Discharge against medical advice among neurological patients: Characteristics and outcomes

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Abstract

Objective: To study characteristics and outcomes of patients with stroke, traumatic brain injury (TBI), and epilepsy with discharge against medical advice (DAMA).

Data Sources/Study Setting: Retrospective analysis of the 2013 Nationwide Readmissions Database, a nationally representative inpatient administrative dataset.

Study Design: Associations between predictors and DAMA at index admission were analyzed using adjusted logistic models. We examined 30-day all-cause readmissions.

Data Collection Methods: Patients aged ≥ 18 years at index admission for International Classification of Diseases-9 diagnosis code of epilepsy, TBI, or stroke were included.

Principal Findings: Discharge against medical advice occurred in 1998/58278 patients (3.43 percent) in the epilepsy group, 1762/211 213 (0.83 percent) in the stroke group, and 1289/74 652 (1.73 percent) in the TBI group. Factors consistently associated with increased likelihood of DAMA included lower age, male sex, non-Medicare and nonprivate insurance, lower socioeconomic status, and behavioral risk factors (smoking history, alcohol history, and drug use). The crude 30-day all-cause readmission rate for those with DAMA from their index admission was 16.4 percent for the stroke cohort, 13.9 percent for epilepsy, and 13.4 percent for TBI. DAMA at index admission was significantly associated with increased risk of 30-day all-cause readmission among all groups (adjusted odds ratio 1.79, 95% CI: 1.65-1.94, $P < .0001$).

Conclusions: Age, sex, insurance status, socioeconomic status, and behavioral factors were associated with DAMA in neurological patients. Further research is needed to develop interventions to reduce DAMA in high-risk groups.

KEYWORDS

discharge disposition, neurological condition, outcomes

1 | INTRODUCTION

Discharge against medical advice (DAMA), a situation in which patients decide to leave the hospital despite the objections of their health care providers, occurs in 1-2 percent of medical admissions.¹⁻³ DAMA has negative implications for patients including higher risks of readmission and mortality, and greater medical costs. Patients often cite poor communication with their health care team and the

high financial costs of medical care as reasons for leaving against medical advice (AMA). Patients who were initially led to believe that their hospitalizations would be shorter in length were also more likely to leave AMA.⁴ It is important to understand which patients are at higher risk for leaving AMA in order to create targeted interventions and potentially improve patient outcomes.

Neurological disorders constitute 10.2 percent of the global burden of disease and 16.8 percent of total deaths.⁵ A higher risk of DAMA has been found in patients with comorbid neurological conditions.⁶ Furthermore, compared to the general population,

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neurological patients have increased rates of comorbid psychiatric conditions,⁷ and impaired cognition and executive function.⁸ Current studies on DAMA in the neurological population are limited by small sample sizes or geographically limited samples that are more prone to regional variation.^{6,9} This is a need to better identify neurological patients who are (a) at risk of DAMA, and (b) at risk of poor outcomes related to DAMA, for potential receipt of interventions to improve outcomes. In this retrospective analysis with a nationally representative US population, we studied the characteristics and outcomes of patients with stroke, traumatic brain injury (TBI), and epilepsy with DAMA. We selected these neurological conditions to capture not only common neurological reasons for admission, but also differing age-groups with a variety of comorbid conditions. Based on prior studies on DAMA in the general population, we hypothesized that younger, male patients with psychiatric comorbidities and substance abuse antecedents will have higher incidence of DAMA.

2 | METHODS

The Nationwide Readmissions Database (NRD) is a national database of readmissions for all payers and the uninsured with data on more than 14 million US admissions during the year 2013. It is one of seven databases in the Healthcare Cost and Utilization Project (HCUP) under an Agency for Healthcare Research and Quality (AHRQ) initiative. The NRD is derived from State Inpatient Databases from 21 states, comprising data from 49.1 percent of all US hospitalizations, excluding rehabilitation and long-term acute-care hospitalizations. The NRD allows analysis of readmissions with the use of a verified linkage identifier for each individual, which has been anonymized to comply with privacy guidelines. An anonymized variable signifying the number of days between admissions for each individual is also provided.

For this analysis, we restricted the cohort to those aged ≥ 18 years at the time of index event. The Mount Sinai IRB reviewed and approved this analytic plan, and all analyses comply with the HCUP data use agreement. MSD had full access to all the data in the study and takes responsibility for its integrity and the data analysis.

Discharge against medical advice was defined as a value of "left against medical advice or discontinued care" for the HCUP variable "disposition of patient at discharge." An independent contractor performs a quality review of the validity and internal consistency of all variables in the NRD, and any discharges with missing or invalid identifiers were appropriately excluded. We used International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9) codes to identify medical conditions. We defined three primary neurological cohorts for analysis: epilepsy, traumatic brain injury, and stroke. An epilepsy index admission was defined as an admission with a primary diagnosis code of 345.xx, which had a positive predictive value (PPV) of 97.7 percent for a diagnosis of epilepsy for inpatient admissions in a 2010 study.¹⁰ Inclusion of the less specific 780.3 (seizure, convulsions) was shown to lower PPV for epilepsy patients to 83.5 percent, so we did not include this code. Similarly,

What This Study Adds

- In neurological patients, age, sex, insurance status, socioeconomic status, and behavioral factors were associated with discharge against medical advice.
- Patients who leave against medical advice are often readmitted for the same reason as for the first hospitalization.
- Epilepsy patients have the highest rates of discharge against medical advice.

another study has shown the most accurate ICD-9 code algorithm to identify epilepsy cases was one hospitalization coded within 2 years for 345.xx.¹¹ Here, we excluded code 345.6x (infantile spasms) given a study population of 18 and older.

The case definition for traumatic brain injury (TBI) was defined using the Centers for Disease Control and Prevention (CDC)'s 2011 case definition as a guideline.¹² The case definition used for this study is more stringent than that of the CDC's due to the exclusion of 905.0 (late effects of fracture of skull and face bones) and 873 (other open wound of head). As the former describes late effects and the latter describes lacerations instead of direct brain injury, these descriptors lack relevance for this study and were excluded. Overall, sensitivity and specificity values for the entire set of included ICD-9 codes are not available in the literature.

We used ICD-9 codes to identify index stroke events. ICD-9 codes previously validated in the literature were used to identify patients with ischemic and hemorrhagic stroke (positive predictive value between 89 and 96 percent).¹³⁻¹⁵ To avoid inclusion of patients with only a history of stroke, index stroke was defined as admissions in which ischemic or hemorrhagic stroke were coded as the primary nonprocedural diagnosis for admission.¹⁶

Baseline characteristics of patients and their index hospitalizations were defined using relevant ICD-9 codes and HCUP variables. Vascular risk factors included diabetes, hypertension, hypercholesterolemia, smoking history, and atrial fibrillation or flutter. The utility of ICD-9 codes to identify vascular risk factors has been previously studied and has been deemed specific (>0.95) but not sensitive ($0.25-0.75$).^{13,17} Validated ICD-9 definitions of psychiatric comorbidities are not as well defined in the literature, which is likely related to the lack of an objective gold standard for diagnosis and changing classifications of psychiatric disorders among versions of the Diagnostic and Statistical Manual of Mental Disorders (DSM). A list of ICD-9 codes used in this study is provided in Table S1.

Characteristics of the index hospitalization were defined using HCUP data elements. This included hospital bed size (small, medium, or large), teaching hospital status (metropolitan nonteaching, metropolitan teaching, and nonmetropolitan hospital), and income quartile of patient's zip code. The All Patient Refined Diagnosis Related Groups (APR-DRGs) are designated using 3M Health Information Systems software. APR-DRGs classify patients into 25 major

diagnostic categories and then further subdivide patients into four severity of illness subclasses in terms of degree of loss of function (minor, moderate, major, and extreme) and four risk of mortality subclasses (minor, moderate, major, and extreme). These two subclasses are calculated separately. Analysis of the APR-DRG has demonstrated that mortality rate correlates with increasing APR-DRG risk of mortality scores¹⁷ and the APR-DRG has been adapted to the VA health system.^{18,19}

2.1 | Statistical analysis

We calculated baseline characteristics of the population by index admission cohort: stroke, epilepsy, and TBI. We calculated means and standard deviations for continuous variables and frequencies and percentages for categorical variables. We included medical comorbidities at the time of the index hospitalization.

We then ran adjusted logistic models testing associations between predictors (demographic variables, medical risk factors, and behavioral risk factors) and the outcome of DAMA at the index admission, calculating the odds ratio and 95% confidence intervals for DAMA for each variable. For this analysis, we ran models in each cohort separately, as well as in the combined cohort.

We then calculated the number of repeat DAMA episodes after an index admission with DAMA. We reported the proportion of each cohort with recurrent DAMA episodes. We then ran unadjusted and adjusted logistic models for the outcome of 30-day all-cause readmission, calculating odds ratios and 95% confidence intervals for the main predictor of DAMA at the index admission. We adjusted successively for demographics, medical risk factors, estimated risks of mortality, estimated severity, behavioral risk factors, and psychiatric comorbidities. We ran models separately in each cohort. In a sensitivity analysis, we ran these same logistic models using a definition of the main exposure of DAMA versus discharge home. Finally, the most common reasons for 30-day readmission after DAMA at index admission were summarized by cohort. Analyses were performed in SAS version 9.4.

3 | RESULTS

Table 1 lists baseline characteristics of the study population at the time of index event. There were 211 213 patients in the stroke cohort, 58 278 in the epilepsy cohort, and 74 652 in the TBI cohort. Stroke patients were older, had greater prevalence of vascular risk factors and cardiovascular disease, and higher estimated risk of mortality and illness severity than the epilepsy and TBI cohorts. Of the three cohorts, the epilepsy cohort was the youngest and had the highest rate of psychiatric comorbidities. Among the TBI patients, males outnumbered females, comprising 60 percent of the cohort. A total of 5049 patients (1.5 percent) were discharged against medical advice: 1762 stroke patients (0.83 percent of the stroke cohort), 1998 epilepsy patients (3.43 percent of the epilepsy cohort), and 1289 TBI patients (1.73 percent of the TBI cohort).

Table 2 shows associations between baseline characteristics and DAMA at index admission, using adjusted models examining each cohort separately, and all cohorts combined. Across all cohorts, several factors were consistently associated with increased likelihood of DAMA, including lower age, male sex, non-Medicare and nonprivate insurance, lower socioeconomic status, and behavioral risk factors such as smoking, alcohol history, and drug use.

When examining recurrent discharges against medical advice up to 1 year after index admission with DAMA, 105 patients (5.96 percent) in the stroke cohort, 233 patients (11.66 percent) in the epilepsy cohort, and 64 patients (4.97 percent) in the TBI cohort left against medical advice upon repeat readmission.

The crude 30-day all-cause readmission rate for those with DAMA from their index admission was 16.4 percent for the stroke cohort, 13.9 percent for epilepsy, 13.4 percent for TBI, and 14.7 percent for all neurological conditions considered together. Table 3 shows unadjusted and adjusted logistic models for the outcome of 30-day all-cause readmission, by index admission cohort. Among all cohorts, DAMA at index admission was significantly associated with increased risk of 30-day all-cause readmission. For each index admission cohort, the magnitude of association between DAMA and 30-day all-cause readmission risk was largely unchanged after adjusting for demographics, medical risk factors, estimated risks of mortality, estimated severity, behavioral risk factors, and psychiatric comorbidities. In fully adjusted models, there was a twofold risk of readmission for stroke and TBI, and a 45 percent increase for the epilepsy cohort. In sensitivity analysis using a definition of DAMA as DAMA versus discharge home, the magnitudes of effect were in fact larger for all groups. In fully adjusted models, the OR was 2.22 (95% CI 1.94-2.53, $P < .0001$) for the stroke cohort, 1.53 (95% CI 1.33-1.75, $P < .0001$) for the epilepsy cohort, 2.14 (95% CI 1.80-2.54, $P < .0001$) for the TBI cohort, and 1.93 (95% CI 1.78-2.10, $P < .0001$) for all groups considered together.

Table 4 demonstrates that the most common reasons for 30-day readmission after DAMA at index admission were most often the same reason for the index admission. Among the stroke cohort, cerebrovascular disease accounted for 51.21 percent of 30-day readmissions; among the epilepsy cohort, epilepsy or convulsions accounted for 42.24 percent of 30-day readmissions; and among the TBI cohort, head trauma accounted for 32.37 percent of 30-day readmissions.

4 | DISCUSSION

This study is the first nationally representative study of DAMA in US patients admitted for neurological conditions. The goals of this retrospective study were to determine the demographic and clinical characteristics of patients with DAMA following index admission for epilepsy, stroke, and traumatic brain injury and to determine associations between DAMA and 30-day readmission. These common reasons for neurological admission were studied to capture a range of age-groups and comorbid conditions. We found DAMA among 3.43

TABLE 1 Baseline characteristics of study population by index event

	Type of index event		
	Stroke	Epilepsy	TBI
Number of participants	211 213	58 278	74 652
Age, mean (SD)	70.0 (14.4)	52.4 (19.1)	61.6 (21.9)
Female, No. (%)	108 041 (51.2)	29 125 (50.0)	30 258 (40.5)
Median income for zip code, No. (%)			
\$0-25 000	58 740 (28.3)	18 734 (32.7)	18 684 (25.5)
\$25 001-30 000	54 512 (26.3)	14 395 (25.2)	18 345 (25.1)
\$30 001-35 000	50 896 (24.5)	12 943 (22.6)	18 498 (25.3)
\$35 001+	43 441 (20.9)	11 165 (19.5)	17 677 (24.2)
APRDRG mortality risk, No. (%)			
Minor likelihood	59 644 (28.2)	30 983 (53.2)	30 019 (40.2)
Moderate likelihood	93 318 (44.2)	14 950 (25.7)	23 103 (31.0)
Major likelihood	42 220 (20.0)	7615 (13.1)	14 061 (18.8)
Extreme likelihood	16 025 (7.6)	4717 (8.1)	7462 (10.0)
APRDRG illness severity subclass, No. (%)			
No or minor loss of function	28 111 (13.3)	14 157 (24.3)	18 071 (24.2)
Moderate loss of function	101 110 (47.9)	23 468 (40.3)	29 594 (39.6)
Major loss of function	64 368 (30.5)	17 259 (29.6)	18 398 (24.7)
Extreme loss of function	17 618 (8.3)	3381 (5.8)	8582 (11.5)
Disposition of patient at discharge, No. (%)			
Routine discharge (discharged home or self-care)	87 551 (41.5)	40 061 (68.8)	40 856 (54.8)
Transfer to short-term hospital	4027 (1.9)	614 (1.1)	1345 (1.8)
Transfer to skilled nursing facility, intermediate care facility, or another type of facility	75 534 (35.8)	9403 (16.1)	21 387 (28.7)
Home health care	41 885 (19.8)	6134 (10.5)	9666 (13.0)
Left against medical advice or discontinued care	1762 (0.8)	1998 (3.4)	1289 (1.7)
Discharged alive, destination unknown	388 (0.2)	32 (0.1)	83 (0.1)
Alcoholism, No. (%)	5089 (2.4)	4243 (7.3)	5234 (7.0)
Atrial fibrillation or atrial flutter, No. (%)	48 054 (22.8)	3897 (6.7)	10 030 (13.4)
Diabetes, No. (%)	74 080 (35.1)	10 456 (17.9)	13 791 (18.5)
Drug abuse, No. (%)	6660 (3.2)	5565 (9.6)	4252 (5.7)
Hypertension, No. (%)	143 644 (68.0)	22 099 (37.9)	32 249 (43.2)
Hypercholesterolemia, No. (%)	117 873 (55.8)	13 439 (23.1)	19 061 (25.5)
Myocardial infarction, No. (%)	4401 (2.1)	374 (0.6)	590 (0.8)
Peripheral vascular disease, No. (%)	10 153 (4.8)	1115 (1.9)	1586 (2.1)
Smoking history, No. (%)	63 271 (30.0)	14 757 (25.3)	16 113 (21.6)
Psychiatric comorbidities, No. (%)	39 377 (18.6)	18 645 (32.0)	13 746 (18.4)
Adjustment disorder, No. (%)	1544 (0.7)	287 (0.5)	295 (0.4)
Anxiety disorder, No. (%)	15 892 (7.5)	7231 (12.4)	4994 (6.7)
Bipolar disorder, No. (%)	2180 (1.0)	2919 (5.0)	1391 (1.9)
Conversion disorder, No. (%)	161 (0.1)	349 (0.6)	27 (0.04)
Depression, No. (%)	24 373 (11.5)	10 163 (17.4)	8254 (11.1)
Post-traumatic stress disorder, No. (%)	10 153 (4.8)	1115 (1.9)	1586 (2.1)
Schizophrenia, No. (%)	3442 (1.6)	3094 (5.3)	1642 (2.2)

(Continues)

TABLE 1 (Continued)

	Type of index event		
	Stroke	Epilepsy	TBI
Hospital bed size, No. (%)			
Small	18 230 (8.6)	4624 (7.9)	3052 (4.1)
Medium	49 949 (23.7)	13 923 (23.9)	13 724 (18.4)
Large	143 034 (67.7)	39 731 (68.2)	57 876 (77.5)
Hospital teaching status, No. (%)			
Metropolitan nonteaching	87 214 (41.3)	22 272 (38.2)	23 895 (32.0)
Metropolitan teaching	107 409 (50.9)	32 457 (55.7)	48 581 (65.1)
Nonmetropolitan hospital	16 590 (7.9)	3549 (6.1)	2176 (2.9)
Primary expected payer, No. (%)			
Medicare	138 154 (65.5)	26 266 (45.1)	37 304 (50.1)
Medicaid	16 433 (7.8)	12 752 (21.9)	6348 (8.5)
Private insurance	37 954 (18.0)	12 055 (20.7)	18 278 (24.5)
Self-pay	10 814 (5.1)	4061 (7.0)	6485 (8.7)
No charge	1375 (0.7)	575 (1.0)	559 (0.8)
Length of stay, days, mean (SD)	7.8 (10.9)	4.2 (6.6)	7.5 (13.2)
Number of procedures, mean (SD)	1.5 (2.5)	0.9 (1.6)	2.0 (3.0)

Note: +psychiatric comorbidities, adjustment disorder, anxiety disorder, bipolar disorder, conversion disorder, depression, post-traumatic stress disorder, and schizophrenia. Abbreviations: APDRG, All Patient Refined Diagnosis Related Group; TBI, traumatic brain injury.

percent of patients admitted for epilepsy, 0.83 percent admitted for stroke, and 1.73 percent admitted for TBI. Across all conditions, several factors were consistently associated with increased likelihood of DAMA, including lower age, male sex, non-Medicare and nonprivate insurance, lower socioeconomic status, and behavioral risk factors such as smoking, alcohol history, and drug use. DAMA at index admission was associated with increased risk of 30-day all-cause readmission among all cohorts (OR: 1.16, 95% CI: 1.13-1.19, $P < .0001$), and the magnitude of these associations was largely unchanged after full adjustment. The most common reasons for 30-day readmission after DAMA at index admission were most often the same reason for the index admission.

Discharge against medical advice occurs in 1-2 percent of medical admissions overall.¹⁻³ We reported a similar DAMA rate of 1.5 percent among hospitalized patients with common neurological conditions. DAMA is the leading cause of premature hospital discharge in the United States; over 500 000 cases of DAMA occur annually.²⁰ Prior studies have demonstrated that DAMA has widespread consequences for patients, care providers, and hospitals, such as worse patient outcomes, higher cost of care, and lower quality of care. Retrospective studies reported that patients who are discharged AMA visit the emergency room more frequently, have higher 30-day readmission rates, and have increased morbidity and mortality rates.^{2,21} Furthermore, 30-day readmission data show that the total cost of care due to readmission from to DAMA is 56 percent higher than the cost anticipated for the first hospitalization.²²

The findings of this study are generally in accordance with those of other studies regarding DAMA in a neurological patient

population. The present study demonstrated a rate of DAMA of 0.83 percent among admitted stroke patients. This is consistent with the previously reported DAMA rate of 0.7 percent for stroke admissions using a proprietary database of 79 561 stroke admissions from the Maryland Health Services Cost Review Commission from 2000 to 2005.²² Our study also demonstrated a rate of DAMA of 1.73 percent among admitted TBI patients. In a retrospective matched-cohort study of 656 patients admitted to Montreal General Hospital between 2010 and 2011, Marcoux et al⁶ found that 1.8 percent of patients admitted for TBI were discharged AMA. We confirmed these prevalences in a larger, contemporary, nationally representative US cohort.

Prior studies have shown that the patients who are at the highest risk of leaving AMA have well-established and overlapping characteristics, similar to those found in this study. These include male sex, young age, lack of private insurance or enrollment in Medicaid, lack of a primary care physician, low household income, comorbidities, substance abuse or other psychiatric diagnoses, and a previous history of DAMA.^{4,9,22} There has been limited information about patients with neurological conditions with DAMA. The few studies that have studied DAMA among neurological patients conducted their analyses on cohorts of admitted stroke and TBI patients.

We found that lower age, male sex, non-Medicare and nonprivate insurance, lower socioeconomic status, and behavioral risk factors such as smoking, alcohol history, and drug use were consistently associated with increased likelihood of DAMA. This is in accordance with prior studies of DAMA, both in the general and neurological population. In their study of DAMA following TBI, Marcoux et al⁶

TABLE 2 Adjusted models testing associations between baseline factors and discharge against medical advice

	Stroke		Epilepsy		TBI		All	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Age	0.97 (0.966-0.973)	<.0001	0.98 (0.978-0.985)	<.0001	0.99 (0.984-0.991)	<.0001	0.98 (0.975-0.979)	<.0001
Female	0.60 (0.55-0.67)	<.0001	0.66 (0.60-0.72)	<.0001	0.54 (0.47-0.62)	<.0001	0.63 (0.59-0.67)	<.0001
Private insurance, vs. other	0.58 (0.52-0.65)	<.0001	0.47 (0.42-0.52)	<.0001	0.43 (0.38-0.49)	<.0001	0.49 (0.45-0.52)	<.0001
Median income for zip code: 2nd quartile vs. 1st	0.87 (0.77-0.98)	.025	0.89 (0.79-1.00)	.041	0.76 (0.65-0.88)	.0003	0.84 (0.78-0.90)	<.0001
Median income for zip code: 3rd quartile vs. 1st	0.72 (0.63-0.82)	<.0001	0.76 (0.67-0.87)	<.0001	0.78 (0.67-0.91)	.0016	0.74 (0.68-0.80)	<.0001
Median income for zip code: 4th quartile vs. 1st	0.71 (0.61-0.82)	<.0001	0.69 (0.59-0.80)	<.0001	0.94 (0.80-1.10)	.43	0.75 (0.69-0.82)	<.0001
Atrial fibrillation or atrial flutter	0.69 (0.58-0.81)	<.0001	0.77 (0.57-1.05)	.099	0.79 (0.60-1.05)	.10	0.67 (0.59-0.76)	<.0001
Diabetes mellitus	0.98 (0.88-1.09)	.73	1.24 (1.07-1.44)	.0042	1.13 (0.93-1.37)	.21	1.04 (0.96-1.12)	.32
Hypercholesterolemia	0.70 (0.63-0.77)	<.0001	0.65 (0.55-0.76)	<.0001	0.53 (0.43-0.67)	<.0001	0.62 (0.57-0.67)	<.0001
Hypertension	0.91 (0.82-1.01)	.076	0.86 (0.76-0.97)	.0103	0.88 (0.76-1.02)	.091	0.85 (0.80-0.91)	<.0001
Myocardial infarction	1.17 (0.80-1.71)	.42	0.52 (0.16-1.62)	.25	0.51 (0.13-2.07)	.35	0.91 (0.64-1.29)	.59
Peripheral vascular disease	1.02 (0.79-1.30)	.91	0.32 (0.14-0.72)	.0058	0.81 (0.42-1.58)	.54	0.83 (0.66-1.03)	.089
Number of procedures	0.83 (0.81-0.85)	<.0001	0.88 (0.85-0.92)	<.0001	0.88 (0.86-0.90)	<.0001	0.85 (0.83-0.86)	<.0001
Smoking history	1.56 (1.41-1.72)	<.0001	1.69 (1.53-1.86)	<.0001	1.17 (1.03-1.33)	.014	1.45 (1.37-1.55)	<.0001
Alcoholism	1.30 (1.05-1.59)	.0014	1.50 (1.31-1.72)	<.0001	1.84 (1.58-2.16)	<.0001	1.66 (1.52-1.82)	<.0001
Drug abuse	1.90 (1.63-2.22)	<.0001	1.93 (1.72-2.17)	<.0001	1.96 (1.68-2.29)	<.0001	1.96 (1.81-2.12)	<.0001
Psychiatric comorbidity	1.06 (0.94-1.20)	.32	0.99 (0.89-1.09)	.81	1.13 (0.97-1.31)	.11	1.13 (1.06-1.21)	.0003

Abbreviations: CI, confidence interval; OR, odds ratio.

TABLE 3 Unadjusted and adjusted logistic models for the outcome of 30-day all-cause readmission

DAMA at index admission, versus other discharge disposition:	Stroke			Epilepsy			TBI			All		
	OR (95% CI)	P-value		OR (95% CI)	P-value		OR (95% CI)	P-value		OR (95% CI)	P-value	
Unadjusted	2.00 (1.76-2.28)	<.0001		1.45 (1.27-1.66)	<.0001		1.99 (1.68-2.36)	<.0001		1.79 (1.65-1.94)	<.0001	
Adjusted for demographics ^a	2.06 (1.81-2.35)	<.0001		1.50 (1.31-1.71)	<.0001		2.14 (1.81-2.53)	<.0001		1.89 (1.74-2.05)	<.0001	
Adjusted for medical risk factors ^b	2.01 (1.77-2.29)	<.0001		1.50 (1.32-1.72)	<.0001		2.09 (1.76-2.47)	<.0001		1.84 (1.70-2.00)	<.0001	
Adjusted only for APRDRG severity	2.11 (1.85-2.39)	<.0001		1.51 (1.33-1.73)	<.0001		1.68 (1.43-1.98)	<.0001		1.82 (1.68-1.97)	<.0001	
Adjusted only for APRDRG mortality	2.20 (1.94-2.50)	<.0001		1.53 (1.34-1.74)	<.0001		1.83 (1.56-2.16)	<.0001		1.91 (1.76-2.06)	<.0001	
Adjusted for behavioral risk factors ^c	2.00 (1.76-2.28)	<.0001		1.46 (1.27-1.66)	<.0001		1.99 (1.68-2.36)	<.0001		1.79 (1.65-1.94)	<.0001	
Adjusted for psychiatric comorbidity ^d	2.00 (1.76-2.28)	<.0001		1.45 (1.27-1.66)	<.0001		1.99 (1.68-2.36)	<.0001		1.79 (1.65-1.94)	<.0001	

^aDemographics model adjusted for age, sex, insurance status, and median income for zip code.

^bMedical comorbidities model adjusted for demographics and atrial fibrillation or atrial flutter, diabetes mellitus, hypercholesterolemia, hypertension, myocardial infarction, peripheral vascular disease, and number of procedures.

^cBehavioral risk factors model adjusted for demographics, medical comorbidities, and smoking history, alcoholism, and drug abuse.

^dPsychiatric comorbidity model adjusted for demographics, medical comorbidities, behavioral risk factors, and psychiatric comorbidity.

found that younger male patients were more likely to be discharged AMA and that factors, such as pre-existing neurological conditions, a history of substance abuse, homelessness, previous neurosurgery, and injury severity score, were likely to increase the likelihood of multiple readmissions and ER visits. Onukwugha et al found that young age, male sex, self-pay/uninsured status, and psychosocial comorbidities were associated with increased likelihood of DAMA in stroke patients. They additionally found that patients who identified as non-Caucasian ethnicities were more likely to leave the hospital against medical advice.⁹ Aliyu's study of all cases of discharge against medical advice at a teaching hospital also revealed increased rates of DAMA among African American patients; however, a more recent study by Yuan et al found that after adjusting for possible confounders, African American patients were not at an increased risk of leaving AMA, and Hispanic and Asian/Pacific Islander patients had lower rates of DAMA relative to those of Caucasian patients.²³ Unfortunately, we were unable to explore the effects of ethnicity as these data are unavailable through the NRD.

We also found that DAMA at index admission was significantly associated with increased risk of 30-day all-cause readmission among all cohorts (adjusted OR 1.79, 95% CI: 1.65-1.94, $P < .0001$). Among the TBI cohort, 64 (4.97 percent) were readmitted at least once and left against medical advice. This is lower than the reported 30-day emergency room (ER) and/or readmission rate of 26.8 percent among TBI patients.⁶ This discrepancy is likely due to the exclusion of 30-day ER visits from our study, as our focus was on hospital readmission. Our reported 30-day readmission rate among neurological patients discharged AMA was 14.7 percent. This rate is slightly lower than the reported 30-day rate of 17.7 percent in a 5-year retrospective cohort of patients discharged from a Veterans Administration hospital¹ and 15-day rate of 21 percent at a general medicine service.²⁴ The cohorts used in these studies were predominantly male (96.8 and 80.0 percent, for the VA and general medicine service studies, respectively), which may contribute to the differences in the results. As this study was conducted using a national database, the findings we report here are generalizable. We also found that the most common reasons for 30-day readmission after DAMA at index admission were most often the same reason for the index admission. This is consistent with a previous study that reported that 95 percent of the readmissions within 15 days of DAMA and 69 percent of the readmissions within 90 days were for the same diagnosis as the initial one.²⁵

This study describes the prevalence of DAMA among patients with neurological disorders at index admission. Research studies like this one can offer important insight into the characteristics of patients at risk for DAMA, with the goal of improving discharge transition interventions being implemented nationally. This includes follow-ups through telephone calls or texting, home visits, and counseling with social workers. DAMA rates are lower if there is earlier communication between patients, the medical team, and caregivers. Patients who were initially led to believe that their hospitalizations would be shorter in length were more likely to leave AMA.⁴

Many of the interventions described in the literature have been employed to reduce DAMA in psychiatric patient populations, which

TABLE 4 Most common reasons for 30-day readmission after discharge against medical advice at index admission

	Stroke index admission		Epilepsy index admission		TBI index admission	
	Primary diagnosis	Percent	Primary diagnosis	Percent	Primary diagnosis	Percent
1	Acute cerebrovascular disease	40.83	Epilepsy; convulsions	42.24	Intracranial injury	28.9
2	Occlusion or stenosis of precerebral arteries	4.84	Alcohol-related disorders	6.14	Alcohol-related disorders	8.67
3	Hypertension with complications and secondary hypertension	3.81	Mood disorders	4.33	Acute cerebrovascular disease	5.78
4	Transient cerebral ischemia	3.46	Substance-related disorders	4.33	Other nervous system disorders	3.47
5	Cardiac dysrhythmias	2.08	Schizophrenia and other psychotic disorders	3.97	Skull and face fractures	3.47
6	Congestive heart failure; nonhypertensive	2.08	Other nervous system disorders	2.89	Mood disorders	3.47
7	Late effects of cerebrovascular disease	2.08	Cardiac dysrhythmias	1.81	Epilepsy; convulsions	2.89
8	Epilepsy; convulsions	1.73	Aspiration pneumonitis; food/vomitus	1.44	Delirium, dementia, and amnestic and other cognitive disorders	2.89
9	Acute myocardial infarction	1.73	Respiratory failure; insufficiency; arrest (adult)	1.44	Substance-related disorders	2.89
10	Nonspecific chest pain	1.73	Skin and subcutaneous tissue infections	1.44	Skin and subcutaneous tissue infections	1.73

suffer from higher rates of DAMA than medical patient populations. Two successful interventions that have reduced DAMA rates in psychiatric patients are utilizing a “nurse patient liaison” or “consultation-liaison psychiatrist,” whose roles were to address patients’ preconceptions, fears, and complaints regarding hospitalization.²⁵ Given that psychiatric comorbidities often exist in medical patients who leave the hospital AMA, it may be useful to explore the effectiveness of implementing them in all hospital settings for at-risk individuals. Interventions to reduce repeat DAMA targeted at patients with a history of DAMA and psychiatric diagnosis may be an effective way to reduce readmission rates.

The major strengths of this study are its use of a large, nationally representative, contemporary cohort, its accurate categorization of neurological diseases, and its accurate determination of DAMA. The major limitation of this study is the utilization of administrative billing codes to identify medical conditions. Although we used validated billing codes from other studies, the use of coding clusters for identification of diagnoses can be imperfect. Moreover, we primarily studied the outcome of 30-day all-cause readmission, which may not accurately estimate the full spectrum of negative health outcomes related with discharge AMA among neurological patients. Patients who leave AMA also have more emergency department visits; because we only examined hospital discharge records, these visits were not captured in our analyses. Finally, the NRD does not allow for longitudinal analysis across multiple years, which limits one’s ability to identify all readmissions within a year.

Discharge against medical advice is an important medical issue that can have significant implications for patient outcomes. Future discharge transition interventions should target neurological patients with these risk factors to decrease rates of DAMA and improve outcomes.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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