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The Majority of 30-Day Readmissions after Intracerebral Hemorrhage are Related to Infections

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Abstract

Background and Purpose—Infections are common after intracerebral hemorrhage (ICH), but little is known about risk of serious infection requiring readmission after hospital discharge.

Methods—In order to determine if infections are prevalent in patients readmitted within 30-days of discharge, we performed a retrospective cohort study of patients discharged from non-federal acute care hospitals in California with a primary diagnosis of ICH between 2006 and 2010. We excluded patients who died during the index admission, were discharged against medical advice, or were not California residents. Our main outcome was 30-day unplanned readmission with primary infection-related ICD-9CM code.

Results—There were 24,540 index ICH visits from 2006 to 2010. Unplanned readmissions occurred in 14.5% (n=3,550) of index patients. Of 3,550 readmissions, 777 (22%) had an infection-related primary diagnosis code. When evaluating primary and all secondary diagnosis codes, infection was associated with 1,826 (51%) of readmissions. Other common diagnoses associated with readmission included stroke-related codes (n=840, 23.7%) and aspiration pneumonitis (n=154, 4.3%). The most common infection-related primary diagnosis codes were septicemia (n=420, 11.8%), pneumonia (n=124, 3.5%), urinary tract infection (n=141, 4.0%), and gastrointestinal infection (n=42, 1.2%). Patients with a primary infection-related ICD-9CM code on readmission had higher in-hospital mortality compared to other types of readmission (15.6% vs. 8.0%, p<0.001). After controlling for other predictors of mortality, primary infection-related readmissions remained associated with in-hospital mortality (RR=1.7, 95% CI 1.3–2.2).

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Conclusions—Infections are associated with a majority of 30-day readmissions after ICH and increased mortality. Efforts should be made to reduce infection-related complications after hospital discharge.

Indexing Terms

intracerebral hemorrhage; infectious disease; readmission; epidemiology; health services research

Subject Terms

Intracranial Hemorrhage; Cerebrovascular Disease/Stroke; Health Services; Quality and Outcomes; Epidemiology

INTRODUCTION

Infections are common after both hemorrhagic and ischemic stroke, with approximately 30% of patients admitted with intracerebral hemorrhage (ICH) developing infections during their hospital stay.¹ There are two main factors that likely contribute to this high rate of infection. First, physical insults including aspiration, dysphagia, intubation, and urinary catheterization predispose patients to site-specific infections such as ventilator-associated pneumonias and catheter-associated urinary tract infections. Second, although better studied in patients with ischemic stroke, some patients with intracerebral hemorrhage undergo a state of post-stroke immunosuppression. Post-stroke immunosuppression is characterized by activation of the hypothalamus-pituitary-adrenal axis and autonomic dysregulation which leads to numerous immunologic effects such as lymphopenia and deactivation of lymphocytes and monocytes.² The interaction between these two processes results in a very high susceptibility to infection. While the increased risk of infection during initial hospitalization is well known, to date no adequately-powered multicenter studies have been performed to examine the risk of serious infection after hospital discharge. We designed this study to assess the hypothesis that infections are associated with a majority of 30-day readmissions to acute care hospitals after ICH.

METHODS

Study Design

We performed a retrospective observational cohort study of patients discharged from non-federal acute care hospitals in California with a primary diagnosis of ICH between 2006 and 2010. Using administrative claims data, we sought to assess the proportion of 30-day readmissions that were either: 1) primary infection-related, defined as an infection-related ICD-9CM code in the primary diagnosis position; or 2) primary or secondarily infection-related, defined as an infection-related ICD-9CM code in the primary diagnosis code position or in any of the subsequent 24 secondary diagnosis code positions listed in the California Statewide Inpatient Database. Details regarding the California Statewide Inpatient Database and Healthcare Cost and Utilization Project have been previously reported. Per policy of the New York University School of Medicine Institutional Review Board, this analysis of de-identified, publicly available data did not require review.

Study Patients

We identified all patients with first admission to an acute care hospital for ICH using primary discharge diagnosis code 431 from the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). This algorithm for identification of ICH patients from administrative datasets has high sensitivity and specificity with a positive predictive value of 89%. In order to avoid analysis of chronic cases, only the first admission with ICH was included as an index case. Additionally, in order to ensure that the study sample was for initial ICH, we used data from 2005 as a 12-month run-in period to ensure none of the cases had previous ICH admissions. Other exclusion criteria included in-hospital death during index admission, discharge against medical advice, and non-California residency.

Study Outcomes and Measurements

The primary outcome was readmission to an acute care hospital within 30 days after index discharge with a primary discharge diagnosis code (DX1) of an infectious disease. Secondary outcome was readmission to an acute care hospital within 30 days after index discharge with any infectious disease discharge diagnosis code (The California Statewide Inpatient Database includes up to 25 discharge diagnosis codes DX1-DX25). Clinical Classification Software (CCS) categorization of ICD-9-CM codes developed by the Healthcare Cost and Utilization Project was utilized for etiology of readmission (see Supplementary Table I). Infections related to tuberculosis, human immunodeficiency virus/sexually transmitted diseases, and hepatitis were excluded as these are chronic conditions. Patients with likely planned readmission for diagnostic or therapeutic procedures were not included as readmissions (e.g., cranioplasty, angiography/embolization; see Supplementary Table II for ICD-9-CM codes defined as planned readmissions). Transfers between acute care hospitals were identified using admission source data and were excluded as readmissions. Readmissions to an acute care hospital from residential, skilled nursing, and immediate care facilities were treated as readmissions. Patients with readmissions to acute care hospitals with primary rehabilitation codes were also excluded as readmissions (see Supplementary Table III). Follow-up included data from 2011 to ensure 30-day follow-up for all cases identified in 2010.

Statistical Analysis

Univariate analyses were performed using chi-square, independent samples t-test, and non-parametric tests. We used multiple logistic regression to assess risk factors for mortality during readmission. All statistical analyses were performed on commercially available software (SPSS 20, IBM).

RESULTS

There were 24,540 index ICH visits from 2006 to 2010. Infectious disease codes were present in 7,741 (31.5%) of index admissions. Unplanned readmissions occurred in 14.5% (n=3,550) of index patients. See Table 1 for the most frequent etiologies of 30-day readmission after ICH. Of 3,550 readmission, 777 (22%) had an infectious disease primary diagnosis code. When evaluating readmission diagnosis codes at all 25 positions, infection

was associated with 1,826 (51%) of readmissions. Other common primary causes for readmission included stroke-related codes (n=840, 23.7%) and aspiration pneumonitis (n=154, 4.3%). The most common infectious disease primary diagnosis codes were septicemia (n=420, 11.8%), pneumonia (n=124, 3.5%), urinary tract infection (n=141, 4.0%), and gastrointestinal infection (n=42, 1.2%) (See Table 2).

See Table 3 for Patient Characteristics. Patients with primary infection-related readmissions were older, had higher prevalence of medical comorbidities, and had longer index admission length of stay compared to those without readmission as well as compared to those with readmission that was not primarily infection-related.

The time to readmission was slightly longer for primary infection-related readmissions compared to other readmissions (day 11 +/-10 vs. Day 10 +/-9, p=0.004). Patients with infection-related codes during index admission were more likely to be readmitted within 30 days than those who did not (17.5% vs 13.2%, p<0.001). Patients with infection-related codes during index admission were also more likely to have primary infection-related readmissions compared to those who did not (27.1% vs 18.7%, p<0.001).

Neurosurgical procedures were performed in 3,201 patients (13.0%). For patients who underwent neurosurgical procedures, 32.6% of readmissions were primary infection-related compared to 20.0% of readmissions for those who did not (p<0.001). Endotracheal intubation was performed in 4,338 patients (17.1%). For patients who underwent endotracheal intubation, 31.9% of readmissions were primary-infection related compared to 19.2% for those who were not (p<0.001).

Patients with primary infection-related readmissions had higher in-hospital mortality compared to other types of readmission (15.6% vs. 8.0%, p<0.001). Other predictors of readmission mortality in univariate analyses included age, DNR status, index visit LOS, insurance status, and race. After controlling for the other predictors of mortality, primary infection-related readmissions remained associated with in-hospital mortality (OR=1.7, 95% CI 1.3–2.2).

DISCUSSION

Infections are a common inpatient complication after intracerebral hemorrhage. In this report we demonstrate that the risk for post-stroke infection continues after hospital discharge and may be a significant cause of 30-day readmission to an acute care hospital. Additionally, we demonstrate that infection-related readmissions are associated with a higher mortality than other etiologies for readmission, in line with our previous report from the ERICH Study that infection during initial admission is independently associated with worse outcomes including death. The frequency of readmission we demonstrate is similar to those previously reported in a cohort of Medicare patients presenting with intracerebral hemorrhage (15.5–16.0%). That report, interestingly, did not find a difference in readmission rates between Joint Commission certified primary stroke centers versus noncertified centers.

Our results on the association between 30-day readmission and infection are similar to those reported in single-center studies. Liotta et al. reported a retrospective cohort of 193 ICH

survivors from a large, academic medical center between 2006 and 2012. Of the 22 (11%) patients readmitted within 30 days, they found that 10 (46%) were for infections. Bjerkeim et al. published an analysis of a cohort of 121 ICH survivors from a regional prospective stroke registry in Norway. Of the 27 (22%) patients readmitted within 90 days, infection was found to be the leading etiology of readmission (26%). The fact that our results are similar to these single-center studies, which were able to identify the precise cause of readmission, lends support to the hypothesis that infections are the likely etiology for readmission associated with infection in our study. Additionally, the frequency of infection during index hospitalization of approximately 30% in this study was similar to our findings in the ERICH Study, which had detailed, adjudicated case and outcome assessment. This lends validity to our use of diagnostic codes to assess for infection in the post-ICH setting.

Our findings suggest the need for improved post-discharge infection prevention in the outpatient and immediate care setting including adoption of best practices for tracheostomy and wound care, aspiration precautions, continued mobilization, and other infection prevention measures. Patients with advanced age, medical comorbidities, and longer index admission lengths of stay should specifically be targeted given our finding that they are more likely to be readmitted with infection.

Our results should be interpreted with several limitations in mind. First, our analysis relies on ICD-9CM codes to identify patients with intracerebral hemorrhage, and we did not have further clinical detail available. Our study is therefore subject to misclassification bias in identification of cases. However, our method of identifying cases is identical to that of Tirschwell and Longstreth who found a positive predictive value of 89% using this method. Second, the sensitivity and specificity of using Clinical Classification Software (CCS) for determining the etiology of readmissions is not known. However, CCS is the method by which the Centers for Medicare & Medicaid Services analyzes readmission discharge diagnoses for their 30-day readmission measures, so our results conform to regulatory practices. Additionally, while we feel that using the primary diagnosis code is likely more specific and less sensitive than use of all available secondary diagnosis codes, confirmation of this is out of the scope of this study and both frequencies we found are within the range of existing single-center study data. It should be noted the sensitivity of secondary diagnosis codes is dependent upon the depth of coding performed by individual hospitals and the number of diagnostic codes available in a given database. Finally, the California SID is de-identified and cannot be linked to the Social Security Death Index so we cannot identify deaths that occur outside of inpatient settings. Therefore, we may be underestimating the burden of post-discharge infectious complications if patients died of infection-related complications in the outpatient setting.

SUMMARY

Infections are associated with a majority of 30-day readmissions to acute care hospitals in patients with intracerebral hemorrhage. Efforts should be made to reduce risk of post-stroke infections even after hospital discharge.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Top Ten CCS Categories and ICD-9-CM Diagnoses for 30-Day Readmission after ICH

Principal Diagnostic Category (CCS)	%	Primary ICD-9-CM Code	%
Acute Cerebrovascular Disease	21.3	Intracerebral Hemorrhage	14.1
Septicemia	11.8	Septicemia NOS	7.9
Aspiration Pneumonitis	4.3	Aspiration Pneumonitis	4.3
Urinary Tract Infections	4.0	Cerebral artery occlusion/infarct	3.7
Pneumonia	3.5	Urinary Tract Infection NOS	3.5
Complications of Surgery or Medical Care	2.5	Pneumonia NOS	2.6
Respiratory Failure	2.4	Acute Kidney Failure NOS	2.3
Late Effects of Cerebrovascular Disease	2.4	Pulmonary Embolism	2.0
Renal Failure	2.4	Acute Respiratory Failure	1.9
Fluid and Electrolyte Disorders	2.1	Late effect of Cerebrovascular Disease	1.5

Table 2

Frequency of Infections Associated with 30-Day Readmission after ICH

Infection Diagnoses	Primary Code %	Any Code %
Septicemia	11.8	17.4
Respiratory Infections (excl. aspiration)	3.8	15.1
Urinary Tract Infection	4.0	28.8
Gastrointestinal Infection	1.3	5.0
Central Nervous System Infection	0.3	0.9
Any Infection	21.9	51.4

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Table 3

Patient Characteristics

Variable	<u>Yes 30-Day Readmission</u>		
	No 30-Day Readmission (N=20,990)	Primary Infection Related (N=777)	Not Primary Infection Related (N=2,773)
Demographics			
Age (Years +/- SD)	66 +/- 17	73 +/- 13	69 +/- 16
Female Sex	10,051 (48.2)	380 (49.0)	1274 (46.1)
Race/Ethnicity			
White	10059 (51.0)	376 (50.0)	1340 (51.0)
Black	1737 (8.8)	82 (10.9)	296 (11.3)
Hispanic	4629 (23.5)	145 (19.3)	568 (21.6)
Asian or Pacific Islander	2815 (14.3)	123 (16.4)	356 (13.6)
Native American	18 (0.1)	3 (0.4)	2 (0.1)
Other	476 (2.4)	23 (3.1)	65 (2.4)
Missing Data	1256	25	146
Insurance			
Medicare	10801 (51.5)	553 (71.2)	1712 (61.7)
Medicaid	2979 (14.2)	96 (12.4)	370 (13.3)
Private Insurance	5158 (24.6)	105 (13.5)	532 (19.2)
Self-Pay	1181 (5.6)	10 (1.3)	91 (3.3)
Other	869 (4.1)	13 (1.7)	68 (2.5)
Comorbidities			
Hypertension	17348 (82.6)	674 (86.7)	2,319 (83.6)
Congestive Heart Failure	1871 (8.9)	112 (14.4)	369 (13.3)
Chronic Pulmonary Disease	2262 (10.8)	135 (17.4)	386 (13.9)
Diabetes, without complications	4717 (22.5)	226 (29.1)	670 (24.2)
Diabetes, with chronic complications	1025 (4.9)	70 (9.0)	225 (8.1)
Deficiency Anemias	3029 (14.4)	236 (30.4)	568 (20.5)
Coagulopathy	1055 (5.0)	59 (7.6)	208 (7.5)
Chronic Liver Disease	609 (2.9)	26 (3.3)	132 (4.8)
Renal Failure	2330 (10.6)	156 (20.1)	507 (18.3)
DNR	2,508 (12.0)	92 (11.8)	260 (9.4)
Length of Index Visit Stay – median days (IQR)	6 (3–12)	11 (6–23)	7 (4–13)