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Predictors of clinical outcomes in ischemic stroke patients with infectious complications

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ABSTRACT

Infection in stroke patients is a significant health problem that is associated with poor prognosis and increased treatment costs. This infection can intensify immune system dysregulation, worsen the risk of cognitive decline, and increase mortality and neurological disability. This study aimed to evaluate predictors influencing clinical outcomes in ischemic stroke patients with infectious complications. The study used a cross-sectional design. Retrospective data were collected from medical records at Jayapura Regional Hospital for the period from January 1, 2023, to May 31, 2025. The study subjects were all patients with ischemic stroke who received antibiotics. Clinical outcomes were evaluated based on clinical improvement, defined by vital signs within the normal range, symptom improvement within three to five days after antibiotic administration, and improvement in laboratory values to within the normal range. A total of 50 patients were included after meeting the study inclusion criteria. The results showed significant relationships between risk factors such as hypertension, kidney failure, respiratory tract infection (pneumonia), and rational antibiotic use, with p-values of 0.007, 0.016, 0.023, and 0.007, respectively, and the clinical outcomes of ischemic stroke patients with infectious complications. Multivariate analysis showed that the factors influencing clinical outcomes were hypertension (OR= 7.292; 95% CI 1.510–35.202; p= 0.013), kidney failure (OR= 1.565; 95% CI 0.027–0.810; p= 0.028), respiratory tract infection (pneumonia) (OR= 5.760; 95% CI 1.147–28.920; p= 0.033), and rational antibiotic use (OR= 7.292; 95% CI 1.510–35.202; p= 0.013). Monitoring risk factors in post-infectious ischemic stroke patients is therefore essential. Pharmacists can play an important role in monitoring patients' clinical conditions to prevent post-stroke complications by paying close attention to patient risk factors.

Key words: antibiotics; clinical outcomes; infection; ischemic stroke; predictors.

INTRODUCTION

Stroke-associated infection is a significant medical problem after stroke and has a major impact on stroke prognosis (Rabaneda-Lombarte *et al*., 2024; Rinawati *et al*., 2025). Stroke with concurrent infection is a less common but still important cause, especially in low- and middle-income countries (Chutinet *et al*., 2025). Post-stroke infection can increase stroke care costs by about 80% (Ali *et al*., 2018). Infection often complicates acute stroke events and is associated with poor prognosis in patients (Ndakotsu *et al*., 2021). Infection can precipitate stroke, and stroke can also trigger immune suppression that increases the risk of infection (Elkind *et al*., 2020).

Infection frequently occurs after stroke and is associated with poorer outcomes in stroke patients (Becker *et al*., 2016). The risk of post-stroke infection requires preventive measures such as early dysphagia screening (Rinawati *et al*., 2025). Post-stroke immune changes also adversely affect long-term cognitive outcomes in stroke patients,

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increasing the risk of neurodegeneration and post-stroke dementia. Infection occurring at the time of stroke can also intensify immune dysregulation after stroke and worsen the risk of cognitive decline (Elkind *et al*., 2020). In addition, infection increases mortality and neurological disability (Xi *et al*., 2017).

Antibiotics are used to treat post-stroke infections and have different antimicrobial and anti-inflammatory effects (Smith *et al*., 2019). Their use appears rational, but their efficacy remains unclear (Ndakotsu *et al*., 2021). Antibiotic therapy for infection in stroke patients has the potential to reduce the risk of infection and mortality and to improve poor functional outcomes (Xi *et al*., 2017). A previous study by Kaseke et al. (2024) showed that functional outcomes significantly affect survival outcomes in stroke patients and that clinical variables should be considered in prognosis assessment and interventions for each individual recovering from stroke.

In addition, patients with a history of diabetes, leukoaraiosis, blood glucose level, systolic blood pressure, and NIHSS score before thrombolysis have better outcomes (Yin-hui *et al*., 2013). A study by Sol *et al*. (2021) found that the positive effects of a clinical pathway can reduce patients' length of stay and improve clinical outcomes, with a clear effect on the quality of patient care. This study aimed to evaluate predictors that influence clinical outcomes in ischemic stroke patients with infectious complications. The findings are expected to provide information for determining clinical monitoring of ischemic stroke patients with infectious complications in hospitals.

MATERIALS AND METHODS

Place and time of study

This study was conducted at the Medical Records Unit (ICM) of Jayapura Regional Hospital from April to June 2025. The medical record files reviewed were those of ischemic stroke patients who received antibiotics during the period from January 1, 2023, to May 31, 2025.

Study design

This study used a descriptive and analytic observational design with a cross-sectional approach and retrospective data collection from ischemic stroke patients with infectious complications at Jayapura Regional Hospital. The study was approved by the RSI Sultan Agung Health Research Ethics Committee under Decree No. 86/KEPK-RSISA/VI/2025.

Study subjects

The study subjects were all patients with ischemic stroke who received antibiotics at Jayapura Regional Hospital from January 1, 2023, to May 31, 2025, and met the inclusion criteria. The inclusion criteria were: (1) patients diagnosed with ischemic stroke complicated by infection and receiving antibiotics; (2) patients aged ≥ 18 years; (3) male and female patients; (4) patients hospitalized for at least three days; (5) patients with comorbid diseases (hypertension, diabetes mellitus, dyslipidemia, heart disease, renal insufficiency, and congestive heart failure or CHF); (6) patients who underwent supporting examinations such as chest X-ray, clinical examination, and/or laboratory examination; and (7) patients with complete medical record data. The exclusion criteria were: (1) patients with incomplete medical data; and (2) patients who were discharged against medical advice or died within ± 48 hours of hospitalization.

The total number of ischemic stroke patients who received antibiotics during the period from January 1, 2023, to May 31, 2025, was 168 patients. Data were collected using nonprobability consecutive sampling through tracing patient medical records. This sampling method means that all collected samples were observed and, if they met the sample selection criteria, were included until the required sample size was reached. The number of subjects in this study was 50 patients.

Research instruments

The instruments used in this study consisted of the medical record files of inpatients treated at

Jayapura Regional Hospital. The research tool used was a data collection sheet (LPD).

Evaluation of clinical outcomes

Evaluation of clinical outcomes included patient clinical improvement, determined by vital signs within the normal range, improvement of symptoms within three to five days after antibiotic administration, and improvement of laboratory values to within the normal range. This information was obtained from the medical records.

Data analysis

Bivariate analysis was performed to determine the relationship between predictors affecting clinical outcomes in ischemic stroke patients with infectious complications using the chi-square test. Multivariate analysis was performed to determine the significance of the effect of each predictor on clinical outcomes using multiple logistic regression analysis. This study used a 95% confidence interval and a significance level of 5%. A p-value < 0.05 indicated a significant difference.

RESULTS AND DISCUSSION

The results showed relationships between predictors such as hypertension, kidney failure, respiratory tract infection (pneumonia), and rational antibiotic use and clinical outcomes in stroke patients with infectious complications. Testing was carried out using the chi-square test, with p-values of 0.007, 0.016, 0.023, and 0.007, respectively, all < 0.05 (Table 1).

Based on Table 1, hypertension was more common in patients who improved, namely 35 patients (70%), compared with 4 patients (8%) who did not improve. Hypertension in ischemic stroke patients is associated with poor functional outcomes and increased mortality. According to Bath *et al*. (2022), this condition causes significant hyperemia in brain tissue with pre-existing blood–brain barrier disruption, leading to hemorrhagic complications and inflammatory consequences.

Patients with comorbid hypertension had a significant relationship with clinical outcomes in stroke patients with infectious complications (p-value = 0.007). A study by Rønning et al. (2026) stated that increased blood pressure within the first 24 hours was associated with poorer neurological and functional outcomes at three months, and higher initial blood pressure was associated with worse neurological status. In addition, hypertension affects brain atrophy, neuronal connectivity and neurogenesis, as well as phenotypic modification of microglia and astrocytes (Maïer & Kubis, 2019). McManus & Liebeskind (2016) also showed that high blood pressure is harmful during the transition from the acute to the subacute phase of stroke and is associated with poorer clinical outcomes.

The variable of comorbid kidney failure was more common in patients who improved, namely 14 patients (28%), compared with 7 patients (14%) who did not improve. Kidney failure in ischemic stroke patients is an independent risk factor for cardiovascular disease and stroke (Nagaraja *et al*., 2023; Yahalom *et al*., 2009). Comorbid kidney failure contributes to differences in clinical effects among patients with cardioembolic stroke and small-vessel occlusion (Miwa *et al*., 2022). According to Hayashi *et al*. (2025), stroke patients with the highest severity on admission among those with CKD may have poorer prognosis and higher mortality. Stroke can also cause renal dysfunction that may adversely affect patient clinical outcomes. This occurs because central autonomic networks, autoregulation, inflammatory and immune responses, and the role of extracellular vesicles and their microRNA cargo mediate post-stroke brain–kidney interactions (Zhao *et al*., 2020).

Comorbid kidney failure had a significant relationship with clinical outcomes in ischemic stroke patients with infectious complications (p-value = 0.016). A study by Kumai *et al*. (2012) reported that patients with chronic kidney failure had a significantly higher risk of neurological deterioration, in-hospital mortality, and poor functional outcomes, with p-value < 0.001. This is supported by Cheng *et al*. (2024), who reported

that renal impairment reduces the effectiveness of endovascular therapy and is associated with poorer functional outcomes and higher mortality at three months.

Kidney disease (AKI or CKD) often complicates stroke and increases in-hospital mortality in ischemic stroke. It is characterized by an increase in serum creatinine of 0.3 mg/dL within 48 hours or by at least a 50% increase from the normal value within seven days during hospitalization (Arora *et al*., 2024). Management of ischemic stroke patients with kidney failure requires special attention to diagnostic factors and therapeutic management related to coagulopathy, impaired immune function, encephalopathy, and renal replacement modalities (Stern-Nezer, 2021).

In patients with respiratory tract infection (pneumonia), 36 patients (72%) improved, compared with 5 patients (10%) who did not improve. Respiratory tract infection (pneumonia) is a common complication in ischemic stroke patients but is often overlooked in stroke care

Table 1. Relationship between predictors and clinical outcomes in ischemic stroke patients with infectious complications.

Variable	*Clinical outcome (n = 50)*		*p-value*
	Improved	Not improved	
Age			
≤ 55 Years	19 (38%)	5 (10%)	0.616
> 55 Years	22 (44%)	4 (8%)	
Sex			0.146
Male	21 (42%)	7 (14%)	
Female	20 (40%)	2 (4%)	
Stroke diagnosis			
Ischemic Stroke	35 (70%)	8 (16%)	0.783
Embolic Stroke	6 (12%)	1 (2%)	
Length of stay			
≤ 7 Days	23 (46%)	4 (8%)	0.525
> 7 Days	18 (36%)	5 (10%)	
Hypertension			
Present	35 (70%)	4 (8%)	**0.007***
Absent	6 (12%)	5 (10%)	
Diabetes Mellitus			0,561
Present	18 (36%)	3 (6%)	
Absent	23 (46%)	6 (12%)	
CHF (Congestive Heart Failure)			
Present	13 (26%)	3 (6%)	0,925
Absent	28 (56%)	6 (12%)	
Kidney Failure			
Present	14 (28%)	7 (14%)	**0.016***
Absent	27 (54%)	2 (4%)	
Heart Disease			
Present	21 (42%)	4 (8%)	0.713
Absent	20 (40%)	5 (10%)	
Respiratory Tract Infection (Pneumonia)			
Present	36 (72%)	5 (10%)	**0.023***
Absent	5 (10%)	4 (8%)	
Rational Antibiotic Use			
Rational	35 (70%)	4 (8%)	**0.007***
Irrational	6 (12%)	5 (10%)	

Note: Chi-square test statistical analysis < 0.05.

(Nakajima *et al*., 2002). Infection during hospitalization is significantly associated with the short-term risk of recurrent stroke (p-value = 0.02) (Xu *et al*., 2020).

Respiratory tract infection (pneumonia) had a significant relationship with clinical outcomes in ischemic stroke patients with infectious complications (p-value= 0.023). Research by Vaghi *et al*. (2024) showed that a higher burden of infection can affect the neurorehabilitation period in ischemic stroke patients (p-value = 0.001). This is a negative prognostic factor and is marked by poorer functional, motor, and neurological performance (Vaghi *et al*., 2024). Another study showed that infection present before and/or acquired in hospital independently predicts poorer short-term and long-term outcomes in stroke patients (Grabska *et al*., 2011).

Respiratory tract infection (pneumonia) is a common medical complication after stroke. Post-stroke pneumonia is associated with mortality at 30 days and one year, longer length of stay, and dependence at discharge (Finlayson *et al*., 2011). Septianingrum *et al.* (2025) reported that most cases of pneumonia occurred in ischemic stroke patients (93.9%). Pneumonia in ischemic stroke patients was significantly associated with dysphagia, diabetes mellitus, and other infections during hospitalization. Another report stated that the mortality percentage among patients with respiratory infectious complications reached 24%, and all patients who improved were discharged or transferred to another hospital (Nakajima *et al*., 2002).

Rational antibiotic use was associated with a higher proportion of improved patients, namely 35 patients, compared with irrational antibiotic use (p-value = 0.007). This is in line with Park *et al*. (2024), who stated that antibiotic use in the ischemic stroke group was associated with a lower risk of death (p-value < 0.001). Another report stated that antibiotic use significantly reduced the incidence of infection in stroke patients (Wang *et al*., 2023).

According to Thoriq *et al*. (2024), there is an effect of appropriate antibiotic use on clinical outcomes (p = 0.000). Early treatment upon hospital admission is an important indicator for reducing stroke mortality (Hamad *et al*., 2023). A narrative review study showed that rapid administration of effective antibiotics can improve clinical outcomes in patients with infectious

Table 2. Predictors affecting clinical outcomes in ischemic stroke patients with infectious complications.

Risk factors	RR	95% CI	*p-value*
Age	0,691	0,162 - 2,948	0,617
Sex	0,300	0,056 – 1,620	0,162
Stroke Diagnosis	0,729	0,077 – 6,932	0,783
Length of Stay	1,597	0,374 – 6,825	0,527
Hypertension	**7,292**	**1,510 – 35,202**	**0,013***
Diabetes Mellitus	1,565	0,343 – 7,135	0,563
CHF (Congestive Heart Failure)	0,929	0,200 – 4,306	0,925
Kidney Failure	**0,148**	**0,027 – 0,810**	**0,028***
Heart Disease	1,312	0,308 – 5,598	0,713
Respiratory Tract Infection (Pneumonia)	**5,760**	**1,147 – 28,920**	**0,033***
Rational Antibiotic Use	**7,292**	**1,510 – 35,202**	**0,013***

Note: Multiple logistic regression test < 0.05

syndromes (Nauclér *et al*., 2021). Antibiotic use requires a patient-specific approach to reduce the risk of antibiotic resistance and antibiotic-related adverse effects (Razzaq *et al*., 2023).

Based on Table 1, the results of the bivariate analysis showed that four independent variables had p-values < 0.25, namely hypertension, kidney failure, respiratory tract infection, and rational antibiotic use. Therefore, these four variables were included in the multiple logistic regression multivariate analysis.

The hypertension variable had a significant relationship with clinical outcomes in ischemic stroke patients with infectious complications (OR = 7.292; 95% CI = 1.510–35.202; p= 0.013). A study by Ishitsuka *et al*. (2014) showed that increased blood pressure after ischemic stroke was significantly associated with poorer functional outcomes (OR= 2.51; 95% CI 1.15–3.27; p-value < 0.001). This condition is clearly unfavorable for clinical outcomes in ischemic stroke patients. Patients with hypertension at hospital admission have a 1.5- to 5-fold greater chance of death and long-term dependence (Bath *et al*., 2022).

Hypertension independently increases the risk of stroke and is associated with poorer prognosis (Maïer & Kubis, 2019). Changes and increases in blood pressure significantly affect poor clinical outcomes in ischemic stroke patients at three months (Rønning *et al*., 2026). According to Thakkar *et al*. (2020), hypertension significantly contributes to higher intracranial pressure, reduced cerebral perfusion pressure, higher mortality, slower functional recovery, and larger infarct volume. Kate *et al*. (2019) reported that antihypertensive use based on blood pressure in ischemic stroke patients was not associated with an increase in the total volume of hypoperfused tissue.

The kidney failure variable had a significant relationship with clinical outcomes in ischemic stroke patients with infectious complications (OR = 0.148; 95% CI = 0.027–0.810; p = 0.028). Kidney failure with a GFR value < 45 mL/min/1.73 m2 and proteinuria is associated with unfavorable functional outcomes in stroke patients (OR = 1.30; 95% CI = 1.01–1.69) (Miwa *et al*., 2022). Cheng *et al*. (2024) reported that better renal function (GFR ≥ 90 mL/min/1.73 m^2) was associated with lower mortality in ischemic stroke patients (OR = 0.47; 95% CI = 0.25–0.88).

Kidney disease is strongly associated with an increased risk of stroke, small-vessel disease, and vascular dementia (Chen *et al*., 2024; Kelly & Rothwell, 2020). Kidney failure (CKD) is a predictor of poorer clinical outcomes in ischemic stroke patients. Proteinuria independently contributes to increased neurological risk, mortality, and poor functional outcomes (Kumai *et al*., 2012). Another report stated that poor functional outcomes depend on the equation used to estimate GFR values (Yahalom *et al*., 2009).

The respiratory tract infection (pneumonia) variable had a significant relationship with clinical outcomes in ischemic stroke patients with infectious complications (OR= 5.760; 95% CI= 1.147–28.920; p= 0.033). According to Rinawati *et al*. (2024), patients with pneumonia have a 6.89-fold greater risk of poor clinical outcomes than those without pneumonia. This condition significantly affects morbidity, mortality, and healthcare costs and can lead to neurological impairment and immunosuppression (Surya tenggara & Munthe, 2024).

Respiratory tract infection (pneumonia) is one of the complications that occurs in ischemic stroke patients and is associated with poorer clinical outcomes (Septianingrum *et al*., 2025). This infection increases the risk of ischemic stroke and can worsen the prognosis of ischemic stroke (Grabska *et al*., 2011). In addition, infection is an independent risk factor for a high risk of recurrent stroke during hospitalization (Xu *et al*., 2020).

A meta-analysis reported a significant relationship between three bacteria (*C. pneumoniae*, *H. pylori*, and *M. tuberculosis*) and the incidence of ischemic stroke (Keikha & Karbalaei, 2022). Nakajima *et al*. (2002) stated that respiratory tract infection is an independent risk factor for poor clinical outcomes (OR = 5.838; 95% CI = 1.792–19.018). The impact of infection on stroke patient clinical outcomes includes a more severe clinical profile, more comorbidities, longer hospital stay,

and increased invasive interventions (Hosseinzadeh *et al*., 2025).

The variable of rational antibiotic use had a significant relationship with clinical outcomes in ischemic stroke patients with infectious complications (OR = 7.292; 95% CI = 1.510–35.202; p = 0.013). Antibiotics are used to treat post-stroke infections (Smith *et al*., 2019). According to Wibowo *et al*. (2021), antibiotic therapy for ischemic stroke patients at Dr. Kariadi Central General Hospital, Semarang, showed a rational use pattern of about 53.0%. Smith *et al.* (2019), and Vermeij *et al*. (2018) reported that the use of macrolides, carbapenems, cephalosporins, or monobactams significantly affected infections in ischemic stroke patients. Antibiotic use prevents infection in stroke patients and saves costs by improving patient quality of life. Ali *et al*. (2023) also stated that this helps healthcare teams follow appropriate clinical guidelines and supports healthcare policy development to review and revise antibiotic guidelines.

CONCLUSION

Monitoring the predictors that influence clinical outcomes in ischemic stroke patients is essential, particularly hypertension, kidney failure, respiratory tract infection (pneumonia), and the rational use of antibiotics. Pharmacists can play a role in monitoring clinical outcomes in ischemic stroke patients to reduce stroke recurrence.

Given the limited number of ischemic stroke subjects receiving antibiotics in this study, further research with broader subject coverage across several hospitals is needed.

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