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Determinants of Post-Discharge Control-Visit Adherence and Stroke Rehospitalization: A Retrospective Cohort Study at Amal Sehat Hospital, Wonogiri, Indonesia

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ABSTRACT

Background: Stroke is a leading cause of death and disability, and post-discharge outcomes depend heavily on continuity of follow-up care. This study analyzed predisposing, enabling, and need factors, together with control-visit adherence, in relation to post-discharge control-visit adherence and stroke rehospitalization using Andersen's Behavioral Model.

Subjects and Method: A retrospective cohort study was conducted at Amal Sehat Hospital, Wonogiri, Central Java, on 257 stroke patients discharged alive in 2025, selected by purposive sampling from medical records. Dependent variables were control-visit adherence and rehospitalization. Independent variables followed Andersen's model: predisposing (age, sex, marital status), enabling (payment, distance, companion), and need (diagnosis, recurrence, comorbidity, hypertension, length of stay, discharge medications). Adherence was assessed at the first follow-up visit (K1) (≤77 days), second follow-up visit (K2) (8–30 days), and third follow-up visit (K3) (31–90 days) post-discharge. The data were analyzed using multiple logistic and Cox proportional-hazard regression.

Results: No predisposing or enabling factor was independently associated with either outcome. K1 adherence was the strongest independent protective factor against rehospitalization (aHR= 0.07; 95% CI= 0.02 to 0.24; p< 0.001). Diagnosis was also independent: ischemic stroke (I63) had lower risk than hemorrhagic stroke (I61) in bivariate (HR= 0.41; 95% CI= 0.17 to 0.98; p= 0.047) and multivariate analysis (aHR= 0.40; 95% CI= 0.16 to 0.99; p= 0.048).

Conclusion: Adherence to the first control visit within seven days independently reduces stroke rehospitalization, and hemorrhagic stroke carries a higher independent risk than ischemic stroke. Hospitals should prioritize securing this first visit and closer monitoring of hemorrhagic-stroke patients.

Keywords: stroke, medication adherence, rehospitalization, health behavior, healthcare utilization

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BACKGROUND

Stroke remains one of the foremost public-health problems worldwide. It is the second leading cause of death and the third leading cause of combined death and disability, with roughly 11.9 million new cases and more than 7.2 million deaths recorded in 2021 (Feigin et al., 2025). The hardship is predicted to escalate significantly: stroke mortality is expected to rise by about 50% between 2020 and 2050, concentrated largely in low- and middle-income countries (Feigin et al., 2025) In Indonesia, the 2023 Indonesian Health Survey reported a diagnosed-stroke prevalence of 10 per 1,000 population aged 15 years and above, while a nationwide geospatial analysis estimated an incidence of 158.47 per 100,000 population with pronounced provincial variation (Ministry of Health of the Republic of Indonesia, 2023; Zainuddin et al., 2025). Central Java lies slightly above the national average and carries a substantial burden, particularly among older adults (Ministry of Health of the Republic of Indonesia, 2023).

Beyond its contribution to mortality, stroke frequently leaves survivors with substantial long-term physical and psychological impairment. Roughly half of survivors experience partial or complete loss of motor function, about 30% cannot walk unaided, 46% develop cognitive impairment, 26% become dependent for activities of daily living, 35% experience depressive symptoms, and 19% develop aphasia, deficits that also carry psychological consequences such as anxiety and a diminished self-concept (Eltrikanawati, 2023). These residual impairments are directly relevant to post-discharge care: because communication and cognition are so frequently affected, the way discharge instructions and follow-up schedules are delivered, and to whom, has a material bearing on whether a patient successfully re-engages with scheduled care after leaving the hospital.

The scale of this challenge is compounded by the risk of recurrence and by persistent gaps in guideline implementation. A comparative study of first-ever and recurrent stroke patients at a referral hospital in Jakarta found that half of the sampled patients had experienced a recurrent event, with uncontrolled blood pressure carrying a 4.6-fold higher risk of recurrence and poor adherence to secondary-prevention medication also significantly associated with recurrent stroke (Dywanti et al., 2025). At the same time, even where structured post-discharge monitoring protocols exist, adherence to them in practice remains incomplete: a quality-improvement study evaluating a guideline-directed discharge checklist still found 10–17% of patients readmitted within the first 90 days despite the structured protocol (Walker et al., 2026). Together, these findings indicate that the risk of a poor post-discharge trajectory is not confined to the index hospitalization itself but continues to accumulate through the vulnerable weeks and months that follow, reinforcing the need to characterize, at the level of an individual hospital, which patients successfully maintain follow-up care and which do not.

The success of stroke management depends not only on the quality of acute care but also on effective post-discharge monitoring that secures adherence to secondary-prevention and rehabilitation programs. Practice statements from major cardiovascular and stroke organizations recommend systematic, time-point monitoring during the critical early period after discharge (Kernan et al., 2021), and Indonesian national stroke guidelines likewise emphasize follow-up control, medication adherence, and rehabilitation parti-

cipation as core strategies (Ministry of Health of the Republic of Indonesia, 2019). Early outpatient follow-up, in particular, has been linked to lower 30- and 90-day readmission after ischemic stroke (Leppert et al., 2020).

Despite these recommendations, how consistently patients actually attend scheduled follow-up after discharge, and how that attendance relates to rehospitalization, remains poorly characterized in Indonesian district-hospital settings. Andersen's Behavioral Model of Health Services Use provides a framework that distinguishes predisposing, enabling, and need factors shaping the use of health services (Andersen, 1995). Accordingly, this study analyzed the association of predisposing, enabling, and need factors, and of control-visit adherence at defined time points, with post-discharge control-visit adherence and stroke rehospitalization at Amal Sehat Hospital, Wonogiri.

SUBJECTS AND METHOD

1. Study Design

An observational analytic study with a retrospective cohort design was conducted at Amal Sehat Hospital, a type-C district referral hospital in Slogohimo, Wonogiri, Central Java, Indonesia. Data collection took place from April to June 2026 using outpatient and inpatient service records for the 2025 calendar year.

2. Population and Sample

This sample size satisfies established adequacy criteria for multivariable statistical estimation, including the rule that a sample of 200–500 observations is generally sufficient to yield stable models without overfitting, and the predictor-to-sample ratio formula proposed by Green (1991); with 14 independent variables examined in this study, the minimum required sample size under this formula is comfortably met by the realized sample of 257. Inclusion criteria were a stroke diagnosis coded ICD-10 I61 or I63 with completed 2025 inpatient care and a scheduled neurology follow-up, discharge alive, and complete medical and outpatient-control records. Patients referred to another hospital, with duplicate records, or with unresolvable incomplete data were excluded.

3. Study Variables

The dependent variables were control-visit adherence and stroke rehospitalization. Independent variables followed Andersen's Behavioral Model: predisposing factors (age, sex, marital status); enabling factors (payment type, home–hospital distance, and patient companion); and need factors (stroke diagnosis, recurrence status, comorbidity count, hypertension category, length of stay, and number of discharge medications). Control-visit adherence was additionally examined at three time points: first follow-up visit (K1) (≤7 days), second follow-up visit (K2) (8–30 days), and third follow-up visit (K3) (31–90 days) after discharge.

4. Operational Definition of Variables

Control-visit adherence (K1/K2/K3) Degree of alignment between scheduled control-visit dates set by the hospital and actual post-discharge follow-up visits across terms K1 (≤7 days), K2 (8–30 days), and K3 (31–90 days), based on modified criteria from Guidelines for Adult Stroke Rehabilitation and Recovery (Winstein, 2016) and AHA/ASA guidelines (Bushnell et al., 2024), retrieved from medical records. At each term, attendance was recorded as Adherent, Less Adherent, or Non-adherent. For analysis across K1–K3, full adherence was dichotomized as fully adherent versus not fully adherent.

Stroke rehospitalization Occurrence of a recurrent stroke attack requiring post-dis-

charge inpatient readmission, as documented in medical records.

Age Patient age in completed years from birth until discharge from post-stroke inpatient care, retrieved from medical records.

Sex Biological sex of the patient, as documented in medical records.

Marital status Legal marital status of the patient during hospitalization, extracted from medical records.

Payment type Type of health insurance coverage or payment mechanism used by the patient during inpatient care, recorded from medical records.

Home–hospital distance Estimated distance in kilometers (km) from the patient's residence (based on subdistrict) to Amal Sehat Hospital, retrieved from medical records.

Patient companion Presence and relationship of the family member or legal guardian accompanying the patient during inpatient care, as recorded in medical records.

Stroke diagnosis Type of stroke diagnosed by the attending physician during hospitalization according to ICD-10 criteria (I63 for CVA Infarct/Ischemic stroke and I61 for CVA Hemorrhagic stroke), extracted from medical records.

Stroke status (recurrence) History of stroke attacks experienced by the patient up to the index admission (primary/first-ever versus recurrent stroke), extracted from medical records.

Hypertension category Severity level of the highest blood pressure recorded during hospitalization, grouped according to standard clinical thresholds, obtained from medical records.

Comorbidity Total number of concurrent chronic conditions other than stroke (such as diabetes mellitus, heart disease, musculoskeletal disorders, and other comorbidities) suffered by the patient, documented in medical records.

Length of stay Total duration in days during which the patient underwent inpatient hospital care, recorded from medical records.

Discharge medications Total number of medication types prescribed and dispensed to the patient upon discharge from inpatient care, obtained from medical records or discharge prescriptions..

5. Study Instruments

Because this study relied on secondary data rather than direct patient contact, no clinical questionnaire or rating scale was administered. Data on all study variables were obtained using a structured data-extraction form applied to inpatient medical records and outpatient administrative records at Amal Sehat Hospital. Stroke diagnosis (ICD-10 code), blood-pressure category, length of stay, discharge medications, comorbidity count, and follow-up attendance at each control term were abstracted from these secondary sources and cross-checked manually against the original SIMRS Khanza records before analysis in STATA.

6. Data analysis

Univariate analysis described frequency distributions and central tendency for all study variables. Bivariate analysis used simple logistic regression (crude OR) for adherence and simple Cox proportional-hazard regression (crude HR) for rehospitalization; variables with $p< 0.25$ were carried forward to the multivariate stage. Multivariate analysis used multiple logistic regression (adjusted OR) for adherence and multiple Cox proportional-hazard regression (adjusted HR) for rehospitalization. Multicollinearity was checked before modeling (mean VIF= 1.99 for the adherence model), and the proportional-hazards assumption for the rehospitalization model

was verified using Schoenfeld residuals (global test $\chi^2(11)= 10.10$; $p= 0.521$). All analyses were performed in STATA.

7. Research Ethics

The study used secondary, de-identified medical-record data. Research-ethics issues including anonymity and confidentiality were addressed throughout the study process, and institutional permission for data access was obtained from Amal Sehat Hospital. The research ethical clearance approval letter was obtained from the Research Ethics Committee at Dr. Moewardi Hospital, Surakarta, Indonesia, No. 1.025/VI/HREC/2026, on June 08, 2026.

RESULTS

1. Sample Characteristics

Of 982 stroke inpatients recorded at Amal Sehat Hospital in 2025, 730 (74.3%) were discharged alive and constituted the source population; after tracing individual records through SIMRS Khanza and applying the inclusion and exclusion criteria, 257 patients with complete longitudinal records were retained as the final sample. The distribution of predisposing, enabling, and need factors for this sample is presented in Table 1, and the corresponding continuous variables are summarized in Table 2.

Table 1. Respondent Characteristics (n=257)

Characteristic	Category	Frequency	%
Predisposing factors			
Age (years)	≤55	45	17.5
	56–64	74	28.8
	≥65	138	53.7
Sex	Male	126	49.0
	Female	131	51.0
Marital status	Married	204	79.4
	Unmarried	2	0.8
	Widowed/divorced	51	19.8
Enabling factors			
Payment type	National insurance (BPJS)	190	74.0
	Out-of-pocket (general)	67	26.0
Home–hospital distance	<10 km	118	45.9
	10–20 km	105	40.9
	>20 km	34	13.2
Patient companion	Spouse	180	70.0
	Child	34	13.2
	Non-nuclear family	43	16.8
Need factors			
Stroke diagnosis	Hemorrhagic (I61)	22	8.6
	Ischemic (I63)	235	91.4
Stroke status	Primary	246	95.7
	Recurrent	11	4.3
Hypertension category	None	62	24.1
	Stage 1	83	32.3
	Stage 2	51	19.8
	Crisis	61	23.7
Number of comorbidities	None	26	10.1
	1	141	54.9
	≥2	90	35.0
Length of stay	≤3 days	107	41.6

Characteristic	Category	Frequency	%
Discharge medications	>3 days	150	58.4
	<5 types	144	56.0
	≥5 types	113	44.0

Table 1 shows that, among predisposing factors, most patients were aged ≥65 years (138 patients, 53.7%), followed by 56–64 years (74 patients, 28.8%) and ≤55 years (45 patients, 17.5%); the mean age was 64.7 years (SD= 11.0), with 82.5% of patients aged ≥56 years. The sex distribution was near-balanced (female 51.0%, male 49.0%), and most patients were married (79.4%). Among enabling factors, national health insurance (BPJS) was the dominant payment scheme (74.0%), 45.9% of patients lived within 10 km of the hospital (Mean distance= 12.3 km), and most patients were accompanied by a spouse (70.0%). Among need factors, ischemic stroke (I63) predominated (91.4%) over hemorrhagic stroke (I61, 8.6%), and most cases were a first (primary) stroke (95.7%). Some degree of hypertension was present in 75.9% of patients, including 23.7% with a hypertensive crisis, and 89.9% had at least one comorbidity. Most patients stayed more than 3 days (58.4%, Mean= 3.9; SD= 1.4 days) and were discharged with ≥5 medication types (44.0%, Mean= 4.5; SD= 1.5).

Table 2. Sample characteristics (continous data, n= 257)

Variables	Mean	SD	Min.	Max.
1. Age (years)	64.7	11.0	29	99
2. Home–hospital distance (km)	12.3	7.9	0.6	73.5
3. Length of stay (days)	3.9	1.4	2	18
4. Discharge medications (types)	4.5	1.5	2	10
5. Number of comorbidities	1.4	0.9	0	4

2. Bivariate Analysis

Bivariate analysis of factors associated with total control-visit adherence is presented in Table 4. No predisposing, enabling, or need factor reached statistical significance (p <0.050). Marital status (OR= 2.58; 95% CI= 0.89 to 7.48; p= 0.080), payment type for health service (OR= 5.65; 95% CI= 0.73 to 43.60; p= 0.090), and number of comorbidities (OR= 0.40; 95% CI= 0.09 to 1.66; p= 0.200) were carried forward to the multivariate model.

Table 4. Simple logistic regression analysis of factors associated with follow-up visit adherence

Variables	Adherent				OR	p
	No		Yes			
	N	%	N	%		
Age (years old)						
≤55	43	95	2	5	Ref.	-
56–64	71	96	3	4	0.90	0.910
≥65	127	92	11	8	1.86	0.430
Sex						
Male	119	94	7	6	Ref.	-
Female	122	93	9	7	1.25	0.660
Marital status						
Married	194	80	10	62	Ref.	-

Variables	Adherent				OR	p
	No		Yes			
	N	%	N	%		
Widowed/divorced	45	95	6	32	2.58	0.080
Payment method						
National health insurance (BPJS)	66	27	1	6	Ref.	-
Out-of-pocket	172	72	15	93	5.65	0.090
Distance						
<10 km	113	46	5	31	Ref.	-
10–20 km	97	40	8	50	1.86	0.280
>20 km	31	13	3	19	2.18	0.300
Companion						
Spouse	169	93	11	7	Ref.	-
Child	31	91	3	9	1.48	0.560
Non-nuclear family	41	95	16	6‡	0.74	0.710
Stroke status						
Primary	231	96	15	94	Ref.	-
Recurrent	10	4	1	6	0.64	0.900
Hypertension						
None	58	24	4	25	Ref.	-
Stage 1	78	32	5	31	0.92	0.910
Stage 2	49	20	2	12	0.59	0.550
Crisis	56	23	5	31	1.29	0.710
Comorbidity						
None	23	9	3	18	Ref.	-
1	134	55	7	44	0.40	0.200
≥2	84	35	6	37	0.54	0.410
Length of stay						
≤3 days	100	41	7	43	Ref.	-
>3 days	141	59	9	56	0.91	0.850
Discharge medicationss						
<5 types	136	56	8	50	Ref.	-
≥5 types	105	43	8	50	1.29	0.610

The corresponding bivariate analysis for rehospitalization, using simple Cox proportional-hazard regression, is presented in Table 5. Attendance at every control term was strongly protective: adherence at K1 showed by far the largest effect (HR= 0.03; 95% CI= 0.01 to 0.08; p< 0.001), followed by K2 (HR= 0.30; 95% CI= 0.16 to 0.57; p< 0.001) and K3 (HR= 0.36; 95% CI= 0.19 to 0.66; p= 0.001). Ischemic stroke (I63) was associated with a significantly lower risk of rehospitalization than hemorrhagic stroke (I61) (HR= 0.41; 95% CI= 0.17 to 0.98; p= 0.047).

Payment type (out-of-pocket) HR= 0.61; 95% CI= 0.32 to 1.15; p= 0.127), a home–hospital distance of 10–20 km (HR= 0.54; 95% CI= 0.26 to 1.08; p= 0.084), and companion by a child (HR= 0.44; 95% CI= 0.13 to 1.46; p= 0.183) all showed a consistent protective direction (HR< 1), suggesting a possible trend toward lower rehospitalization risk that this study was underpowered to confirm. In contrast, comorbidity count showed the opposite pattern: patients with one comorbidity (HR= 4.98; 95% CI= 0.67 to 36.77; p= 0.115) and those with two or more (HR= 4.19; 95% CI= 0.55 to 31.79; p= 0.165) both carried a markedly elevated point estimate for rehospitalization risk, even though the wide confidence intervals — a reflection of

the small number of comorbidity-free patients with an event — prevented this from reaching significance. Because these estimates were imprecise rather than clearly null, all four variables were carried into the multivariate model together with diagnosis and the three adherence terms to determine whether their association remained after adjustment.

Table 5. Bivariate analysis of factors associated with rehospitalization (simple Cox proportional-hazard regression, n= 257)

Independent Variables	Rehospitalization				HR	p
	No		Yes			
	N	%	N	%		
Age (years old)						
≤55	37	82	8	17	Ref.	-
56–64	63	85	11	14	0.85	0.729
≥65	155	83	23	16	0.95	0.914
Sex						
Male	106	84	20	16	Ref.	-
Female	109	83	22	17	1.05	0.863
Marital status						
Married	171	84	33	16	Ref.	-
Widowed/divorced	42	82	9	18	1.03	0.933
Payment						
National health insurance (BPJS)	52	78	15	22	Ref.	-
Out-of-pocket	163	86	27	14	0.61	0.127
Distance to health service						
<10 km	95	44	23	55	Ref.	-
10–20 km	93	43	12	29	0.54	0.084
>20 km	27	13	7	17	0.92	0.857
Companion						
Spouse	148	69	32	76	Ref.	-
Child	31	14	3	7	0.44	0.183
Non-nuclear family	36	17	7	17	0.86	0.728
Diagnosis						
Hemorrhagic (I61)	16	7	6	14	Ref.	-
Ischemic (I63)	199	93	36	86	0.41	0.047
Stroke status						
Primary	10	5	1	2	Ref.	-
Recurrent	205	95	41	98	1.51	0.681
Hypertension						
None	54	25	8	19	Ref.	-
Stage 1	68	32	15	36	1.51	0.342
Stage 2	43	20	8	19	1.21	0.692
Crisis	50	23	11	26	1.47	0.407
Comorbidity						
None	25	12	1	2	Ref.	-
1	115	53	26	62	4.98	0.115
≥2	75	35	15	36	4.19	0.165
Length of stay						
≤3 days	92	43	15	36	Ref.	-
>3 days	123	57	27	64	1.21	0.542
Discharge meds						
<5 types	120	56	24	57	Ref.	-

Independent Variables	Rehospitalization				HR	p
	No		Yes			
	N	%	N	%		
≥5 types	95	44	18	43	0.95	0.876
Adherence to the first follow-up visit (≤7 days)						
Not adherent	215	86	35	14	Ref.	-
Adherent	0	0	7	100	0.03	<0.001
Adherence to the second follow-up visit (8–30 days)						
Not adherent	33	66	17	34	Ref.	-
Adherent	182	87	25	17	0.30	<0.001
Adherence to the third follow-up visit (31–90 days)						
Not adherent	45	70	19	30	Ref.	-
Adherent	170	88	23	12	0.36	0.001

3. Multivariate Analysis

The results of multiple logistic regression analysis of factors associated with follow-up visit adherence were presented in Table 6. The model showed that there were no single variable was independently associated with follow-up visit adherence. Out-of-pocket payment (aOR= 5.83; 95% CI= 0.74 to 45.50; p= 0.093) and marital status (widowed/ divorced) (aOR= 2.75; 95% CI= 0.93 to 8.12; p= 0.067)) were marginally significant increased the likelihood of follow-up visit adherence.

Table 6. Multiple logistic regression of factors associated with follow-up visit adherence

Independent Variables	aOR	95% CI		p
		Lower limit	Upper limit	
Marital status				
Married	*Ref.*	-	-	-
Widowed/divorced	2.75	0.93	8.12	0.067
Payment method				
National health insurance (BPJS)	*Ref.*	-	-	-
General (out-of-pocket)	5.83	0.74	45.50	0.093
Comorbidity				
None	*Ref.*	-	-	-
1	0.44	0.10	1.89	0.274
≥2	0.60	0.13	2.69	0.510

Table 6 confirms that, after mutual adjustment, none of the three candidate variables retained an independent, statistically significant association with total control-visit adherence, so that control-visit adherence in this cohort could not be explained by predisposing or enabling characteristics alone.

The multivariate Cox proportional-hazard model for rehospitalization, adjusting simultaneously for payment type, distance, companion, diagnosis, comorbidity, and adherence at the first to the third (K1-K3) follow-up visits, is presented in Table 7. The model was significant overall (LR $\chi^2(11)$= 44.84; p< 0.001). Adherence at K1 remained the strongest independent

protective factor (aHR= 0.07; 95% CI= 0.02 to 0.24; p< 0.001), corresponding to an approximately 93% reduction in rehospitalization risk after controlling for payment type, distance, companion, diagnosis, comorbidity, and adherence at K2 and K3. Stroke diagnosis was independently associated with rehospitalization: ischemic stroke (I63) carried a significantly lower risk than hemorrhagic stroke (I61) (aHR= 0.40; 95% CI= 0.16 to 0.99; p= 0.048), an approximately 60% lower risk. Adherence at K2 (aHR= 0.66; 95% CI= 0.28 to 1.57; p= 0.355) and K3 (aHR= 0.65; 95% CI= 0.28 to 1.52; p= 0.331) were no longer independently significant after adjustment.

Table 7. Multivariate analysis of factors associated with rehospitalization (multiple Cox proportional-hazard regression, n= 257)

Independent Variables	aHR	95% CI		p
		Lower limit	Upper limit	
Payment				
National health insurance (BPJS)	*Ref.*	-	-	-
General (out-of-pocket)	0.85	0.44	1.67	0.657
Distance				
<10 km	*Ref.*	-	-	-
10–20 km	0.66	0.31	1.40	0.280
>20 km	1.10	0.44	2.76	0.833
Companion				
Spouse	*Ref.*	-	-	-
Child	0.55	0.16	1.85	0.341
Non-nuclear family	1.08	0.45	2.54	0.857
Diagnosis				
Hemorrhagic (I61)	*Ref.*	-	-	-
Ischemic (I63)	0.40	0.16	0.99	0.048
Comorbidity				
None	*Ref.*	-	-	-
1	3.93	0.52	29.81	0.184
≥2	4.24	0.54	33.36	0.169
Adherence to the first follow-up visit (≤7 days)				
Not adherent	*Ref.*	-	-	-
Adherent	0.07	0.02	0.24	<0.001
Adherence to the second follow-up visit (8–30 days)				
Not adherent	*Ref.*	-	-	-
Adherent	0.66	0.28	1.57	0.355
Adherence to the third follow-up visit (31–90 days)				
Not adherent	*Ref.*	-	-	-
Adherent	0.65	0.28	1.52	0.331

Table 7 shows that, of the eleven variables entered into the final Cox model, only adherence at K1 and stroke diagnosis remained independently significant at p< 0.05, indicating that among all the factors examined, timely attendance at the first post-discharge control visit and the type of stroke diagnosis were the dominant independent determinants of rehospitalization in this cohort.

DISCUSSION

Predisposing Factors and Control-Visit Adherence in Stroke Patients

In the multivariate logistic regression model for control-visit adherence, none of the predisposing factors demonstrated independent association. Age showed no consistent direction of effect, nor did sex. Marital status showed a non-significant tendency toward higher adherence among widowed/divorced patients relative to married patients. This null pattern aligns with systematic evidence that Andersen-model predisposing factors vary substantially across populations and clinical settings, indicating that demographic markers alone rarely predict outpatient health service utilization in a stable direction (Alkhawaldeh et al., 2023). Since administrative marital status indicates legal responsibility rather than the presence of an active caregiver who reminds and accompanies the patient to follow-up visits, it serves as an imperfect proxy for social support (Bushnell et al., 2024). Consequently, the lack of a statistically significant demographic signal suggests that post-discharge adherence in this cohort is driven by post-acute functional and logistical factors rather than basic demographic classifications (Goulding et al., 2018).

Predisposing Factors and Risk of Rehospitalization in Stroke Patients

Multivariate Cox proportional-hazards analysis revealed that predisposing demographic factors were not independently associated with rehospitalization: age 56-64 years and ≥65 years did not differ significantly from the ≤55-year reference group. Similarly, female sex and widowed/ divorced marital status showed no independent association with readmission. These findings reinforce wider clinical evidence indicating that basic demographic characteristics become weak independent predictors of readmission once clinical severity and acute complications are controlled for (Lloyd-Jones et al., 2010). For instance, in a retrospective cohort of 1,973 acute ischemic stroke patients, age lost its univariate significance after multivariable adjustment, and sex demonstrated no independent effect (Jumah et al., 2025). Demographic signals in single-center cohorts are frequently overshadowed by immediate clinical determinants, particularly post-discharge care adherence and underlying stroke severity (Vahidy et al., 2017).

Enabling Factors and Control-Visit Adherence in Stroke Patients

Among enabling factors evaluated in multivariable analysis, out-of-pocket payment status approached the screening threshold but was not independently associated with adherence. This contrast with broader international literature, where out-of-pocket expenses constitute a significant financial barrier to medication and appointment adherence (Baker-Goering et al., 2019), reflects the financial protection provided by Indonesia's universal health coverage scheme (national health insurance/ BPJS), which minimizes direct point-of-care costs for routine follow-up care (Pan et al., 2019).

Distance to facility and companion type at admission were likewise non-significant in multivariate models. As Amal Sehat Hospital is the primary referral facility in eastern Wonogiri, structural accessibility constraints, such as specialist availability, may outweigh physical distance once families perceive clinical urgency (Pan et al., 2019). Furthermore, registering the companion present at hospital admission fails to reflect the ongoing quality of post-discharge family support, which observational studies identify as a key driver of outpatient adherence (Bariroh et al., 2023).

Enabling Factors and Risk of Rehospitalization in Stroke Patients

In the multivariate Cox regression model for rehospitalization, enabling factors showed no independent statistical association. Out-of-pocket payment, which had shown a borderline protective trend on bivariate analysis, after adjustment for the other covariates. Similarly, a home-to-hospital distance of 10–20 km, which had also approached the screening threshold on bivariate analysis in the adjusted model. The absence of an independent distance effect is consistent with findings from a cohort of 2,022 post-discharge patients, where travel time was not independently associated with readmission after multivariable adjustment (Lenzi et al., 2019).

This pattern may be explained by a distance-decay phenomenon, wherein patients living farther away who experience recurrent events seek emergency care at local community facilities rather than returning to the index referral hospital. Additionally, the companion present at discharge was not independently protective against rehospitalization, contrasting with regional cohort studies in Singapore and Indonesia that link active caregiver preparation to reduced post-stroke readmissions (Tay, 2021; Septianingrum et al., 2024). This study's cross-sectional assessment of companion status at admission is itself a limitation, since it does not capture the ongoing quality of post-discharge caregiver engagement that these regional cohorts suggest is protective.

Need Factors and Control-Visit Adherence in Stroke Patients

When evaluating health need factors in multivariable analysis, comorbidity count did not independently predict control-visit adherence. Neither stroke diagnosis nor length of stay was significantly associated with visit adherence, creating a notable divergence from their strong predictive role in rehospitalization. This distinction supports broader empirical evidence that objective clinical severity determines involuntary outcomes (such as readmission or mortality) more directly than voluntary health behaviors like clinic attendance (Heinze et al., 2022). In a cohort of 676 stroke survivors, clinical parameters including diagnosis and comorbidity burden did not differ between patients who attended outpatient follow-up and those who did not (Alhusain et al., 2025).

Under Andersen's behavioral model, while need factors strongly drive direct illness-related care seeking (Alkhawaldeh et al., 2023), adherence to scheduled outpatient visits depends heavily on post-discharge communication and cognitive capacity (O'Kane et al., 2026). A further limitation of this study is the lack of granular data on the quality of discharge communication, rehabilitation referrals, or anticoagulation-indication categories, any of which could modify a patient's likelihood of returning for scheduled follow-up.

Need Factors and Risk of Rehospitalization in Stroke Patients

Need factors provided the primary clinical signal for rehospitalization risk in multivariate Cox analysis. Ischemic stroke (I63) was independently protective against rehospitalization compared to hemorrhagic stroke (I61), corresponding to approximately 60% lower risk. Comorbidity count did not retain statistical significance after multivariable adjustment. The higher independent risk observed among hemorrhagic stroke cases aligns with the known severe clinical course, elevated risk of early rebleeding, and acute complications inherent to intracerebral hemorrhage (Casolla et al., 2019). Clinical severity metrics regularly demonstrate an independent correlation with short-term readmissions across vascu-

lar cohorts (Shaikh et al., 2024). However, population-based studies emphasize that because ischemic strokes constitute over 90% of all stroke presentations, the absolute volume of readmission events remains highest among ischemic stroke cases despite their lower relative hazard ratio (Zhou et al., 2023). Clinically, this elevated risk among hemorrhagic-stroke patients means that secondary-prevention medication adherence, which this study was unable to measure directly, warrants close attention, and clinicians should maintain heightened vigilance for recurrent symptoms in the first two weeks post-discharge, particularly in this cohort, where the risk of early re-bleeding is greatest (Casolla et al., 2019).

First follow-up visit (K1) Adherence as an Independent Predictor of Rehospitalization

The primary independent determinant of rehospitalization identified in this study was early control-visit adherence. After controlling for diagnosis, payment mode, distance, companion, and comorbidity burden, adherence to the first control visit (K1, ≤7 days) remained a powerful independent protective factor, representing a 93% risk reduction. This robust multivariate protective effect aligns with international multicenter cohorts demonstrating that early post-discharge clinical follow-up significantly lowers 30-day readmissions (Leppert et al., 2020). Meta-analytic evidence confirms a pooled 21% reduction in 30-day readmissions associated with outpatient follow-up visits (Bilicki & Reeves, 2024), with acute post-discharge vulnerability concentrated within the initial two weeks post-discharge (Alhusain et al., 2025). Nevertheless, analytical syntheses caution that immortal-time bias—where patients who suffer early rehospitalization before their scheduled appointment are categorized as non-adherent—can overestimate the effect size of early adherence (Religioni et al., 2025).

Notably, adherence at K2 and K3 did not retain independent significance after adjustment, suggesting that the protective effect is concentrated exclusively in the early (≤7 days) post-discharge window. With only 16 of 257 patients (6.2%) achieving full adherence across all three control visits, this finding points to a substantial adherence gap that hospitals should address by prioritizing structured, early (≤7 days post-discharge) neurological follow-up: confirming the appointment before discharge, sending active phone or SMS reminders three to five days beforehand, and holding contingency slots for patients facing transportation barriers or competing acute demands (Kernan et al., 2021).

This conclusion should be read alongside several limitations: the final analytic sample (n= 257 of 730 eligible patients, 35.2%) depended on complete longitudinal medical records, which may have introduced selection bias, and the single-center design limits generalizability beyond the Wonogiri district. Prospective studies incorporating structured discharge-communication protocols, real-time appointment reminders, and a more granular assessment of caregiver-level barriers would strengthen causal inference and better inform district-level readmission-reduction initiatives (Jumah et al., 2025).

AUTHOR CONTRIBUTION

GAU conceptualized the study, performed data collection and analysis, and wrote the original draft of the manuscript. NHH supervised the overall research, contributed to the study design, and guided the manuscript drafting. RGHN provided supervision and critical input for the manuscript

structure and discussion. S and SM contributed to the methodological validation, provided critical feedback on the methodology and discussion sections, and revised the text. All authors have read, critically reviewed, and approved the final version of the manuscript, and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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