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Predictors of 30-day readmission after aneurysmal subarachnoid hemorrhage: a case-control study

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Abstract

OBJECTIVE—Despite persisting questions regarding its appropriateness, 30-day readmission is an increasingly common quality metric used to influence hospital compensation in the United States. However, there is currently insufficient evidence to identify which patients are at highest risk for readmission after aneurysmal subarachnoid hemorrhage (SAH). The objective of this study was to identify predictors of 30-day readmission after SAH, to focus preventative efforts, and to provide guidance to funding agencies seeking to risk-adjust comparisons among hospitals.

METHODS—The authors performed a case-control study of 30-day readmission among aneurysmal SAH patients treated at a single center between 2003 and 2013. To control for

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Author Contributions

Conception and design: Zipfel, Greenberg, Washington, Derdeyn. Acquisition of data: Greenberg, Guniganti, Arias, Desai, Dhar. Analysis and interpretation of data: all authors. Drafting the article: Greenberg, Guniganti. Critically revising the article: Zipfel, Greenberg, Guniganti, Arias, Desai, Washington, Yan, Fondahn, Cross, Moran, Rich, Chicoine, Dhar, Dacey, Derdeyn. Reviewed submitted version of manuscript: all authors. Statistical analysis: Yan, Weng, Xiong. Administrative/technical/material support: Zipfel. Study supervision: Zipfel.

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Disclosures

Dr. Derdeyn reports that he has ownership in Pulse Therapeutics and is a consultant for Microvention, Penumbra, and Pulsar Vascular.

geographic distance from the hospital and year of treatment, the authors randomly matched each case (30-day readmission) with approximately 2 SAH controls (no readmission) based on home ZIP code and treatment year. They evaluated variables related to patient demographics, socioeconomic characteristics, comorbidities, presentation severity (e.g., Hunt and Hess grade), and clinical course (e.g., need for gastrostomy or tracheostomy, length of stay). Conditional logistic regression was used to identify significant predictors, accounting for the matched design of the study.

RESULTS—Among 82 SAH patients with unplanned 30-day readmission, the authors matched 78 patients with 153 nonreadmitted controls. Age, demographics, and socioeconomic factors were not associated with readmission. In univariate analysis, multiple variables were significantly associated with readmission, including Hunt and Hess grade (OR 3.0 for Grade IV/V vs I/II), need for gastrostomy placement (OR 2.0), length of hospital stay (OR 1.03 per day), discharge disposition (OR 3.2 for skilled nursing vs other disposition), and Charlson Comorbidity Index (OR 2.3 for score ≥ 2 vs 0). However, the only significant predictor in the multivariate analysis was discharge to a skilled nursing facility (OR 3.2), and the final model was sensitive to criteria used to enter and retain variables. Furthermore, despite the significant association between discharge disposition and readmission, less than 25% of readmitted patients were discharged to a skilled nursing facility.

CONCLUSIONS—Although discharge disposition remained significant in multivariate analysis, most routinely collected variables appeared to be weak independent predictors of 30-day readmission after SAH. Consequently, hospitals interested in decreasing readmission rates may consider multifaceted, cost-efficient interventions that can be broadly applied to most if not all SAH patients.

Keywords

hospital readmission; patient readmission; subarachnoid hemorrhage; neurosurgery; quality indicators (Health Care); vascular disorders

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Driven by a motivation to reduce health care spending and increase the quality of health care delivery, policy makers in the United States have emphasized the need to reduce 30-day hospital readmission.[6] While experts have debated the appropriateness of this quality measure,[21] hospital readmission is undoubtedly a widespread and costly occurrence in the United States.[14] In particular, almost one-fifth of Medicare beneficiaries are readmitted within 30 days of hospital discharge, costing approximately $17 billion annually.[20] These readmission rates vary substantially across hospitals and geographic regions, suggesting potentially uneven quality in local practices.[14] To reduce avoidable readmissions, the Centers for Medicare and Medicaid Services (CMS) recently instituted a program that financially penalizes hospitals with “excess” readmissions.[6] While this program initially focused on readmissions following acute myocardial infarction, heart failure, and stroke, the list of disorders is growing to include other medical and surgical conditions,[6] prompting proactive efforts to reduce readmissions for a number of common conditions.[12,28,30,32]

Diagnosed in up to 33,000 people in the United States each year, nontraumatic subarachnoid hemorrhage (SAH) is a significant source of morbidity and mortality that accounts for about one-fourth of stroke-related potential years of life lost before age 65 years.[35] Despite the substantial clinical and economic impact of hemorrhagic forms of stroke including SAH, most investigators have focused on reducing readmissions following ischemic stroke,[26] with only a few examining the causes of readmission following hemorrhagic stroke,[25,27] and even fewer specifically examining this important issue in patients with SAH.[15,34] Recently, we qualitatively examined the causes of readmission following SAH, finding that most readmissions occur despite adherence to best practices and appear to result from the severity of illness and its consequences, including patient immobility. Only a minority of readmissions after SAH were due to identifiable preventable causes, such as shortcomings in the transitional care environment.[15] While such information is valuable, identifying which patients are at highest risk for readmission is still an important element of focusing preventative efforts (e.g., assigning transition care coordinators) and risk-adjusting comparisons among hospitals. Consequently, the objective of this study was to perform a case-control analysis to identify independent predictors of 30-day readmission after SAH.

Methods

Study Design and Participants

This single-center case-control study was designed to identify variables predictive of 30-day readmission after SAH. One major confounder in studying readmission is variability in patients' geographic distances from the hospital. Consequently, we used the case-control design to control for this factor as well as year of treatment (to account for changes in institutional practice over time). To identify study patients, we queried the Barnes-Jewish Hospital (BJH) electronic medical record system (ICD-9 diagnosis code 430, 852.0, or 852.1 AND procedure code 39.51, 39.52, 39.70, or 39.72) to identify all patients who received surgical or endovascular treatment for aneurysmal SAH between January 2003 and June 2013. From this cohort, we defined cases as those patients readmitted to BJH at least once within 30 days of discharge, excluding planned readmissions (e.g., for bone flap replacement). For each case, we attempted to randomly match 2 controls based on the first 3 digits of their home ZIP code (surrogate marker for distance to BJH) and the year of treatment (± 1 year). In cases in which matched controls were excluded from the analysis (e.g., incorrectly classified as aneurysmal SAH from administrative queries), a new control was randomly chosen from the remaining cohort of nonreadmitted patients. Matching was performed using a Fuzzy extension in SPSS (http://www.ibm.com/spss), as previously reported.[2,7] To mitigate the possibility that controls had admissions to outside hospitals not captured by our electronic query, we searched for references to outside hospital admissions within hospital and clinic notes within 30 days of discharge and the first clinic visits shortly thereafter, when present.

We excluded from the analyses all patients who died during index admission or within 30 days of discharge. Since we were unable to reliably collect data from outside hospital admissions, we also excluded 2 patients for whom the medical record indicated that they had received inpatient admission and extended management (minimum of 5 days) for SAH at an outside hospital, rather than immediate transfer to BJH. Finally, we excluded one patient who developed SAH while already hospitalized for other reasons, since the patient's primary reason for admission (thoracoabdominal aneurysm repair) confounded potential predictor data.

Predictor Variables

We retrospectively reviewed the medical record to evaluate variables related to the routine care of aneurysmal SAH patients. Specifically, we recorded variables related to baseline disease severity (e.g., Hunt and Hess grade[18] and modified Fisher scores[13]); aneurysm treatment type (coiling vs clipping); aneurysm location (anterior vs posterior circulation); postadmission disease course (e.g., delayed cerebral ischemia [DCI]; external ventricular drain [EVD], shunt, gastrostomy, or tracheostomy placement; postprocedural or delayed cerebral infarction, length of stay [LOS], and discharge disposition); the presence of comorbid disease (composite Charlson Comorbidity Index [CCI],[8] American Society of Anesthesiologists [ASA] class, and individual comorbidities); demographic characteristics (e.g., age, sex, and race); and socioeconomic status (e.g., marital status, median income of home ZIP code, and insurance status). Cases in which no postoperative imaging was performed were treated as not having infarction, given the absence of clinical concern prompting radiological evaluation. Chronic pulmonary disease was defined based on the simple presence of a recorded history of a major lung disease (e.g., asthma, chronic obstructive pulmonary disease), since detailed descriptions of disease severity were typically not available in the medical record. To increase statistical power, we also considered certain clinically reasonable combinations of variables, including EVD or shunt placement, gastrostomy or tracheostomy placement, and any new cerebral infarction (postprocedural or delayed). Due to the very small number of subjects affected, patients with treatment other than exclusive coiling or clipping (e.g., combination treatment or bypass) were treated as missing for analyses of this variable to avoid erroneous conclusions resulting from small cell sizes. When Hunt and Hess grades and modified Fisher scores were not recorded in the medical record, they were assigned retrospectively. DCI was defined based on the presence of moderate or severe radiographic vasospasm associated with a decline in neurological status and/or initiation of vasopressor therapy. Data on median income for home ZIP code (years 2006–2010) were obtained from American Community Survey data made available by the University of Michigan Population Studies Center (http://www.psc.isr.umich.edu/dis/census/Features/tract2zip/).

Statistical Analysis

Standard descriptive statistics (e.g., frequencies, mean, and median) were computed for each variable. To analyze the impact of each predictor on the risk of readmission, we used a conditional logistic regression model to account for the matched design of the study. Univariate analyses were first performed for each predictor to guide selection for multivariate analysis. While building a multivariate model, we recognized that the final model was very sensitive to selection criteria for variable entry and retention, likely reflecting weak independent predictive ability of individual predictors in the data set. Given this limitation, we reported multivariate results based on entering variables with $p < 0.2$ in univariate analysis and retaining those with $p < 0.05$ in multivariate analysis, since such criteria yielded the most stable results. The final multivariate model was derived using forward selection and tested for stability using backward selection. All analyses were conducted using SAS software (version 9.4, SAS Institute), and p values < 0.05 were considered statistically significant.

All study procedures were approved by the Washington University in St. Louis Institutional Review Board.

Results

Of the 761 aneurysmal SAH patients treated during the study period, we identified 82 unplanned readmissions (10.8%). From that cohort, we matched 78 readmitted patients (cases) with a total of 153 controls based on year of treatment and home ZIP code. We were unable to find any matching controls for 4 readmitted patients, and for 3 patients only 1 control was available. The median number of days from discharge to readmission was 7.5 (interquartile range 3–18 days). The average age in the overall cohort was 55.0 years, and was slightly higher among cases (57.0 years) than controls (54.0 years). The majority of cases and controls were female (75.6% and 66.7% for cases and controls, respectively) and white (51.3% and 59.5% for cases and controls, respectively). The median income of patients' home ZIP codes was somewhat lower among cases ($39,223) than controls ($44,254), although the proportion of privately insured patients was similar (44.9% and 44.4% for cases and controls, respectively). A complete list of population demographic, socioeconomic, and clinical characteristics is shown in Table 1.

In univariate analysis, we found that 30-day readmission was associated with baseline clinical (OR 3.0 for Hunt and Hess Grade IV/V vs I/II) and radiological (OR 2.3 for Fisher Score 4 vs 0/1) severity, as well as select markers of a complicated hospital course, such as gastrostomy placement (OR 2.0) and longer hospital LOS (OR 1.03 per day). While postprocedure and delayed infarctions were not individually significant, the composite metric of any post-SAH infarction was significantly associated with readmission (OR 2.0). Discharge to skilled nursing was also associated with increased risk of readmission (OR 3.2 compared with other dispositions), as was higher CCI (OR 2.0 and 2.3 for a score of 1 or 2, respectively, vs 0). The only specific comorbid disease significantly associated with increased risk of 30-day readmission was chronic pulmonary disease (OR 2.5). Notably, demographic variables, including age, race, sex, and marital status were not associated with 30-day readmission, nor were markers of socioeconomic status, such as insurance type or median income of home ZIP code. The complete results of the univariate analyses are shown in Table 2.

The results of the final multivariate analysis are shown in Table 2. Based on an entry criterion of p < 0.2 in univariate analysis, 19 variables were entered into the initial multivariate model. Of these variables, the only predictor of readmission retained in the final multivariate model at a significance level of p < 0.05 was discharge disposition (OR 3.2 for skilled nursing vs other dispositions). While the final model was sensitive to varying entry and retention criteria, this result remained stable using both forward and backward selection procedures with entry criteria of either p < 0.20 or p < 0.15 in univariate analysis.

Discussion

Increasingly, governmental agencies have focused on reducing readmissions in both medical and surgical populations.[6] However, the vast majority of randomized interventions have focused primarily on medical patients,[24] suggesting that there might be a significant knowledge gap in identifying strategies to reduce readmission in surgical patients. Recent efforts in neurosurgical patients broadly and SAH patients in particular have given insight into the causes underlying 30-day readmissions.[4,15,33] Building on this qualitative work, the goal of this quantitative analysis was to identify concrete factors independently predictive of 30-day readmission. Using a case-control design to account for patient distance from the hospital and year of treatment, we found multiple significant predictors in univariate analysis, but only discharge disposition to a skilled nursing facility remained significant in the final multivariate model.

In a recent qualitative analysis, we detailed the primary medical and surgical reasons for 30-day readmission after aneurysmal SAH, as well as the underlying root causes.[15] We found that hydrocephalus and related diagnoses (e.g., headache) accounted for over 25% of readmissions, while infections (17%), thromboembolic complications (8%), and planned procedures (8%) were other common reasons. Among the root causes for readmission, delayed development of SAH-related pathology (e.g., hydrocephalus or seizure) accounted for 37% of cases, followed by complications related to neurological impairment and immobility (e.g., pneumonia or urinary tract infection; 22%). Thus, while these results demonstrated that most readmissions did not result from failure to adhere to best practices, we did identify almost 25% of cases in which specific shortcomings likely contributed to readmission. These cases typically involved potentially inadequate outpatient follow-up of SAH-related pathology (e.g., hyponatremia or dehydration; 12%) or comorbid medical disease (e.g., chronic obstructive pulmonary disease exacerbation; 4%), and 6% of readmissions were due to problems with health care transitions or premature discharge.

Although this study demonstrated that most readmissions occurred despite a high standard of care, it also showed that an important minority of readmissions might be prevented by closer adherence to current best practices. In addition, while no intervention is likely to avoid readmission from delayed hydrocephalus in SAH patients, it is possible that novel innovative strategies may reduce some early morbidity and readmissions (e.g., from pneumonia), even in cases in which adherence to current best practices did not. Consequently, this study was designed to identify routinely collected variables that could be used to target high-risk populations with preventative strategies.

To our knowledge, only one study has specifically sought to identify predictors of 30-day readmission after SAH,[34] while others have investigated factors associated with readmission after hemorrhagic stroke[26] and vascular neurosurgery more broadly.[31] While that previous analysis of SAH patients provided information about factors potentially associated with readmission, such as hospital LOS and EVD placement, it had several key shortcomings. Most importantly, with only 21 readmitted patients included in its analysis, a multivariate analysis could not be conducted to identify which factors independently predicted readmission, after adjusting for potential confounding among variables. In addition, as a single-center study that did not account for patient geography, that analysis may have been subject to bias given the known relationship between travel distance from home to the hospital and readmission.[15]

To address these shortcomings, we conducted a large-scale analysis to identify independent predictors of 30-day readmission, using a case-control design to account for potential bias resulting from varying distances between patients' homes and our hospital. While we found several factors associated with readmission in univariate analysis, only discharge disposition was significant in the final multivariate novel. This result, along with the multivariate analysis' sensitivity to entry and retention criteria, likely reflected a close correlation among potential predictors and the relatively low independent predictive ability of each. This finding is consistent with the fact that, even in univariate analysis, all significant predictors were markers of clinical severity (e.g., discharge disposition) or comorbidity status (e.g., CCI). Likewise, we were surprised that demographic features, marital status, surrogates of socioeconomic status (payer status and median income of home ZIP code) were not significantly associated with 30-day readmission, even in univariate analysis. Although it is possible that such social characteristics do not have a significant impact on readmission risk, we believe it is likely that the variables available to us for analysis, such as marital status or payer status, may be overly simplistic measures of the complex social dynamics that influence a patient's risk for readmission. Instead, social support networks[22] and educational disparities[17] may be more important influences on readmission risk.

While measures of more complex social dynamics and a sufficiently large data set would almost certainly yield additional significant predictors, the results of this large single-center study suggest the limited independent predictive ability of routinely collected variables, such as demographics and comorbidity status. Even discharge to skilled nursing, the only significant predictor in multivariate analysis, captured less than 25% of all readmissions within the matched cohort. Therefore, although we initially intended to identify a small subset of patients at highest risk, our results suggest that cost-efficient strategies applied to most—if not all—SAH patients may be most effective in preventing readmission.

Based on these results, we recommend that the following strategies be explored for their potential to reduce readmission and potentially improve SAH care more broadly. First, SAH patients should have early follow-up with their primary care physicians (PCPs), neurosurgeon, or their surgeon's advanced patient practitioner in the week after discharge, an important shortcoming identified in our earlier qualitative analysis.[15,16] For maximal impact, such appointments should also be arranged before hospital discharge.[3] Second, given evidence showing that discharge summaries are available to PCPs in one-third or fewer postdischarge visits, hospitals should routinely send discharge summaries to PCPs, including key diagnostic test results.[23] Third, complementing these in-person visits, structured postdischarge telephone calls by transition coordinators, or "coaches" may help identify early concerns among patients or caregivers and prevent the development of conditions requiring readmission.[9–11,29] Fourth, recognizing the important association between discharge disposition and readmission found in this and other studies,[1] hospitals should look for ways to improve coordination with and care capabilities available at nursing facilities. In particular, discharging teams should provide nursing facilities and families with lists of concerning “red flag” symptoms prompting neurosurgical evaluation versus normal expected disease sequelae or minor conditions that could be managed by a nursing facility (e.g., an uncomplicated urinary tract infection).[9] Finally, clinicians and administrators should continue to rely on physician judgment regarding appropriate discharge timing to ensure that pressure to reduce hospital LOS does not inadvertently increase readmission rates.[5]

Individually, these interventions may have some benefit, but focusing on a single approach may yield limited success. Instead, evidence shows that implementing multifaceted comprehensive discharge programs that incorporate patient education, early follow-up, and effective information transfer is likely to be most impactful.[3,9,19,24] However, one collection of interventions is unlikely to be effective in all hospitals, and each institution should select a set of interventions based on both cost-effectiveness and their existing infrastructure and services.

By utilizing a relatively large patient cohort and a case-control design that accounts for patient distance from the hospital, this study addresses many of the shortcomings in the existing SAH readmission literature. However, this study also has several limitations. First, while the case-control design of the study allowed us to control for bias from patient distance from the hospital and year of treatment, it is possible that over-matching limited our ability to identify significant predictors of readmission. Although over-matching is a known risk in case-control studies, our matching criteria (general geographic region and treatment year) should have had a low correlation with other clinically important predictors (e.g., Hunt and Hess grade), decreasing the likelihood that this problem skewed our findings. Nonetheless, our results should be validated in other institutions and using alternative study designs to test their external validity.

Second, despite our efforts to identify outside hospital readmissions, it is possible that some patients may have had readmissions to local hospitals not captured in this analysis. While the case-control design of this study helped minimize bias from unrecorded readmissions, the possibility of missed readmissions is an inherent limitation in any single-center analysis. Third, due to the limitations of retrospective chart review, certain potentially important data points, including substance abuse status and educational attainment, were not reliably available, and other information may have been recorded incompletely or inconsistently in some instances. Fourth, the relatively low comorbidity burden recorded in this study—62% of patients had a score of 0 and only 14% had a score of 2 or higher—may have limited our ability to evaluate the impact of more severe comorbidity status on readmission risk. Finally, this study was focused only on inpatient care and data points recorded during hospitalization. Future analyses should also evaluate the impact of postdischarge processes of care on 30-day readmission.

Conclusions

While several routinely collected clinical variables, including markers of disease severity and comorbidity status, were associated with 30-day readmission after SAH in univariate analysis, only discharge disposition was significant in multivariate analysis, complicating efforts to focus on high-risk subgroups. Given these results, effective readmission reduction efforts should likely focus on multifaceted strategies that can be broadly applied to all SAH patients. However, in light of the small proportion of readmissions related to identifiable shortcomings in care, such efforts should be prospectively investigated for both clinical effectiveness and cost-effectiveness.

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ABBREVIATIONS

ASA	American Society of Anesthesiologists
BJH	Barnes Jewish Hospital
CCI	Charlson Comorbidity Index
DCI	delayed cerebral ischemia
EVD	external ventricular drain
LOS	length of stay
PCP	primary care physician
SAH	subarachnoid hemorrhage

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TABLE 1.

Demographic, socioeconomic, and clinical characteristics of aneurysmal SAH patients who experienced 30-day readmission along with nonreadmitted matched controls*

Variable	Total	30-Day Readmission	No 30-Day Readmission
Total	231	78	153
Mean age in yrs (SD)	55.0 (14.4)	57.0 (14.9)	54.0 (14.1)
Sex			
Female	161 (69.7)	59 (75.6)	102 (66.7)
Male	70 (30.3)	19 (24.4)	51 (33.3)
Race			
White	131 (56.7)	40 (51.3)	91 (59.5)
Other	100 (43.3)	38 (48.7)	62 (40.5)
Marital status			
Married	102 (45.7)	30 (39.0)	72 (49.3)
Not married	121 (54.3)	47 (61.0)	74 (50.7)
Payer status			
Private	103 (44.6)	35 (44.9)	68 (44.4)
Medicare	60 (26.0)	18 (23.1)	42 (27.5)
Other	68 (29.4)	25 (32.1)	43 (28.1)
Median income (US $)	41,273	39,223	44,254
Hunt & Hess grade			
I	20 (8.7)	5 (6.5)	15 (9.9)
II	99 (43.2)	29 (37.7)	70 (46.1)
III	73 (31.9)	22 (28.6)	51 (33.6)
IV	26 (11.4)	15 (19.5)	11 (7.2)
V	11 (4.8)	6 (7.8)	5 (3.3)
Modified Fisher grade			
0	9 (4.1)	1 (1.3)	8 (5.5)
1	44 (19.9)	15 (19.7)	29 (20.0)
2	10 (4.5)	2 (2.6)	8 (5.5)
3	94 (42.5)	29 (38.2)	65 (44.8)
4	64 (29.0)	29 (38.2)	35 (24.1)
Disposition			
Home	87 (40.1)	23 (30.3)	64 (45.4)
Rehabilitation	102 (47.0)	36 (47.4)	66 (46.8)
Skilled nursing/extended care	28 (12.9)	17 (22.4)	11 (7.8)
Discharge day			
Weekday	214 (92.6)	74 (94.9)	140 (91.5)
Weekend	17 (7.4)	4 (5.1)	13 (8.5)
Treatment			

Variable	Total	30-Day Readmission	No 30-Day Readmission
Clip	137 (59.3)	46 (59.0)	91 (59.5)
Coil	88 (38.1)	30 (38.5)	58 (37.9)
Other	6 (2.6)	2 (2.6)	4 (2.6)
Aneurysm location			
Anterior circulation	195 (84.4)	67 (85.9)	128 (83.7)
Posterior circulation	36 (15.6)	11 (14.1)	25 (16.3)
DCI	54 (23.4)	22 (28.2)	32 (20.9)
ASA class			
I	2 (0.9)	0 (0)	2 (1.3)
II	39 (17.3)	12 (16.0)	27 (18.0)
III	110 (48.9)	33 (44.0)	77 (51.3)
IV	72 (32.0)	29 (38.7)	43 (28.7)
V	2 (0.9)	1 (1.3)	1 (0.7)
Emergent	121 (53.5)	38 (50.0)	83 (55.3)
Hyponatremia	28 (12.1)	10 (12.8)	18 (11.8)
EVD	124 (53.7)	49 (62.8)	75 (49.0)
Shunt	54 (23.4)	23 (29.5)	31 (20.3)
Tracheostomy	24 (10.4)	11 (14.1)	13 (8.5)
Gastrostomy	52 (22.5)	24 (30.8)	28 (18.3)
Craniectomy	17 (7.4)	8 (10.3)	9 (5.9)
Postprocedure infarct	24 (10.4)	8 (10.3)	16 (10.5)
Delayed infarct	56 (24.2)	24 (30.8)	32 (20.9)
Any post-SAH infarct	69 (29.9)	31 (39.7)	38 (24.8)
Median hospital LOS (days)	18	21	17
Median ICU LOS (days)	13	14	12
Comorbidities			
CCI			
0	144 (62.3)	39 (50.0)	105 (68.6)
1	54 (23.4)	23 (29.5)	31 (20.3)
≥2	33 (14.3)	16 (20.5)	17 (11.1)
Myocardial infarction	14 (6.1)	6 (7.7)	8 (5.2)
Chronic pulmonary disease	30 (13.0)	16 (20.5)	14 (9.2)
Diabetes	34 (14.7)	12 (15.4)	22 (14.4)
Solid tumor	13 (5.6)	6 (7.7)	7 (4.6)
Hypertension	137 (59.3)	50 (64.1)	87 (56.9)
Coronary artery disease	26 (11.3)	12 (15.4)	14 (9.2)
Cerebrovascular disease	9 (3.9)	3 (3.9)	6 (3.9)
Psychiatric disease	34 (14.6)	10 (12.8)	24 (15.7)

*Values are presented as the number of patients (%) unless indicated otherwise.

TABLE 2.

Univariate and multivariate analyses of factors associated with 30-day readmission after aneurysmal SAH

	Univariate		Multivariate	
Variable	**OR (95% CI)**	**p Value**	**OR (95% CI)**	**p Value**
Age	1.01 (0.995–1.03)	0.14		
Sex				
Male	Reference			
Female	1.6 (0.83–3.0)	0.16		
Race				
White	Reference			
Other	1.6 (0.84–3.2)	0.15		
Marital status				
Married	Reference			
Not married	1.6 (0.90–2.9)	0.11		
Payer status				
Private	Reference			
Medicare	0.79 (0.37–1.7)	0.42		
Other	1.1 (0.57–2.1)	0.48		
Median income (in $1000)	0.99 (0.97–1.01)	0.22		
Hunt & Hess Score				
I–II	Reference			
III	1.1 (0.59–2.2)	0.71		
IV–V	3.0 (1.4–6.4)	0.005		
Modified Fisher Score				
0–1	Reference			
2–3	1.0 (0.53–2.0)	0.93		
4	2.3 (1.01–5.5)	0.048		
Disposition				
Other	Reference		Reference	
Skilled nursing/extended care	3.2 (1.5–7.0)	0.004	3.2 (1.5–7.0)	0.004
Discharge day				
Weekday	1.8 (0.58–5.5)	0.31		
Weekend	Reference			
Treatment				
Coil	Reference			
Clip	0.98 (0.54–1.8)	0.96		
Aneurysm location				
Anterior circulation	1.2 (0.53–2.6)	0.69		
Posterior circulation	Reference			
DCI	1.5 (0.80–2.8)	0.22		

	Univariate		Multivariate	
Variable	**OR (95% CI)**	**p Value**	**OR (95% CI)**	**p Value**
ASA class				
I–II	Reference			
III	1.1 (0.49–2.6)	0.78		
IV–V	1.8 (0.76–4.1)	0.19		
Emergent	0.76 (0.42–1.4)	0.37		
Hyponatremia	1.1 (0.47–2.6)	0.83		
EVD	1.7 (0.995–3.0)	0.05		
Shunt	1.7 (0.90–3.1)	0.10		
Tracheostomy	1.7 (0.76–4.0)	0.19		
Gastrostomy	2.0 (1.03–3.7)	0.04		
Craniectomy	1.7 (0.66–4.4)	0.27		
Postprocedure infarct	1.0 (0.40–2.3)	0.94		
Delayed infarct	1.6 (0.89–3.0)	0.12		
Any post-SAH infarct	2.0 (1.1–3.5)	0.02		
Hospital LOS (days)	1.03 (1.003–1.05)	0.03		
ICU LOS (days)	1.03 (0.999–1.07)	0.06		
Comorbidities				
CCI				
0	Reference			
1	2.0 (1.0–4.0)	0.04		
≥2	2.3 (1.1–5.0)	0.03		
Myocardial infarction	1.6 (0.51–4.7)	0.44		
Chronic pulmonary disease	2.5 (1.1–5.5)	0.02		
Diabetes	1.1 (0.48–2.3)	0.89		
Solid tumor	1.7 (0.58–5.1)	0.33		
Hypertension	1.4 (0.77–2.5)	0.27		
Coronary artery disease	1.8 (0.74–4.6)	0.19		
Cerebrovascular disease	0.92 (0.23–3.7)	0.91		
Psychiatric disease	0.84 (0.37–1.9)	0.66		