Many Neurology Readmissions Are Nonpreventable

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Abstract

Introduction: Reducing unplanned hospital readmissions has become a national focus due to the Centers for Medicare and Medicaid Services' (CMS) penalties for hospitals with high rates. A first step in reducing unplanned readmission is to understand which patients are at high risk for readmission, which readmissions are planned, and how well planned readmissions are currently captured in comparison to patient-level chart review. **Methods:** We examined all 5455 inpatient neurology admissions over a 2-year period to University of California San Francisco Medical Center and Johns Hopkins Hospital via chart review. We collected information such as patient age, procedure codes, diagnosis codes, all-payer diagnosis-related group, observed length of stay (oLOS), and expected length of stay. We performed multivariate logistic modeling to determine predictors of readmission. Discharge summaries were reviewed for evidence that a subsequent readmission was planned. **Results:** A total of 353 (6.5%) discharges were readmitted within 30 days. Fifty-five (15.6%) of the 353 readmissions were planned, most often for a neurosurgical procedure (41.8%) or immunotherapy (23.6%). Only 8 of these readmissions would have been classified as planned using current CMS methodology. Patient age (odds ratio [OR] = 1.01 for each 10-year increase, P < .001) and estimated length of stay (OR = 1.04, P = .002) were associated with a greater likelihood of readmission, whereas index admission oLOS was not. **Conclusions:** Many neurologic readmissions are planned; however, these are often classified by current CMS methodology as unplanned and penalized accordingly. Modifications of the CMS lists for potentially planned neurological and neurosurgical procedures and for acute discharge neurologic diagnoses should be considered.

Introduction

Reducing readmissions has become a focus of policy makers due to its potential to lower costs and improve transitions of care. In 2012, the Centers for Medicare & Medicaid Services (CMS) initiated the Hospital Readmissions Reduction Program, which penalizes hospitals with readmission rates that are deemed excessive. When the program began, it was limited to 3 index admission conditions: acute myocardial infarction, pneumonia, and congestive heart failure.[1] Three additional conditions were added in 2014 (chronic obstructive pulmonary disease, total hip arthroplasty, and total knee arthroplasty).[1] In 2013, CMS developed the hospital-wide all-cause unplanned readmission measure, a claim-based, risk-adjusted, publicly reported measure of care quality for hospitalized patients, including those admitted for neurology services.[2] The Hospital Readmissions Reduction Program, with penalties now as high as 3% of a hospital's total CMS payments, has prompted clinical interventions to improve

discharge planning, ensure timely follow-up, and improve the inpatient to outpatient transition.[3] Importantly, CMS recognizes that certain planned readmissions do not reflect poor care quality and thus has made an effort to identify and exclude planned readmissions from its hospital readmission measure. The CMS has defined planned readmissions as those for organ transplantation, maintenance chemotherapy, rehabilitation, or a list of procedures for nonacute discharge diagnoses (Table 1).[4] Any nonacute hospital readmission with a discharge condition including one of these procedures is

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Table 1. CMS Criteria for Planned Readmissions, Potentially Planned Neurological and Neurosurgical Procedures, and Acute Neurological and Neurosurgical Discharge Diagnosis Categories Classified as Never Planned.[4]

CMS criteria for planned readmissions:
  1. Always planned readmission procedure and diagnosis categories
     Transplant surgery
     Maintenance chemotherapy
     Rehabilitation
     Cesarean section; forceps, vacuum, and breech delivery are
        included in all-payer population
  Or
  2. A nonacute readmission for a planned procedure, excluding for
     acute illness or for complications of care
     A procedure is performed that is in one of the categories that
        are always planned regardless of diagnosis
     Or
     The principle diagnosis is in one of the diagnosis categories that
        are always planned
     Or
     A procedure is performed that is in one of the potentially
        planned procedure categories, and the principle diagnosis is
        not in the list of acute discharge diagnoses
**CMS potentially planned neurological and neurosurgical
  procedures:**
     Laminectomy, excision intervertebral disc
     Insertion of catheter or spinal stimulator and injection into spinal
     Other OR therapeutic nervous system procedures
     Endarterectomy, vessel of head and neck
     Other OR procedures on vessels of head and neck
     Spinal fusion
**CMS acute neurological and neurosurgical discharge
  diagnosis categories:**
     Meningitis (except that caused by tuberculosis or sexually
        transmitted disease)
     Encephalitis (except that caused by tuberculosis or sexually
        transmitted disease)
     Other CNS infection and poliomyelitis
     Paralysis
     Epilepsy, convulsions
     Headache, including migraine
     Coma, stupor, and brain damage
     Blindness and vision defects
     Conditions associated with dizziness or vertigo
     Acute cerebrovascular disease
     Transient cerebral ischemia
     Spinal cord injury
     Intracranial injury
     Syncope
     Delirium, dementia, amnestic, and other cognitive disorders

Abbreviations: CMS, Centers for Medicare and Medicaid Services; CNS, central nervous system; OR, operating room.

excluded from the hospital readmission calculation and therefore not penalized.

Despite this focus on readmissions, little is known regarding readmissions for patients with a diverse set of neurologic conditions.[5] Much of the previous work has focused on ischemic and hemorrhagic stroke[6-14] and epilepsy,[15] which represent only a fraction of the burden of neurological disease in the United States.[16] Furthermore, even less is known regarding how many readmissions from neurological disease represent unplanned, and hence potentially preventable, encounters and how many represent planned neurological readmissions that CMS may or may not accurately identify using their current methodology.

Although national data sets can provide a "high-level" snapshot of readmission rates and predictors of readmission,[5] examination of patient-level data via detailed chart review can more precisely understand the frequency and characteristics of planned readmissions among neurologic inpatients as well as general predictors of 30-day readmission. We aimed to answer these questions using an analysis by chart review of all admissions to 2 tertiary care academic hospitals in the United States.

Methods

The study design and procedures were approved by the institutional review board at Johns Hopkins University and the Committee on Human Research at the University of California San Francisco (UCSF). A waiver of informed consent was granted. We conducted a retrospective cohort study that included all inpatient encounters involving patients aged 18 years or older who were discharged from the neurologic services at UCSF Medical Center and Johns Hopkins Hospital between May 1, 2012, and April 30, 2014. The neurology inpatients at these tertiary academic hospitals are cared for by the general neurology, cerebrovascular, and epilepsy monitoring unit services. At both hospitals, the majority of patients with primary neurological diagnoses are admitted to or transferred to and subsequently discharged from these dedicated inpatient neurological services. We included all index admissions due to transfer to capture as many readmissions to the respective tertiary centers, recognizing that many such patients would be more likely to be readmitted to other institutions. We excluded all encounters that resulted in death before discharge and those patients who left against medical advice. We then identified which of these index encounters led to subsequent readmission to any service of the respective hospital within 30 days of discharge. For patients with many encounters, this methodology allows an admission to be considered both a readmission and an index admission. We calculated a readmission rate by dividing the number of readmissions by the number of index admissions, which is consistent with methodology for calculating readmission rates from Vizient (formerly University HealthSystem Consortium), the largest member-owned health-care company in the country that maintains a Clinical Data Base/Resource Manager (CDB/RM) with national administrative claims of extracted patient data for quality measurement and outcome improvement from participating academic medical centers in the United States.[17] Of note, Vizient also excludes readmissions for chemotherapy, radiation therapy, routine inpatient dialysis, obstetrics, and rehabilitation when identifying unplanned readmissions.

To further characterize these encounters, we obtained administrative data from these encounters, including age, observed length of stay (oLOS), procedure codes, and All Patient Refined–Diagnosis-Related Groups (APR-DRGs). We then linked these data to Vizient's CDB/RM to obtain expected length of stay (eLOS), a patient-specific risk-adjusted metric calculated using regression models that incorporates patient factors such as age, gender, race, socioeconomic status, admission source, comorbidities, and the severity of illness in light of billed diagnoses and procedures associated with that patient's admission with respect to the patient population.[18] Because there are over 400 APR-DRGs, we grouped the APR-DRGs into 31 diagnosis categories using our previous methodology for neurological diagnostic categories, with the addition of organ system categories for nonneurological diseases and procedures.[5] The modifications to the neurological categories included incorporation of ischemic stroke with tissue plasminogen activator along with other ischemic strokes in the category "intracranial hemorrhage and ischemic stroke," expansion of bacterial and nonbacterial infections to the nervous system in general and not limiting to the central nervous system, and expansion of malignancies of the nervous system to be a general category not limited to the central nervous system. The categories for nonneurological organ system categories were selected by consensus opinion of 3 authors (S.T.L., S.A.J., and J.C.P.).

We subsequently performed a chart review of each of these readmissions to assess which readmissions were planned. Readmissions were coded as planned or unplanned by authors (S.T.L. and J.C.P.) at their respective institutions on the basis of whether the procedures or treatment performed during the readmission had been specifically stated in the discharge summary for the discharge diagnosis of the index admission. If there was uncertainty regarding readmission classification, this was discussed with the other authoring neurologists at the respective institutions (S.A.J and H.A.P.). Also a readmission was considered planned if either the readmission or an outpatient visit to coordinate readmission for the procedure or treatment was scheduled and specifically stated in the discharge summary of the index admission.

We subsequently identified which of these readmissions would be classified as planned using CMS methodology (Table 1). Per CMS, there are specific, limited types of care that are always considered planned. Otherwise, a planned readmission is a nonacute readmission for a scheduled procedure and is never an admission for an acute illness or complication of care. A readmission is considered planned if it is for a procedure or diagnosis that has been defined by CMS as always planned.[4]

Analysis

We calculated readmission rates, percentage of readmissions that were planned, and percentage of readmissions classified as planned by CMS. Because some neurology patients were readmitted multiple times during our study period and some of these readmissions occurred within 30 days of a prior 30-day readmission, only the first 30 day readmission was included.[4,6,11] To assess which factors were associated with readmission, logistic regression models were used to examine the impact of age, eLOS, and oLOS on likelihood of readmission. We performed both bivariate and multivariate modeling to assess the effect of each of these factors on likelihood of readmission.

We considered a 2-tailed p value of less than .05 as significant. All analyses were performed using Stata 13 (StataCorp LP, College Station, Texas).

Results

A total of 5455 admissions were identified, 353 (6.5%) of which resulted in an initial readmission within 30 days (Table 2). Fifty-five (15.6%) of the 353 readmissions were found to be planned (Figure 1). Forty-one (74.5%) of these planned readmissions occurred within 14 days of index discharge, with the mean interval duration from index discharge to readmission being 17.5 days (standard deviation [SD]: 9.4). The most common planned reasons for readmission were for a neurosurgical procedure such as craniotomy and biopsy (N = 23, 41.8%; Figure 1B), immunotherapy such as plasmapheresis or intravenous immunoglobulin infusion (N = 13, 23.6%; Figure 1C), a neurovascular procedure such as arteriogram and endovascular stenting (N = 5, 9.1%; Figure 1D), or a nonneurological procedure such as biopsy (N = 5, 9.1%). Only 8 (14.5%) of these readmissions would have been classified as planned using CMS methodology.

Turning to neurological diagnosis groups, the highest volume of readmissions was seen in patients with ischemic or hemorrhagic stroke (N = 57), whereas the highest readmission proportions were seen among patients with cancer of the nervous system (19.0%) and not of the nervous system (31.0%; Table 1). The highest proportions of planned readmissions were among patients with miscellaneous disorders of the nervous system including movement disorder, sleep disorder, myopathy, and myelopathy (38.2%), nervous system malignancy (33.3%), and spinal cord disorders (33.3%; Table 1).

The reasons for readmission varied across index admission neurological diagnosis, as demonstrated among the diagnosis groups with highest volume of readmissions (Figure 2). For instance, a neurosurgical procedure was the leading reason for readmission among readmitted patients within the miscellaneous disorder of the nervous system diagnosis group, whereas it was the third most frequent reason for readmission among readmitted patients with seizure.

Patient age (odds ratio [OR] = 1.01 for each 10-year increase, $p < .001$) and eLOS (OR = 1.03, $p < .001$) were associated with a greater likelihood of readmission in bivariate multivariate logistic regression models (Supplemental File 1). Observed length of stay was not associated with likelihood of readmission in either the bivariate or the multivariate models.

Table 2. Characteristics of Index Admissions and Readmissions.[a]

Primary Admission Diagnosis	Number of Index Admissions	Number of Readmissions (Readmission Rate)	Planned Readmission (Proportion)
Neurological			
Seizure	1203	34 (2.8%)	3 (8.8%)
Intracranial hemorrhagic and ischemic stroke	1043	57 (5.5%)	4 (7.0%)
Headache	342	11 (3.2%)	0 (0.0%)
Miscellaneous disorder of the nervous system including movement disorder, sleep disorder, myopathy, and myelopathy	328	34 (10.4%)	13 (38.2%)
Ataxia and demyelinating disease	323	33 (10.2%)	10 (30.3%)
Neurodegenerative disorder	182	9 (4.9%)	2 (22.2%)
Intravascular procedure	161	11 (6.8%)	3 (27.3%)
Nontraumatic coma	128	7 (5.5%)	0 (0.0%)
Transient ischemic attack	123	6 (4.9%)	1 (16.7%)
Other nonbacterial nervous system infection	106	8 (7.5%)	0 (0.0%)
Peripheral nerve disorder	98	16 (16.3%)	1 (6.3%)
Bacterial infection of nervous system	65	9 (13.8%)	1 (11.1%)
Nervous system malignancy	63	12 (19.0%)	4 (33.3%)
Spinal cord disorder	43	3 (7.0%)	1 (33.3%)
Viral meningitis	36	3 (8.3%)	0 (0.0%)
Traumatic brain injury	27	2 (7.4%)	0 (0.0%)
Total neurological	4271	255 (6.0%)	43 (16.9%)
Nonneurological			
Psychiatric or mood disorder	179	6 (3.4%)	0 (0.0%)
Neurosurgical procedure	153	15 (9.8%)	0 (0.0%)
Orthopedic, plastic surgical, and skin disorders and procedures	149	12 (8.1%)	3 (25.0%)
Other	148	17 (11.5%)	4 (23.5%)
Disorders and procedures of eyes	122	7 (5.7%)	0 (0.0%)
Disorder or procedure of pulmonary system	121	8 (6.6%)	0 (0.0%)
Infectious disease, nonneurological	89	9 (10.1%)	2 (22.2%)
Disorder or procedure of cardiovascular system	83	6 (7.2%)	1 (16.7%)
Disorder of renal system including electrolyte imbalance	37	5 (13.5%)	0 (0.0%)
Endocrine diagnoses and procedures	34	0 (0.0%)	-
Cancer, not of nervous system	29	9 (31.0%)	1 (11.1%)
Disorder of liver and gastrointestinal tract	24	3 (12.5%)	1 (33.3%)
Disorder or procedure of face, ears, nose, neck, or throat	8	1 (12.5%)	0 (0.0%)
Hematologic/immunologic	5	0 (0.0%)	-
Burns and trauma	3	0 (0.0%)	-
Total nonneurological	1184	98 (8.3%)	12 (12.2%)
Total	5455	353 (6.5%)	55 (15.6%)

[a]Only 8 (14.5%) of 55 considered planned using Centers for Medicare and Medicaid Services (CMS) methodology. Of note, no patients in this period were admitted or readmitted with diagnosis codes for the neurological categories "arterial stenosis" and "nonhypertensive encephalopathies."

Discussion

In this retrospective cohort study of patients treated at 2 academic centers, 6.5% of discharged patients were readmitted to their respective hospital within 30 days. Approximately 16% of these initial 30-day readmissions were for planned procedures and treatments, the majority of which would not be captured as planned readmissions using current CMS methodology. This chart-level description of reasons for readmission complements prior work in describing rates of readmission across the neurological patient population.[5]

The 30-day readmission rate is considered by CMS and other organizations as a standard measure of inpatient care quality and efficiency of health-care utilization. After 30 days, factors outside a hospital provider's control, such as patient behavior, care provided by others, and patient's comorbidities, are felt to have a substantial impact on risk for readmission.[4] It is important to note that the 6.5% initial 30-day readmission rate observed here is comparable to prior single-center studies of readmission in epilepsy and ischemic stroke, less than the 11% observed for neurologic disorders using the Vizient database, and less than the national 13.7% readmission rate for the neurology cohort and 16.0% for all qualifying Medicare patients recently observed by CMS.[5,10,12,15]

Important exceptions to the 30-day readmission rate are planned readmissions that occur within 30 days but reflect a scheduled part of a patient's plan of care rather than the
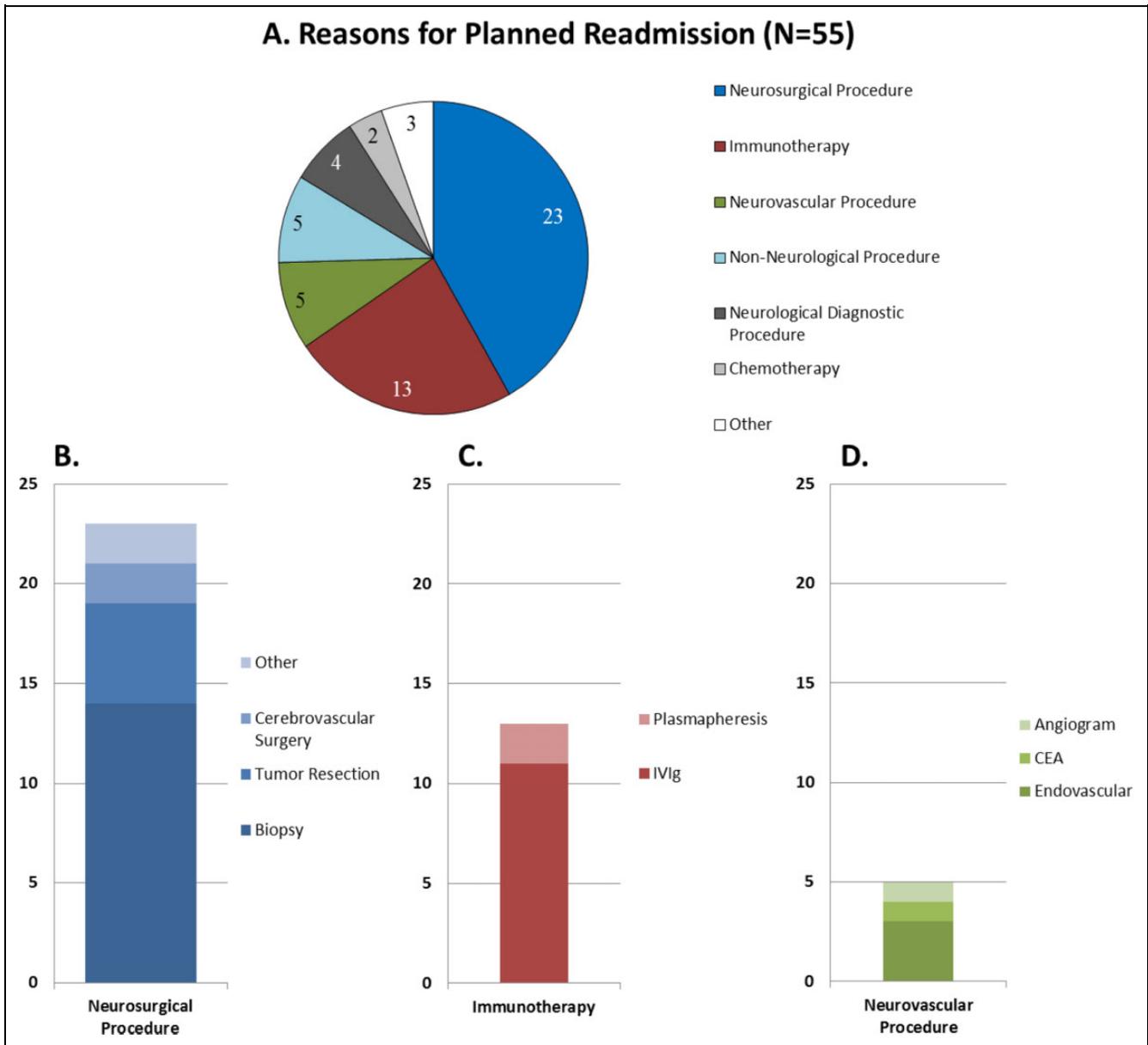
Figure 1. Reasons for planned readmission. A, Categories of planned readmission with (B) specific neurosurgical procedures, (C) specific immunotherapies, and (D) specific neurovascular procedures.

product of an acute complication. The designation of planned readmission has been limited by CMS to a defined list of indications.[4] Potentially planned neurological and neurosurgical procedures as currently defined by CMS include laminectomy, insertion of a spinal catheter or stimulator, therapeutic operative procedures of the nervous system, operative procedures of the vessels of the head and neck, endarterectomy, and spinal fusion (Table 1).[4] Here, detailed chart review of readmissions allowed for designation of initial readmissions as planned or unplanned, granularity not available using national databases.[5] Among the 353 readmissions identified here, only 8 met CMS criteria, whereas an additional 45 readmissions were planned for

procedures such as immunotherapy infusions, elective craniotomy, and biopsy. These additional readmissions reflect nonpreventable portions of a patient's care plan, suggesting an opportunity for neurology-specific additions to the planned readmission definition used by CMS and others. For example, an adult patient initially admitted for evaluation of seizures who is found to have a brain mass through the course of index admission, discharged after achieving seizure control for rehabilitation and outpatient neurosurgical follow-up for biopsy planning, and then readmitted for neurosurgical biopsy, the potential resection would be categorized as an unplanned readmission using current CMS definitions. At the moment, neurologists and hospitals are
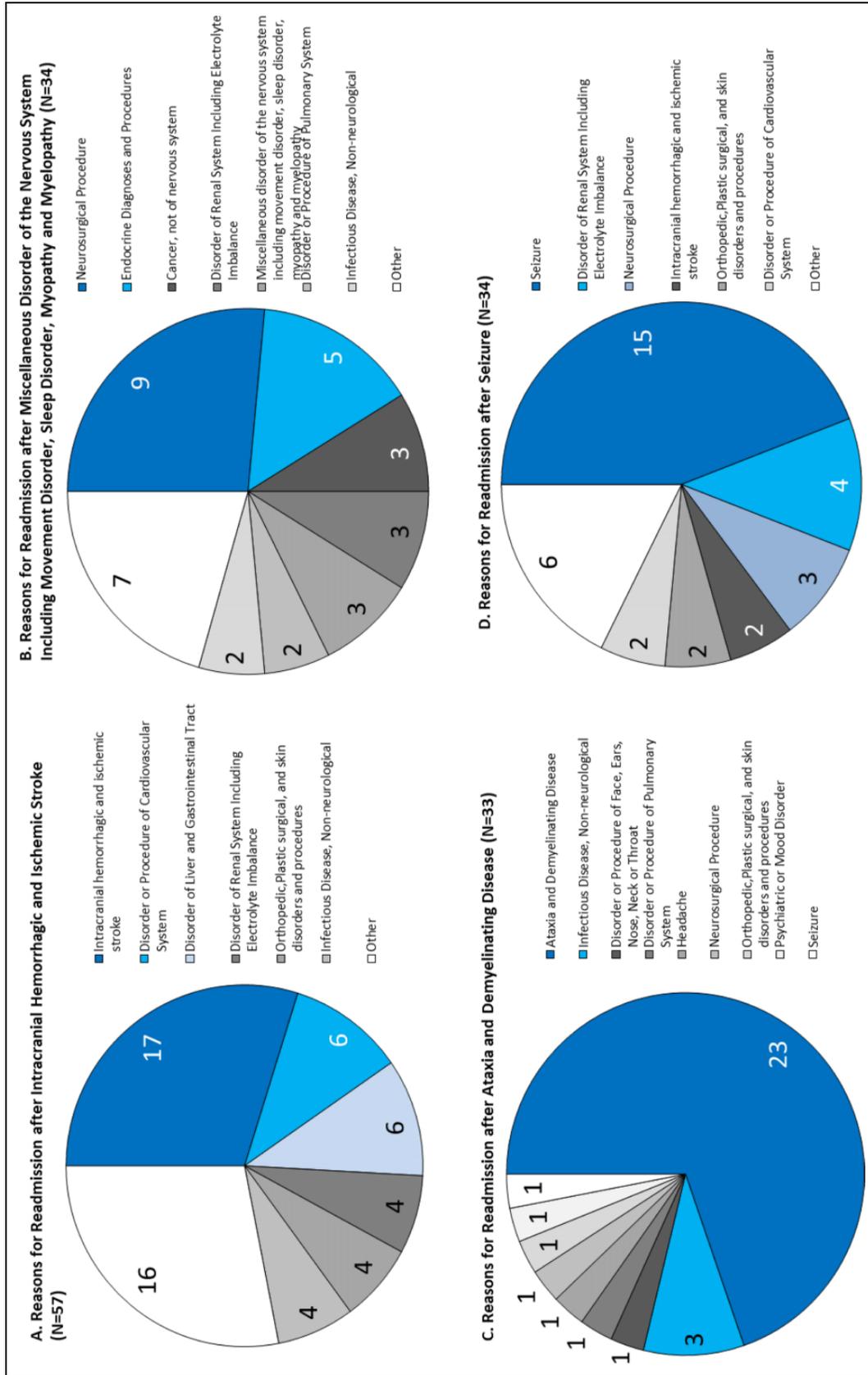
Figure 2. Reasons for readmission vary by index admission diagnosis. A, Reasons for readmission after intracranial hemorrhage and ischemic stroke (n = 57). B, Reasons for readmission after miscellaneous disorder of the nervous system including movement disorder, sleep disorder, myopathy, and myelopathy (n = 34). C, Reasons for readmission after ataxia and demyelinating disease (n = 33). D, Reasons for readmission after seizure (n = 34).

Table 3. Possible Modifications to CMS Criteria for Planned Readmission.

Suggested additions to list of potentially planned neurological and
    neurosurgical procedures
        Neurosurgical incision and excision
        Procedures of vessels of head and neck other than
           endarterectomy
        Immunotherapy including plasmapheresis and intravenous
           immunoglobulin
Suggested deletions from list of acute neurological and neurosurgical
    discharge diagnoses
        Epilepsy; convulsions
        Acute cerebrovascular disease
        Transient cerebral ischemia

Abbreviation: CMS, Centers for Medicare and Medicaid Services.

potentially being penalized for such nonpreventable readmissions, which reflect well-coordinated care rather than unplanned complications of care delivered. Patient-level observations such as those provided here can inform proposed refinements to current planned readmission definitions, including additions to the list of potentially planned procedures for nonacute diagnoses (Table 3).

Prior studies of readmission of patients with epilepsy or after ischemic stroke have excluded planned readmissions either per CMS criteria or if for elective procedures, with focus resting on unplanned and potentially preventable readmissions.[10-12,15] In single-center studies of readmission in ischemic stroke by detailed medical record review, the number of readmissions for planned procedures ranged from to 4.2% to 41%.[10,12] Because a number of 30-day readmissions for neurology patients are for elective procedures, the suggestion has been made to either ensure completion of elective procedures during the index admission and potentially increase the oLOS or defer elective procedures for greater than 30 days after discharge.[10] Such practices would likely compromise care quality, with either accumulated risks of medical complications in the setting of extended hospitalization or risks of deferred care to meet a quality metric.

Here, the most common index admission diagnosis category for readmitted patients was intracranial hemorrhage and ischemic stroke, as has been observed among the Medicare neurology cohort but not the Vizient database where patients with peripheral nerve disorders were most commonly readmitted.[4,5] Importantly, the reason for readmission varied by index admission diagnosis. These differences could potentially be used to guide neurology-specific quality improvement interventions at the institutional and national levels. Such directed interventions may be further refined by studying those at risk for readmission and for what reasons within a matter of days from discharge as opposed to weeks. As observed within the general medicine population, those with a longer length of stay and greater acuity of illness appear more likely to be readmitted within 7 days of index hospitalization.[19]

Patient-specific factors, generally captured here by the eLOS incorporating patient-specific factors, medical severity, and patient age, were associated with likelihood of readmission, whereas oLOS was not. A variety of factors have previously been associated with patient risk for readmission, from patient-specific factors[11,15,20,21] to characteristics of index hospitalizations,[10-12] neurological service structure,[22] hospital practice[8] and attributes,[23] and regional differences.[24] Also, increased severity of neurological disease and the presence of related comorbidities and medical complications of index hospitalization are associated with increased rates of readmission.[5,11,12,20,21] As presented here, the association of patient-specific factors with readmission extends throughout the neurological inpatient population. The degree and direction of association of oLOS on likelihood for readmission have been observed to vary in different neurology patient populations, perhaps accounting for oLOS here not being associated with likelihood of readmission.[10,12] It should be noted that the ORs for readmission in relation to patient age and eLOS are small, likely reflecting other factors predicting readmission not captured in our study design. Also, the number of variables collected for each admission in the combined multi-institutional data set limited the control for confounders in regression analyses of predictors for readmission.

The major limitations of this study are that it is retrospective and that it was performed at tertiary academic medical centers with associated limits of generalizability. Individual chart review performed here allowed for the confirmation of the indication for readmission and associated index admission, as well as the determination of whether readmission was planned by providers, details not readily available for review through national databases nor captured in administrative and billing data.

It is important to note that in this study, all patients 18 years of age and older were included, whereas the Medicare cohort is limited to patients 65 years of age and older. The differing readmission rates observed may potentially reflect the effect of accrued comorbidities with age in the Medicare population as opposed to the general neurology population. However, this rate is likely an underestimate for multiple additional reasons. First, this inpatient neurological services readmission rate is likely an underestimate of all readmitted patients with neurological disease discharged from the respective tertiary hospitals. Patients may have been admitted for other nonneurological reasons to other services initially, which may have been captured in previous analyses but not here.[5] With dedicated cerebrovascular, epilepsy monitoring, general neurology services, and neurocritical care units, the vast majority of patients with primary neurological reasons for admission are admitted to or transferred to the inpatient services at the study centers but potentially not all patients with neurological disease. Second, readmission was determined by readmission to the discharging tertiary center. As both medical centers care for patients transferred for tertiary-level care, some patients discharged from each center may have been readmitted within

30 days to another facility, and this was not captured in this study. This also likely explains why the rate of readmission observed here is lower than other population-based studies but similar to other single-center studies.[10,11,15] To address this limitation, agencies such as the Maryland Health Services Cost Review Commissions have developed algorithms to reliably match patients and admissions across multiple hospitals.[25] Future studies on rates of readmission may benefit from the use of such state-wide and national readmission databases not limited to certain age groups to build on the findings provided here.

Patients could potentially have been readmitted multiple times during our study period, many of whom within 30 days of a prior 30-day readmission. Here, only the first 30-day readmission in a series was included, consistent with publicly reported disease and procedure-specific readmission measures as well as prior studies exploring reasons for readmission in neurological disease.[4,6,11] Additionally, some readmissions were to other nonneurological inpatient services at the respective hospitals, including for potentially planned procedures, and subsequent readmissions within the 30-day period would be potentially attributable to care received during those readmissions rather than the care received during the index admission. In the future, it would be important to study patients with multiple 30-day readmissions to identify factors associated with multiple, frequent readmissions in this particularly at-risk group.

In terms of other limitations, some developing hospital practices may lead to apparent reductions in rates of readmission, such as utilization of emergency department observation units for the acute care of neurological patients.[26] Such brief observation stays were not studied specifically, though warrant further study. Finally, the most commonly readmitted neurological diagnoses noted here differ from those observed in a recent review of admissions for neurological diagnoses using the Vizient database.[5] This may be the consequence of the billing-based classifications used in the Vizient database across patients treated by neurologists and other physicians in comparison with the chart review methods of inpatients treated by neurologists employed here.

Conclusion

Many readmissions following index admission to an inpatient neurology service are not preventable, often reflecting continuation of planned care rather than reflecting poor care quality. The majority of these planned readmissions are not captured by current CMS methodologies, and here, we provide evidence to inform potential revised definitions of planned and unplanned care across the spectrum of neurological diseases. In addition, neurological patient complexity is a primary and potentially intervenable factor associated with readmission, whether by further refinements in diagnosis and treatment of neurological diseases or implementation of interventions to prevent or mitigate associated medical complications.

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