

Hospital Readmission after Intracerebral Hemorrhage

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Background: Intracerebral hemorrhage (ICH) is the most severe form of stroke, but limited literature exists on readmission after ICH. We aimed to assess frequencies, causes, and predictors of early and late readmissions within 1 year after ICH. *Methods:* All patients admitted to the Department of Neurology at Haukeland University Hospital with acute stroke were prospectively included in the Bergen Norwegian Stroke Research Registry (NORSTROKE) registry. Surviving patients diagnosed with ICH were followed by medical chart reviews for 1 year. The first unplanned readmission was used as final outcome, and readmitted patients were defined as early readmitted (≤ 90 days) and late readmitted (91-365 days). Logistic regression was performed to assess predictors for early and late readmission. *Results:* Of 121 patients discharged alive, 27 were early readmitted, and 17 were late readmitted. Within 1 year, 40.6% had at least 1 unplanned readmission. The most frequent cause of early readmission was infection, and the most frequent causes for late readmission were recurrent stroke and cardiovascular disease. Nursing home discharge was the only independent predictor of early readmission. Diabetes mellitus and increased length of the index admission were independent predictors of late readmission. Early readmitted patients were older and had more severe stroke and lower levels of fibrinogen on index admission compared with patients who were readmitted late. *Conclusions:* Readmission after ICH is frequent, and many patients are early readmitted. Early and late readmissions differed in both causes and predictors for readmission, reflecting different underlying mechanisms for readmission. **Key Words:** Readmission—rehospitalization—stroke—hemorrhagic stroke—outcome research.

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Introduction

Stroke survivors carry a great risk of readmission, which is associated with greater disability and mortality, and

increased costs for the society.^{1,2} Intracerebral hemorrhage (ICH) accounts for 8%-15% of stroke subtypes, with an estimated incidence of 10-25 per 100,000.³⁻⁵ In addition to lack of treatment, ICH is the most severe form of stroke with the highest rates of dependence or death.⁶⁻⁸ Existing literature on readmission after ICH is limited compared to ischemic stroke (IS). The 30-day readmission rate after ICH varies from 11% to 16%, the primary reasons being infections and vascular events.^{9,10} The frequency of readmission after any subtype of stroke is 17% within 90 days, and 30%-62% within 1 year.¹¹

The aims of our study were to assess frequencies, causes, and predictors of the first unplanned readmission within 1 year after ICH. We hypothesized that patients with early (≤ 90 days) and late (91-365 days) readmission were different in causes and predictors, and we therefore investigated them separately.

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Methods

All patients admitted to the Department of Neurology at Haukeland University Hospital with acute stroke between July 1, 2007, and June 30, 2012, were prospectively registered in the Bergen NORSTROKE Registry. The Stroke Unit serves a well-defined region of approximately 250,000 people.

Stroke was defined as “rapidly developed signs of focal (or global) disturbance of cerebral function lasting longer than 24 hours (unless interrupted by death), with no apparent nonvascular cause.”¹² Stroke subtype was assessed by computed tomography or magnetic resonance imaging by an experienced neurologist, and was classified as IS, ICH, or transitorial ischemic attack. We excluded traumatic ICH, extracerebral intracranial hemorrhages, and ICH related to neoplasia. The National Institutes of Health Stroke Scale (NIHSS) score was used to assess stroke severity on admission and on day 7. Short-term functional outcome was determined by modified Rankin Scale (mRS) on day 7 (or at discharge if discharged earlier than 7 days). Clinical characteristics, medical history, and cause of stroke were registered by a neurologist less than 1 day after admission. Comorbidity, any complication during the index admission, the discharge destination, and the length of index admission (days) were registered during the admission and at discharge, respectively. Secondary preventive treatment on discharge was based on the Norwegian guidelines for stroke treatment.¹³

Data on readmission until August 1, 2012, were collected by medical chart reviews of patients living in the local area of Haukeland University Hospital. The first unplanned readmission within 1 year after discharge was used as the final outcome. Planned readmissions were not registered. For the analysis, patients were classified as readmitted or not readmitted. We further classified readmitted patients as early readmitted (first readmission within 90 days) or late readmitted (first readmission between day 91 and 365). Patients who died during index admission were excluded from the analyses. Patients who could not be followed for the respective time intervals were excluded from the respective intervals. Patients who were either dead or had been readmitted before day 91 were excluded from the 91-365 interval. The study was approved by the Western Regional Ethics Committee.

Statistics

Baseline characteristics were investigated by Student's *t*-test, chi-squared test, and Mann-Whitney's *U*-test. Independent predictors of early and late readmissions were assessed by logistic regression analyses by stepwise backward elimination of all significant parameters ($P < .05$) from the univariate analyses. Age, sex, mRS/NIHSS scores on admission, and length of index admission were independent variables used in the regression analysis to adjust for potentially confounding factors. Kaplan-Meier failure

estimate was performed to illustrate readmission over time. Statistical analyses were performed with Stata 13.0 (Stata Corporation, College Station, TX, USA).

Results

Of 1541 patients admitted with acute stroke, 161 (10.6%) had ICH. During the index admission, 40 (24.5%) patients died; thus 121 patients were discharged alive and included in the study. Among these, 67 (55.4%) were male, and the mean age was 72.3 years. Frequencies and causes of first unplanned readmission are presented in Table 1. Of all patients with a minimum of 1 year of follow-up time ($n = 101$, 82%), 41 (40.6%) were readmitted within 1 year, and 15 (14.9%) patients died. Figure 1 shows Kaplan-Meier failure estimates for readmission over time.

Early Readmission (≤ 90 days)

A total of 27 (22.3%) patients were readmitted within 90 days after discharge. Of all patients discharged alive, nine (7.4%) did not survive the first 90 days after discharge. Of these, four had been readmitted at least once. The most frequent causes of readmission were infections and unspecified events related to the index stroke (readmission with presumed recurrent stroke where this

Table 1. Causes of first unplanned readmission within 1 year after intracerebral hemorrhage

Readmission cause	Early readmission (≤ 90 days) n (%)	Late readmission (91-365 days) n (%)
Cardiovascular disease	1 (.8)	3 (4.2)
Cerebrovascular disease	0	3 (4.2)
Ischemic stroke	0	2 (2.8)
Transitorial ischemic attack	0	0
Hemorrhagic stroke	0	1 (1.4)
Events related to index stroke*	5 (4.1)	3 (4.2)
Seizure	2 (1.7)	2 (2.8)
Infection	7 (5.8)	2 (2.8)
Pneumonia	3 (2.5)	0
Urinary tract infection	1 (.8)	1 (1.4)
Other infection	3 (2.5)	1 (1.4)
Pulmonary embolism	1 (.8)	1 (1.4)
Hip fracture	2 (1.7)	0
Other causes	9 (7.4)	3 (4.2)
Readmitted patients	27 (22.3)	17 (23.6)
All patients	121 (100)	72 (100)

*Disproved presumed recurrent stroke.

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