Predictors for readmissions after video-EEG monitoring

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ABSTRACT

Objective: Identification of variables prognosticating 30-day readmission among adult patients admitted for video-EEG (VEEG) monitoring at a major epilepsy center.

Methods: A retrospective cohort study was conducted, examining 865 consecutive admissions to the epilepsy monitoring unit (EMU) from January 2010 to June 2013. Data extracted from chart review included demographics, length of stay (LOS), seizure type(s), number of 30-day readmissions or emergency department (ED) visits and reasons for these, and patient and system/provider factors potentially contributing to the readmission.

Results: Of 865 elective admissions for VEEG monitoring, 49 patients accounted for 33 readmissions and 40 ED visits within 30 days of discharge for an overall 30-day encounter rate of 7.0% after excluding those lost to follow-up; 9 patients had more than one ED visit or readmission. Statistically significant risk factors for urgent 30-day encounters included a history of nonepileptic seizures (NES) (odds ratio [OR] 1.9, 95% confidence interval [CI] 1.1–3.4), a dual diagnosis of both epilepsy and NES (OR 5.9, 95% CI 3.0–11.8), an urgent index admission to the EMU (OR 2.5, 95% CI 1.4–4.8), and a shorter LOS of index hospitalization (median 4.0 days vs 5.0 days, $p < 0.01$). The most common contributing patient factors included active psychiatric symptoms, medically refractory epilepsy, and living alone; the most common hospitalization-related factors included antiepileptic drug (AED) treatment adverse events or AED adjustment.

Conclusions: In addition to the presence of intractable epilepsy and shorter LOS, mental health comorbidities and the presence of NES were important risk factors for 30-day readmissions and ED visits in the epilepsy population. Therefore, proactively addressing mental health comorbidities may decrease urgent health care utilization after VEEG monitoring. *Neurology*® 2014;83:450–455

GLOSSARY

AED = antiepileptic drug; **CI** = confidence interval; **CMS** = Centers for Medicare & Medicaid Services; **DHEC** = Dartmouth-Hitchcock Epilepsy Center; **DHMC** = Dartmouth-Hitchcock Medical Center; **ED** = emergency department; **EMU** = epilepsy monitoring unit; **LOS** = length of stay; **NES** = nonepileptic seizures; **OR** = odds ratio; **VEEG** = video-EEG.

United States hospital readmission rates within 30 days of discharge are estimated to approach 20%, and many readmissions are preventable.¹ The Centers for Medicare & Medicaid Services (CMS) initiated the Hospital Readmission Reduction Program in 2012, which financially penalizes hospitals with excessive hospital readmissions, dramatically heightening our awareness of care transitions.² The majority of hospitals in the United States have undertaken readmission reduction collaboratives given the national priority to reduce hospital readmissions. Neurology-specific readmission reduction programs are increasingly becoming commonplace,^{3,4} and CMS has moved forward with using 30-day readmission rates for stroke starting in fiscal year 2016.³

Patients face numerous challenges after hospital discharge, some of which may be unrelated to their initial reason for hospitalization, which can predispose them to readmission.⁵ Patients with epilepsy represent a particularly vulnerable population given the complexity of medication regimens and safety instructions, the toxicity of therapies, the potential for breakthrough seizures in refractory epilepsy, and the high prevalence of underlying cognitive dysfunction and

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psychiatric comorbidities. Consequently, the potential for bounce-back readmissions and emergency department (ED) visits could be significant, warranting further research in this area.^{6–9} However, little is known about the factors that may predispose patients with epilepsy to unexpected readmissions.

Our objective was to identify predictors of readmissions or ED visits within 30 days following inpatient admission for video-EEG (VEEG) monitoring at Dartmouth-Hitchcock Epilepsy Center (DHEC).

METHODS Setting. The study was conducted at DHEC at Dartmouth-Hitchcock Medical Center (DHMC), an academic medical center in New Hampshire. DHEC is the only level 4 epilepsy center in northern New England (New Hampshire, Maine, and Vermont) and serves a rural population. The 5-bed adult epilepsy monitoring unit is staffed by 4 attending physicians, a fellow, dedicated nursing staff, and a care coordinator.

Standard protocol approvals, registrations, and patient consents. Data collection methods were reviewed and approved by the Committee for the Protection of Human Subjects at Dartmouth College.

Data collection. A review of the DHMC epilepsy monitoring unit (EMU) database, maintained by DHEC, was undertaken to retrospectively identify 865 consecutive adult patients who were admitted to the DHMC EMU for 24-hour VEEG monitoring between January 2010 and June 2013. We excluded patients younger than 18 years. Patients admitted and monitored on other services (including general medicine and critical care) for other neurologic conditions were excluded. Baseline characteristics including age, sex, insurance status, and seizure type(s) were extracted from the electronic medical record. To identify patients who had a 30-day urgent posthospitalization encounter (defined as a hospital readmission or an ED visit not resulting in admission within 30 days of the index EMU hospitalization), we used 2 methods: (1) query of administrative data, which included DHMC and regional affiliated hospitals, and (2) manual chart extraction and review of telephone notes occurring within 30 days and follow-up clinic notes, which were manually reviewed to capture any additional readmissions or ED visits, including those that occurred at community hospitals outside the Dartmouth-Hitchcock health system. For patients with a 30-day urgent posthospitalization encounter, we manually reviewed all available documentation regarding the index hospitalization and extending to 30 days posthospitalization to determine the primary reason for the urgent encounter and contributing factors.

Based on existing literature¹⁰ as well as observations from our own recent quality improvement initiative examining our discharge process for patients with epilepsy,¹¹ we preemptively created a checklist of contributing factors that could potentially influence health care utilization after hospital discharge. This checklist for “potential contributing factors” was based on literature review and ongoing work at Massachusetts General Hospital, State Action on Avoiding Readmissions.¹² This checklist was used to guide the chart review and extract data. Patient-related factors extracted included the type of epilepsy or seizures, comorbid conditions, treatment, adherence to treatment, refractoriness to treatment,

employment, living situation, and social support. Hospitalization-related factors extracted included type of antiepileptic drug (AED) adjustments made during index hospitalization, side effects of AED treatment, quality of written discharge instructions, errors made in discharge instructions or medication instructions, medical complications resulting from the hospitalization (including hospital-acquired infections and deep vein thrombosis), and whether appropriate neurology follow-up was scheduled.

Statistical analysis. A χ^2 analysis was used to compare dichotomous baseline data variables between VEEG admissions who had 30-day posthospitalization emergent encounters ($n = 49$) and those who did not ($n = 816$). For variables in which there were fewer than 5 subjects, a Fisher exact test was used. Odds ratios (ORs) and their 95% confidence intervals (CIs) were also calculated. A 2-tailed independent group t test was used to compare normally distributed continuous data variables. A Mann-Whitney test was used to compare nonparametric data such as length of stay (LOS). A p value of less than 0.05 was considered significant. A logistic regression to adjust for variables such as seizure type was not performed due to the small sample size in the readmission cohort.

RESULTS Of 865 elective admissions for VEEG monitoring, 49 patients accounted for 33 readmissions and 40 ED visits within 30 days of discharge. Nine patients had more than one 30-day urgent encounter after their index EMU admission and 3 patients had more than one EMU encounter with an associated 30-day readmission or ED visit. Of note, 19% were lost to follow-up or had follow-up outside our system with no postadmission encounters available for review; excluding these patients, the rate of 30-day encounters was 7.0%. Patients with urgent 30-day encounters were more likely to have been admitted or seen in the ED in the 12 months prior to the index hospitalization; there was no statistically significant difference in age, sex, or insurance status (table 1). An urgent index admission to the EMU was more likely to be associated with an urgent 30-day encounter (OR 2.5, 95% CI 1.4–4.8). Patients with a 30-day urgent encounter had a statistically significant shorter LOS for the index EMU hospitalization (median LOS 4 days, interquartile range 3–5 days) compared to control VEEG admissions (median LOS 5 days, interquartile range 4–7 days; $p < 0.01$); average LOS was also no different between readmitted patients who had been initially admitted urgently and those whose index EMU hospitalization was planned. Patients with any history of nonepileptic seizures or spells (NES) were more likely to be readmitted (OR 1.9, 95% CI 1.1–3.4), and a dual diagnosis of both epilepsy and NES was more frequent in patients who were readmitted (28.6% vs 6.3% in controls, OR 5.9, 95% CI 3.0–11.8). Primary generalized epilepsy was the only specific epilepsy type more common among readmissions, which may be due to the fact that 4 of the 6 readmissions with primary generalized epilepsy had a dual diagnosis of comorbid NES.

Table 1 Baseline characteristics of patients with 30-day ED visits or readmissions compared to elective VEEG admissions without readmissions (controls)

Characteristic	30-day ED visits and readmissions (N = 49)	VEEG admission controls (N = 816)	p Value
Median age, y	37.1 ± 13.3	40.5 ± 14.9	>0.1
% Male	46.9	41.7	>0.1
Insurance, %			
Medicare	40.8	34.4	>0.1
Medicaid	16.3	21.7	>0.1
Commercial	34.7	33.1	>0.1
Self-pay	4.1	4.6	>0.1
Other	4.1	5.5	>0.1
Average no. of ED encounters 12 months prior	1.1 ± 1.8 (range 0–8)	0.2 ± 0.6 (range 0–7)	<0.001 ^a
Average no. of admissions 12 months prior	0.8 ± 1.2 (range 0–6)	0.2 ± 0.6 (range 0–4)	<0.001 ^a
Acuity of admission, %			
Planned	67.3	80.3	0.01 ^a
Urgent (ED or OSH transfer)	30.6	15.8	0.002 ^a
Depth electrode implantation, %	2.0	3.9	NT
Median LOS, d (1st, 3rd quartile)	4.0 (3, 6)	5.0 (4, 7)	<0.01 ^a
Primary diagnosis at hospital discharge, %			
All epilepsy syndromes	71.4	59.8	0.1
Primary generalized epilepsy	14.3	5.6	0.01 ^a
Symptomatic generalized epilepsy	2.0	3.5	>0.1
Focal epilepsy	55.1	50.8	>0.1
Nonepileptic seizures (NES) only	26.5	31.9	>0.1
Undetermined diagnosis	0.0	4.2	>0.1
Other medical diagnosis	2.0	4.1	>0.1
Any history of NES (with or without epilepsy)	55.1	39.2	0.02 ^a
Dual diagnosis (NES + epilepsy)	28.6	6.3	<0.002 ^a

Abbreviations: ED = emergency department; LOS = length of stay; NT = statistical testing not performed due to low number of subjects; OSH = outside hospital; VEEG = video-EEG.

^ap < 0.05, statistically significant.

The most common primary reasons for 30-day urgent encounters as described in table 2 were breakthrough seizures (28.8% of encounters), recurrent or new-onset NES (26.0%), active psychiatric symptoms (depression, psychosis, or suicidal ideation; 20.5%), AED treatment complication (6.8%), and medical complication resulting from hospitalization (1.4%). Three patients had terminated their initial VEEG admission early against medical advice because of anxiety or agitation and had to be electively readmitted for VEEG monitoring. Other medical reasons unrelated to epilepsy accounted for 15.1% of ED visits and readmissions, most commonly motor vehicle collisions, which occurred in 2 patients with NES and 1 patient with focal seizures who had been instructed not to drive. Of the 33 readmissions, 22 were readmitted to neurology, 6 were readmitted to psychiatry, and 3 were readmitted to medicine or other inpatient services.

The most common patient-related factors associated with urgent posthospitalization encounters were active psychiatric symptoms (including suicidal ideation, severe symptoms of depression and anxiety, and psychosis), medically refractory epilepsy, other medical comorbidities (including cancer and injuries), and living alone (table 3). All but one of the patients with breakthrough seizures had medically refractory epilepsy; 3 readmissions for breakthrough seizures were the result of patient nonadherence with discharge or medication instructions. Of patients with 30-day urgent encounters, 27% had a preexisting psychiatric diagnosis and all of these patients received psychiatry consultation or admission at the time they presented, while 39% were subsequently followed by a psychiatrist after their index admission. Of patients re-presenting with active psychiatric symptoms, 50% had received an inpatient psychiatry consultation

Table 2 Primary reason for 30-day posthospitalization urgent encounters (readmissions and ED visits)

Primary reason for 30-day urgent encounter	% (N = 73)
Breakthrough epileptic seizure	28.8
Nonepileptic seizure	26.0
Active psychiatric issue	20.5
Other medical condition	15.1
AED treatment side effect or complication	6.8
Left first admission against medical advice	4.1
Complication of hospitalization	1.4

Abbreviations: AED = antiepileptic drug; ED = emergency department.

during their index hospitalization. The majority of patients presenting with recurrent NES had active psychiatric symptoms as well, and 63% required urgent psychiatric consultation or involvement. The most common admission- or provider-related factors included complications from AED therapy and either initiating or discontinuing an AED upon discharge from the index hospitalization (table 3). One patient with depth electrodes implanted was readmitted for a deep vein thrombosis following his EMU admission; no hospital-acquired infections or other hospital-related complications were identified.

DISCUSSION There is a paucity of studies that have examined factors to reduce readmissions for neurologic

conditions, and to date no studies have investigated factors associated with unexpected readmissions in patients with epilepsy. Preventing a hospital readmission reduces the cost of health care and benefits not only the patient but also care providers, hospitals, and other potential patients that might better utilize the valuable resource of a hospital bed. Furthermore, traditional definitions of readmission may miss other opportunities to decrease health care utilization and costs, and many ED encounters may generate preventable medical expenditures. When patients require readmission, often it is not directly attributable to a personal failure on the part of either the patient or the care provider but rather is multifactorial.

Our aim was to understand the characteristics that drive 30-day readmissions as well as bounce-back ED visits in this population. This is of importance given that a large proportion of patients admitted to EMUs are electively invited for admission, so it is imperative that the experience be as safe and low risk as possible. While it is not surprising that breakthrough seizures constitute a common reason for epilepsy readmissions and ED visits, it is remarkable that active psychiatric issues and NES were also very common reasons for 30-day urgent posthospitalization encounters. Therefore, the optimal management of comorbid behavioral health symptoms may play a crucial role in the prevention of epilepsy readmissions. While there are no available readmissions data in the literature on patients with epilepsy, we hypothesize that potential readmissions could be prevented by more optimal assessment and treatment of comorbid psychiatric illnesses.

Epidemiologic studies have shown that depression represents the most common comorbid condition in epilepsy, with a prevalence ranging between 6% and 64%.^{13,14} In particular, it has been estimated that the incidence of depressive symptoms and suicidal ideation in patients with epilepsy is 4 to 5 times higher than in the general population or in patients with other neurologic disorders or chronic diseases.^{15,16} It has been approximated that upward of 50%–75% of patients with NES may have a diagnosable mental health disorder benefiting from psychiatric treatment.⁷ Our findings provide evidence that psychiatric comorbidities are strong drivers of post-hospitalization utilization of urgent health care services. This suggests that screening for mental health comorbidities may prognosticate which patients are at risk for readmission, and efforts to address untreated depression or anxiety in the inpatient setting prior to discharge could potentially prevent readmissions. Some epilepsy centers involve psychiatry in all patients admitted to the EMU, which potentially could be a cost-effective measure to prevent readmissions, particularly when targeted at patients with known psychiatric comorbidities and NES.

Table 3 Contributing factors associated with 30-day posthospitalization urgent encounters

Contributing factors	% of patients (N = 49)
Patient factor	
Active psychiatric symptoms (anxiety, depression, suicidal ideation)	51.0
Medically refractory epilepsy	51.0
Other chronic medical comorbidity (cancer, etc.)	33.3
Patient lives alone	28.6
Patient noncompliant with AEDs or instructions	8.2
Patient misunderstood instructions	2.0
System/provider factor	
AED treatment side effect	14.3
AED discontinued (epilepsy only)	12.2
New AED initiated	10.2
Error made in medication dose/taper/instructions	4.1
Preventable complication of hospitalization (DVT, infection)	2.0

Abbreviations: AED = antiepileptic drug; DVT = deep vein thrombosis.

There is wide variability among epilepsy centers regarding the duration of VEEG monitoring.¹⁷ Our study suggests a shorter length of hospitalization for VEEG monitoring as an increased risk for readmission. This remained true even after excluding patients who had left their initial admission against medical advice, and did not appear to reflect the urgency of the index hospitalization. It is possible that a longer duration of monitoring provides higher diagnostic yield, increasing the potential for either epileptic seizures or NES to be captured and appropriately diagnosed and treated. In particular, a number of patients carry a dual diagnosis of both epilepsy and NES, and a brief hospitalization may allow for one type of seizure to be captured but may not capture all types of spells that the patient is having or may not yield sufficient time to provide adequate education about the diagnosis. AEDs are also discontinued upon admission for monitoring, and it is possible that an expedited discharge does not provide proper time to retitrate AED levels to the preadmission therapeutic dose, making patients susceptible to breakthrough epileptic seizures. However, this would need to be studied systematically.

Our review of readmissions and ED visits for breakthrough seizures also identified potential areas for improvement. Having a clear seizure management plan for patients with refractory epilepsy at the time of discharge is important so that both patients and family/caregivers have a clear understanding of when it is appropriate to utilize urgent services. Increased contact between the clinic and the patient in the days following discharge could also potentially mitigate unnecessary visits, and increased communication could potentially benefit patients who live alone or do not have an adequate support structure. We are currently in the process of examining the effectiveness of a routine post-EMU discharge follow-up phone call.

There are many limitations to our study. It is challenging to capture all health care utilization that occurs at other hospitals, which can introduce limitations to hospital readmission data.¹⁸ We minimized this by reviewing telephone notes and follow-up clinic notes when available in the chart to attempt to capture outside hospital visits; however, it is likely that we were not able to capture all 30-day urgent encounters, and thus the actual readmission rate is underestimated. Another limiting factor of our study is that due to a low readmission rate, there was not a sufficient number of patients in the readmissions cohort to perform a reliable statistical test for some of the risk factors of interest. A larger prospective multicenter study could certainly address this.

In addition, it is difficult to accurately ascertain all contributing patient characteristics, including living situation, social support systems, functional abilities, and psychiatric comorbidities and other characteristics,

due to the inordinate burden of manual chart review. Thus, there may be missing data that a larger coordinated study may be better able to capture.

CONCLUSION In addition to the presence of intractable epilepsy and shorter LOS, mental health comorbidities and the presence of NES were identified as important risk factors for 30-day readmissions and ED visits in the epilepsy population. In addition to interventions targeting patients with refractory epilepsy, objective data emphasizes a need for mental health screening and concomitant behavioral health interventions to prevent readmissions or urgent encounters. A larger prospective multicenter study would help confirm these findings and provide further data to assist in preemptively identifying patients at risk for readmission in further improvement efforts.

AUTHOR CONTRIBUTIONS

Dr. Caller oversaw this study in its entirety from inception to completion. Dr. Chen co-wrote and provided substantial critical review of the article and collected and analyzed data. Mrs. Harrington collected and analyzed data. Dr. Bujarski provided substantial critical review of the article. Dr. Jobst provided substantial critical review and oversight over the project.

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DISCLOSURE

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