scan examination. The sample was patients from the population reach who met the inclusion criteria.

2.3.1 Inclusion criteria

1. All acute stroke patients with pneumonia who have complete medical record data.

2. Acute stroke patients, both ischemic and hemorrhagic, confirmed by head CT scan.

3. Patients with medical record data that have the following components: demographic characteristics and one or more risk factors for pneumonia, namely type of stroke, Glasgow Coma Scale (GCS) score, dysphagia, nasogastric tube (NGT) placement, diabetes mellitus, and hypertension

2.3.2 Exclusion criteria

1. Acute stroke patients with incomplete medical record data.

2. Acute stroke patients, both ischemic and hemorrhagic, which are not confirmed by head CT-Scan examination.

3. Acute stroke patients who are not diagnosed with pneumonia or have a history of pneumonia before the onset of stroke.

2.3.3 Sample size

The calculation of sample size for the Cross Sectional Study design and the method used is simple random sampling, so the calculation of sample size is determined using the Lemeshowb formula, obtaining a sample size of 31 people.

2.4 Data Collection Technique

The sampling of both groups was carried out using random sampling techniques.

2.5 Research Instrument

The research instrument used was to take secondary data with medical record data from patients who experienced acute stroke with pneumonia at Chasbullah Abdulmadjid Hospital for the period 2023.

2.6 Data Processing and Analysis

The collected data will be processed on a computer for data processing using MS Excel and SPSS v.25 programs. After that, univariate analysis will be carried out to produce the frequency distribution and percentage of each variable. The univariate analysis in this study is demographic data, GCS, dysphagia, NGT installation, history of diabetes mellitus, and

history of hypertension which will then be presented in the form of number (n) and percentage (%) in all research subjects. Data analysis is in the form of the prevalence of each risk factor for the incidence of pneumonia in acute stroke patients.

3. RESULTS AND DISCUSSION

3.1 Research Results

From the results of the study conducted by taking secondary data, namely taking medical record data at Chasbullah Abdulmadjid Hospital for the period 2023 - 2024, the population of acute stroke patients with pneumonia was 32 patients, with the number of samples that met the inclusion criteria of 31 patients because 1 patient had incomplete medical record data.

3.1.1 Characteristics of acute stroke patients

The basic characteristics of stroke patients with pneumonia obtained based on age range tend to occur more frequently in the elderly age range, namely at the age of 60 - 69 years, there were 13 people (41.9%), followed by pre-elderly age, namely at the age of 45 - 59 years, there were 11 people (35.5%) and at high risk elderly age, namely above 70 years, there were 7 people (22.6%).

Table 1. Distribution of categories by age

Age	Frequency (n)	Percentage (%)
45 - 59	11	35,5
60 - 69	13	41,9
>70	7	22,6
Total	31	100.0

The basic characteristics of stroke patients with pneumonia obtained based on gender tend to occur more frequently in females, namely 21 people (67.7%) and followed by males, namely 10 people (32.3%).

Table 2. Distribution of categories by gender

Gender	Frequency (n)	Percentage (%)
Male	10	32,3
Female	21	67,7
Total	31	100.0

Table 3. Distribution of categories based on stroke type

Stroke Type	Frequency (n)	Percentage (%)
Ischemic Stroke	29	93,5
Hemorrhagic Stroke	2	6,5
Total	**31**	**100.0**

Characteristics of stroke patients with pneumonia obtained based on the type of stroke tend to occur more often in the elderly age range, namely at the age of 60 - 69 years (41.9%) with female gender as many as 21 patients (67.7%). The most common type of stroke experienced was ischemic stroke, which occurred in 29 patients (93.5%).

3.1.2 Risk factors for pneumonia in acute stroke patients

In the study of GCS (Glasscow Coma Scale) values, it was found that the number of stroke patients with pneumonia had GCS values dominated by scores of 13-15, namely in 17 patients (54.8%). At a GCS value of 9 - 12, there were 11 patients (35.5%), and at a GCS value of 3 - 8, there were 3 patients (9.7%).

Table 4. Distribution of categories based on GCS values

GCS	Frequency (n)	Percentage (%)
GCS score 3 - 8	3	9,7
GCS score 9 - 12	11	35,5
GCS score 13 - 15	17	54,8
Total	31	100.0

Table 5. Distribution of categories based on NGT usage

NGT	Frequency (n)	Percentage (%)
Yes	12	38,7
No	19	61,3
Total	31	100.0

In a study on the use of NGT (Nasogastric Tube), it was found that more stroke patients with pneumonia did not use NGT, namely 19 patients (61.3%) compared to those who used NGT, namely 12 patients (38.7%).

Table 6. Distribution of categories based on dysphagia incidence

Dysphagia	Frequency (n)	Percentage (%)
Yes	19	61,3
No	12	38,7
Total	31	100.0

In a study on dysphagia, it was found that more stroke patients with pneumonia experienced dysphagia, namely 19 patients (61.3%) compared to those who did not experience dysphagia, namely 12 patients (38.7%).

Table 7. Distribution of categories based on diabetes mellitus comorbidities

Diabetes mellitus	Frequency (n)	Percentage (%)
Yes	21	67.7
No	10	32.3
Total	31	100.0

In a study on comorbidities of diabetes mellitus, it was found that the number of acute stroke patients with pneumonia who experienced comorbidities of diabetes mellitus was greater, namely 21 patients (67.7%) compared to those who did not experience diabetes mellitus, namely 10 patients (32.3%).

Table 8. Distribution of categories based on hypertension concomitant diseases

Hypertension	Frequency (n)	Percentage (%)
Yes	23	74,2
No	8	25,8
Total	31	100.0

In a study on comorbid hypertension, it was found that the number of stroke patients with hypertension had more comorbid hypertension, namely in 23 patients (74.2%) compared to those without hypertension, namely in 8 patients (25.8%). In this study, risk factors were found in stroke patients with pneumonia at Chasbullah Abdulmadjid Hospital for the 2023-2024 period, namely pneumonia was more common in elderly patients (aged 60-69) as many as 13 patients

(41.9%), female gender in 21 patients (67.7%), ischemic stroke type in 29 patients (93.5%), with a fairly good GCS score of 13-15 as many as 17 patients (54.8%), not using NGT in 19 patients (61.3%), dysphagia in 19 patients (61.3)%, experiencing DM in 21 patients (67.7)% and hypertension in 23 patients (74.2%). Categorical data is presented in frequency (n) and percentage (%).

3.2 Discussion

The purpose of this study was to determine the most common risk factors for pneumonia in acute stroke patients with the hope of preventing and reducing the prevalence of pneumonia complications in stroke patients and reducing the impact on patient health status where the recovery process can be hampered, increased mortality, and the impact on patient finances due to longer hospitalization times and increased treatment costs. The data from the study of stroke patients with pneumonia obtained at Chasbullah Abdulmadjid Hospital for the period 2023 - 2024 amounted to 31 samples.

In the research findings, based on the age category of stroke patients who developed pneumonia, it was found that the age group of 60–69 years, classified as elderly according to the age criteria of the Indonesian Ministry of Health (Ministry of Health of the Republic of Indonesia 2016), had the highest frequency of pneumonia complications, with 13 patients (41.9%). This was followed by the age group of 45–59 years, classified as pre-elderly, with 11 patients (35.5%). This finding is consistent with a study by Muhafidzah et al. in Bandung, which reported an average age of stroke patients with pneumonia as 59 ± 13.53 years, as well as a prospective study in India that reported a younger average age for patients with hospital-acquired pneumonia at 55.1 ± 16.2 years (Muhafidzah et al., 2021, Kunhikatta et al., 2016). This phenomenon may be due to the decline in overall health functions with increasing age, particularly the weakening of the immune system in elderly patients (60+). In older adults, changes in gut microbiota characteristics also occur, including reduced bacterial diversity, which is associated with declining nutritional status and an increased risk of frailty, ultimately leading to a higher risk of infection (Guo et al., 2021, Wen et al., 2019). Immunodepression is a key factor that enhances the progression of bacterial infections, leading to pneumonia (Hoffmann et al. 2012, Kalra et al., 2016, Langdon et al., 2009,

Titsworth et al., 2013, Prass et al., (2006). Additionally, aging is associated with a decline in protective reflexes such as coughing and swallowing, which increases the risk of aspiration pneumonia due to the inhalation of pharyngeal secretions, food, liquids, or gastric contents into the lower respiratory tract (Muhafidzah et al., 2021, Hoffmann et al., 2012). Impaired lung clearance and reduced mobility contribute to airway obstruction and impaired drainage of lung secretions, further promoting the development of pneumonia.

In this study, based on the gender category of stroke patients who developed pneumonia, the majority were female, with 21 patients (67.7%). This result aligns with a study by Matsumuro et al., which found that female stroke patients were more likely to develop pneumonia (Matsumura et al., 2014). This may be because females have a higher risk of experiencing stroke compared to males. According to a study by Feigin et al., which examined stroke risk in 195 countries over 25 years (1990–2016), the lifetime stroke risk after the age of 25 was 25.1% for females and 24.7% for males (Feigin et al., 2018). Several factors contribute to the higher incidence in females, including the use of hormonal contraception or hormone replacement therapy (estrogen and progestin), as well as pregnancy-related complications such as preterm birth, gestational hypertension, and preeclampsia (Rexrode et al., 2022). However, this differs from the study by Muhafidzah et al., (2021) which stated that being male is a predictive factor for pneumonia in acute stroke patients. This is related to the androgen hormone dihydrotestosterone (DHT), a potent male hormone that exacerbates immunosuppression following brain injury due to stroke (Muhafidzah et al. 2021). Additionally, other predictive factors may include lifestyle habits, smoking, and obesity, which were not examined in this study. The differences in gender prevalence may also be influenced by the fact that most acute stroke patients admitted to RSUD Chasbullah Abdulmadjid were female.

In the results of this study, based on the category of stroke type in stroke patients who experienced pneumonia, the dominant type was ischemic stroke, namely 29 patients (93.5%). The high incidence of pneumonia in ischemic stroke patients may be caused by immunodepression due to stroke caused by excessive activation of the sympathetic nervous system (Prass et al., 2006, Prass et al., 2003). These results differ from the study by Muhafidzah et al., (2021) Hasan Sadikin Hospital in Bandung who found that stroke patients with pneumonia were more common in hemorrhagic stroke patients, namely 17 patients (56.67%), and the study by Ritonga et al at RSPON Jakarta who found SAP patients with a primary diagnosis of hemorrhagic stroke as many as 99 patients (67.7%) (Ritonga et al. 2019, Muhafidzah et al., 2021). Hemorrhagic stroke is associated with a higher decrease in consciousness and higher intracranial pressure which causes nerve damage, greater inflammatory response and immunosuppression, and a more severe decrease in consciousness or the need for NGT or ventilator installation which increases the risk of aspiration (Muhafidzah et al., (2021). The difference in the results of this study regarding the type of stroke in stroke patients with pneumonia may be caused by the prevalence of patients who come to Chasbullah Abdulmadjid Hospital experiencing ischemic stroke is higher than hemorrhagic stroke.

In the results of this study, based on the GCS value in stroke patients with pneumonia, the highest GCS value was 13-15, which was 17 patients (54.8%). This result is different from the study by Muhafidzah et al. (2021) at Hasan Sadikin Hospital, Bandung, which found that stroke patients with pneumonia tended to have a GCS value of 9-12 in 15 patients (50%) followed by a GCS value of 3-8 in 9 patients (30%) and a GCS value of 13-15 in 6 patients (20%) (Muhafidzah et al., 2021). Research by Ritonga et al., (2019) at RSPON Jakarta also had different results, namely the GCS value in stroke patients with pneumonia was found to have the highest GCS value at 3-8 in 94 patients (72.3%) (Ritonga et al., 2019). Lower GCS values are associated with increasingly severe decreased consciousness, affecting the patient's protective reflex in swallowing or coughing when aspiration occurs. The lower GCS value is also associated with the increasing need for NGT for nutritional needs or ventilators in patients with severe symptoms which are risk factors for aspiration in causing pneumonia (Muhafidzah et al., 2021). In this study, acute stroke patients with pneumonia were found to have a fairly high GCS value of 13-15, which is different from other studies. This may be due to other factors that influence patients with good GCS values such as experiencing dysphagia, use of NGT or use of ventilators, and elderly patients.

In the results of this study, it was found that stroke patients who experienced dysphagia experienced more pneumonia infections, namely

in 19 patients (61.3%). This is by research by Muhafidzah et al. (2021) in Bandung which found that 64.71% of acute stroke patients with dysphagia experienced pneumonia and research by Quyet et al in Vietnam which examined 508 stroke patients where swallowing ability was assessed using the GUSS (Gugging Swallowing Screen) method. Patients with GUSS values between 0 - 14 (low swallowing ability) were found to have a higher risk of pneumonia compared to patients with GUSS values between 15 - 20.30 This is also in line with research by Muhafidzah et al. in Bandung and Cohort research in Germany and China which stated that dysphagia is a predictor of pneumonia (Muhafidzah et al., 2021, Hoffmann et al., 2005, Ji et al., 2013). Dysphagia plays a role in increasing the risk of aspiration and can cause complications such as pneumonia, dehydration, malnutrition, or airway obstruction. Dysphagia is characterized by reduced coordination of the pharyngeal muscles potentially due to reduced cortical connectivity. In addition, oral weakness of the facial, palatal, and pharyngeal muscles may also contribute to dysphasia symptoms (González-Fernández et al. 2013, Teasell et al., 2018). Aspiration due to dysphagia is thought to be a key component of SAP pathogenesis. A meta-analysis of seven studies with 891 patients showed that dysphagia conferred a more than threefold relative increase in risk for SAP, and dysphagia with aspiration on swallowing increased the risk more than tenfold (Martino et al., 2012).

In the results of this study, based on the category of NGT use, stroke patients who experienced pneumonia were found to be more in patients who did not use NGT, namely in 19 patients (61.3%). This is by research by Kalra et al, which found that there was no relationship between NGT use and SAP events, and research by Lang don et al, where the study found a higher risk of lower respiratory tract infection in patients who were given food and drink enterally (Kalra et al., 2016, Langdon et al., 2009). This can be caused because patients who do not use NGT have a cough and swallowing reflex that is already reduced and experience dysphagia so pulmonary aspiration is more likely to occur when given food or drink enterally (Eltringham et al., 2019). The low incidence of SAP in NGT use can also be explained by routine preventive measures such as positioning, regular suction, swallowing techniques, and diet modification in patients with NGT in stroke specialist units (Titsworth et al., 2013, Zawiah et al., 2023).

In the results of this study, based on the presence of comorbid diabetes mellitus in stroke patients who experienced pneumonia, it was found that there were more patients with diabetes mellitus, namely in 21 patients (67.7%). Research by Quyet et al also found that patients with a history of diabetes had a higher percentage (26.5%) of pneumonia compared to those who did not experience pneumonia (9.5%) (Quyet Do et al. 2019). This is also in line with research by Zhang et al in 2016 which found that the percentage of patients with diabetes experiencing pneumonia was higher (24.4%) compared to patients who did not experience diabetes (18.4%) (Zhang et al., 2016) Diabetes is a common risk factor in stroke patients and hyperglycemia is a prognostic factor for bacterial infection and SAP. Hyperglycemia can cause disturbances in the immune response. The stress response in the acute phase of ischemic stroke also increases blood sugar due to the release of stress hormones, especially cortisol and norepinephrine, and results in lymphopenia and lymphocyte dysfunction (Prass et al., 2003, Chamorro et al., 2007).

In the results of this study, based on the presence of comorbid hypertension in stroke patients who experienced pneumonia, it was more in patients who experienced hypertension, namely in 23 patients (74.2%). Hypertension sufferers are one of the risk factors that play an important role in causing SAP. Research in Japan by Ishigami et al found a high association between high-grade hypertension (200/120 mmHg) and the occurrence of SAP after conducting a study on 118 ischemic stroke patients aged over 70 years (Ishigami et al., 2012). These results are also in accordance with research by Muhafidzah et al., (2021)where 90.33% of stroke patients with pneumonia experienced hypertension during acute stroke onset and also research by Matz et al in Australia which found that 83.8% of stroke patients with hypertension experienced pneumonia (Muhafidzah et al., 2021, Matz et al., 2016). The severity of hypertension also determines excessive sympathetic nerve activation as the basis for immunodepression which is a risk of pneumonia in stroke patients, in line with research by Matz et al., (2016) which found that patients with hypertensive crisis experienced more pneumonia (20%) compared to stroke patients without pneumonia (14.47%) (Matz et al., 2016, Zhang et al., 2016, Ropper et al., 2019).

4. CONCLUSION

The conclusion of the research results of the description of risk factors for pneumonia in acute stroke patients at the Chasbullah Abdulmadjid Regional Hospital for the 2023 period against 31 samples is as follows: 1) Based on age group, the incidence of pneumonia in acute stroke patients is most common in the 60-69 year age group, with a total of 13 patients (41.9%); 2) Based on gender group, the incidence of pneumonia in acute stroke patients is most common in women with a total of 21 patients (67.7%); 3) Based on the type of stroke group, the incidence of pneumonia in acute stroke patients is most common in ischemic stroke with a total of 29 patients (93.5%); 4) Based on the GCS value group, the incidence of pneumonia in acute stroke patients is most common in GCS values 13-15, with a total of 17 patients (54.8%); 5) Based on the NGT usage group, the incidence of pneumonia in acute stroke patients is most common in patients who do not use NGT, with a total of 19 patients (61.3%); 6)Based on the dysphagia group, the incidence of pneumonia in acute stroke patients was most common in patients with dysphagia, with a total of 19 patients (61.3%); 7) Based on the group with comorbid diabetes mellitus, the incidence of pneumonia in acute stroke patients was most common in patients with diabetes mellitus, with a total of 21 patients (67.7%), and 8) Based on the group with comorbid hypertension, the incidence of pneumonia in acute stroke patients was most common in patients with hypertension, with a total of 23 patients (74.2%).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

CONSENT

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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