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Use of an Electronic Medical Record Alert to Prevent Iatrogenic Interventions in Patients With Psychogenic Nonepileptic Seizures

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Abstract

Background and Objectives

Seizures are a common presentation to the emergency department and the hospital setting. Psychogenic or functional seizures are often misdiagnosed as epileptic seizures or status epilepticus, and patients are subject to aggressive interventions including sedation, intubations, and prolonged hospital admissions. An electronic medical record (EMR) best practice alert (BPA) was implemented in 2016 for all patients with a confirmed diagnosis of psychogenic nonepileptic seizures (PNES) at Rush University Medical Center. It informs health care providers of the diagnosis and provides education on interacting with the patient's chart. This study evaluates the effectiveness of an EMR BPA in preventing iatrogenic interventions for patients with a diagnosis of PNES.

Methods

A retrospective chart review was performed on all patients who presented to Rush University Medical Center between January 2017 and December 2019 and had a PNES BPA triggered. Data on emergency department (ED) visits and inpatient admissions for these patients from the year before and the year after the first BPA trigger were compared. A Wilcoxon signed-rank test and McNemar test were used for analysis.

Results

A PNES BPA was triggered in 178 patients. One hundred and forty-three (80%) were female. The mean age was 41 (18–81) years. There was a decrease in the number of ED visits; hospital admissions; intensive care unit (ICU) admissions; and interventions such as intubations and rescue benzodiazepine use in the year after the BPA was first triggered compared with the previous year ($p < 0.05$). No adverse events were identified in relation to the BPA.

Discussion

This study demonstrates that the use of an EMR BPA can be safe and effective in preventing potential iatrogenic interventions and reducing acute health care utilization in patients with PNES. These BPAs can also be used as an educational tool to communicate the presentation, risks, and needs of these patients within the hospital setting.

Introduction

Patients with psychogenic nonepileptic seizures (PNES) have episodes of alteration of awareness and/or responsiveness, episodic movements, and changes in behavior that can resemble epileptic seizures. It should be noted that the terminology of PNES continues to evolve.[1,2] PNES, now also commonly referred to as functional seizures, are a recognized subtype of functional neurologic disorder (FND).

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Previous studies have found that making the diagnosis of PNES alone can reduce health care utilization and costs.[3-5] However, prognosis for these patients remains poor in our current health care environment. The misdiagnosis of functional seizures often results in patients being subject to iatrogenic interventions and treated with escalating antiseizure medications despite their lack of appropriate response.[6,7] It has been reported that 40% or less of adults with PNES achieve seizure freedom in the 5 years after diagnosis,[8] and patients with PNES have a 2.5-fold increased rate of mortality compared with the general population, a rate that is comparable with those with drug-resistant epilepsy.[9] Patients with PNES account for 20%–40% of admissions to inpatient epilepsy monitoring units (EMUs),[10] and 26%–50% of patients who are given a primary diagnosis of epileptic seizures in the emergency department (ED) actually present with PNES.[11]

The gold standard for the diagnosis of PNES is capturing a typical event on video EEG. As with other presentations of FND, functional seizures are a clinical diagnosis that should be made using positive signs as opposed to only a diagnosis of exclusion.[12] When compared with epilepsy specialists, ED staff without specific training are less likely to identify PNES. The experience of the clinician matters in the recognition of functional seizures,[13] which remain a challenge for health care professionals in the acute settings. Many note uncertainty and frustration over the diagnosis and management of PNES,[14] further highlighting the need for increased educational efforts and tools to aid in recognizing this condition, understanding its pathophysiology, and offering effective, evidence-based treatments.[15-17] The use of rescue medications during seizures can escalate to intubation and management in the intensive care setting,[18] all of which increase the risk of iatrogenic interventions and their complications.

In 2016, at Rush University Medical Center, a best practice alert (BPA) was implemented in the electronic medical record (EMR) for patients with PNES. When a diagnosis of PNES is entered for a given patient, the BPA is generated. Entering a PNES diagnosis is not limited to epileptologists, although it is often during EMU admissions that the diagnosis is made. Similar institutional BPAs were already in use, largely as executive summaries and specific care requirements for patients who were frequently admitted to the hospital or determined to be medically high risk. Other medical specialties have reported success using BPAs to reduce unnecessary or redundant laboratory and imaging testing.[19,20]

While it is commonly advised for patients with epilepsy to have and implement seizure action plans,[21] similar practices are not currently part of the standard of care in patients with functional seizures. The intention of the PNES BPA is to inform the health care teams of the diagnosis and to educate them regarding the presentation, pathophysiology, and risks to these patients in the hospital environment, as well as to prompt them to consider whether the acute presentation is consistent with functional seizures.

This study aims to investigate the effectiveness of such an alert in a large cohort of patients with PNES and its impact on iatrogenic interventions and health care resource utilization within our health care system.

Methods

Study Design

This was a single-center retrospective chart review of adult patients with PNES who presented to Rush University Medical Center between January 1, 2017, and December 31, 2019, and had a PNES BPA triggered in that time. When a provider opens the patient's chart for the first time during inpatient and ED encounters, the BPA appears noting the diagnosis and directs the provider to a document outlining PNES characteristics and management principles (Figure 1). The BPA does not prevent teams from taking any diagnostic or treatment action they consider necessary, nor does it discourage care. Demographic information and concomitant diagnosis of epilepsy were recorded. For each patient, data were collected at 2 time points in relation to the time of the first alert trigger: 12-month period before the first BPA trigger (t_1) and 12-month period after the first BPA trigger (t_2). Hospital resource utilization was determined by number of ED visits, hospital admissions, and ICU admissions. Potentially iatrogenic interventions were defined as number of intubations, instances of rescue benzodiazepines (BZDs), and number of prescribed outpatient antiseizure medications (ASMs).

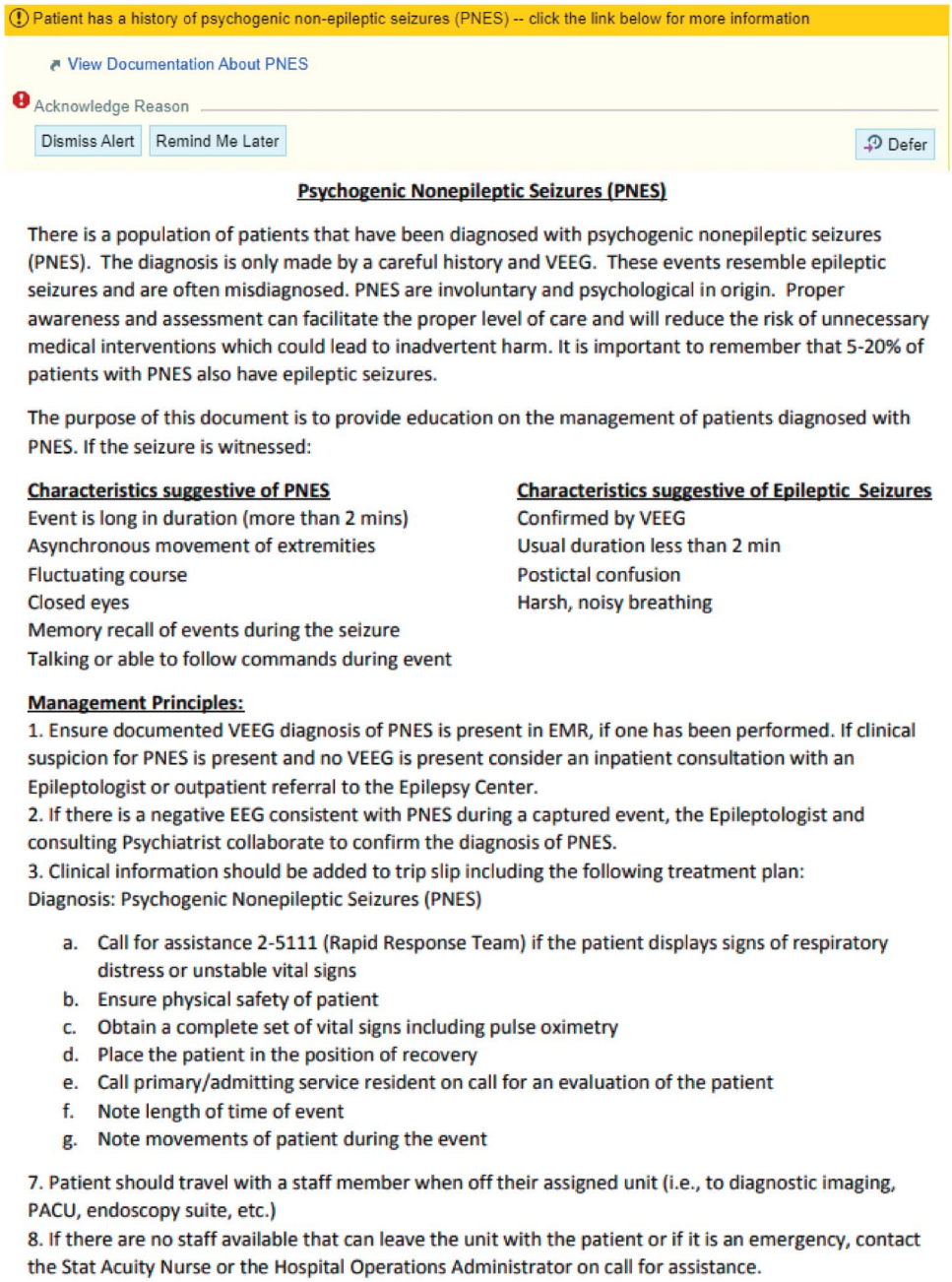
Statistical Analysis

Demographic data were summarized with descriptive statistics. Effectiveness of the PNES BPA was evaluated by comparing outcomes including ED visits, hospital admissions, ICU admissions, and intubations between t_1 and t_2. Outcomes were compared as continuous variables with the Wilcoxon signed-rank test. We also dichotomized the outcomes as none vs at least 1 and compared dichotomized outcomes with the McNemar test. The same statistical analyses were performed while excluding the 41 patients with a t_2 after the start of the COVID-19 pandemic. Relationships between demographics and change in those outcomes, i.e., change between t_1 and t_2, were also examined with the Wilcoxon rank-sum test or χ^2 test. A p value <0.05 was considered statistically significant. All analyses were performed with SAS 9.4 (SAS Institute Inc., Cary, NC).

Standard Protocol Approvals, Registrations, and Patient Consents

The study protocol was reviewed and approved by Rush University Medical Center's Institutional Review Board. Participant informed consent was waived as determined by the review board.

Figure 1 PNES Best Practice Alert and Educational Instrument



PNES = psychogenic nonepileptic seizures.

Data Availability

Anonymized data not published within this article will be made available by request from any qualified investigator.

Results

Demographics

Of the patients who presented to the hospital during the study period, 178 met inclusion criteria and were included in the final data set. The mean age was 41 (range: 18–81) years with a female predominance (n = 143%, 80%). Among the total patients, 67 (37%) had coexisting epilepsy (Table 1).

Potentially Iatrogenic Interventions

Median, interquartile range, and ranges of studied interventions are provided in Table 2 for the 12 months preceding (t_1) and the 12 months after (t_2) the date of the first BPA trigger. A reduction in both the number of intubations ($p = 0.03$) and the total instances of rescue BZDs given ($p < 0.0001$) was evident at t_2. Patients with PNES also had a median of 2 ASMs included in their medication list at t_1, compared with a median of 1 ASM at t_2 ($p < 0.0001$).

The total percentage of patients who received any given intervention at least once at t_1 compared with t_2 is presented in

Table 1 Demographics

Total patients, n	**178**
Age, mean (SD)	41 (14)
Race, n (%)	White: 100 (66)
	Black: 46 (30)
	Asian: 2 (1)
	More than one race: 2 (1)
	American Indian/Alaska Native: 1 (1)
	Unreported: 28
Sex, n (%)	Female: 143 (80)
	Male: 35 (20)
Concomitant epilepsy, n (%)	67 (38)

Table 3 and Figure 2. Thirty-one percent of study patients were given at least one rescue BZD before the BPA, compared with only 5% of patients after the BPA ($p < 0.001$). Likewise, the percentage of patients who were intubated at least once decreased from 3% to 1% ($p < 0.05$). No reports of missed epileptic seizures, deaths, respiratory failure, or delayed intubations were found among these populations during the studied time.

Utilization of Health Care Resources

The median number of total presentations to the ED decreased from 1 before the BPA to 0 after the BPA ($p < 0.0001$). The number of total hospital admissions and specific ICU admissions also decreased ($p < 0.0001$).

Table 3 provides the total percentage of patients who presented to the ED, were admitted to the hospital, or were admitted to the ICU for any reason at least once at t_1 and t_2. Overall, there was a reduction in the percentage of patients who used health care resources in the period after the BPA ($p < 0.001$). Of the 178 patients with PNES who met inclusion criteria, 71% of patients presented to the ED at least once at t_1 compared with 32% of patients at t_2. Sixty-nine percent of patients were admitted to the hospital, including planned admissions to the EMU at t_1 while 18% were admitted at t_2. Patients after the BPA were also less likely to be admitted or transferred to an ICU: 11% of patients at t_1 and only 1% at t_2.

Demographic Associations

Younger patients were more likely to decrease the number of ED visits in the time after the BPA ($p = 0.002$). For the 108 patients who had a reduction in the total number of ED visits, the average age was 38 years, whereas the average age for patients who showed no change (n = 47) or increased their ED visits (n = 22) was 45 years. Younger patients were also more likely to have a reduction in the number of instances a rescue BZD was administered. The average age of patients who were given fewer BZDs after the BPA was 37 years, compared with an average age of 42 and 41 years for patients who had, respectively, no change and an increase in BZDs received ($p = 0.04$).

Women were more likely than their male counterparts to have a decrease in the number of prescribed ASMs after the BPA. 46% of women compared with 17% of men had fewer documented ASMs at t_2 ($p = 0.01$).

Notably, patients with only a diagnosis of PNES were also more likely than patients with both PNES and epilepsy to decrease their total number of ED visits in the time after the BPA ($p = 0.01$). No other significant differences were found between these 2 groups.

Role of COVID-19 Pandemic

When we excluded the 41 patients for whom t_1 or t_2 occurred after the start of the COVID-19 pandemic (Tables 4 and 5), there was still a reduction in the number of ED visits, hospital and ICU admissions, instances of rescue BZD use, and number of ASMs in their medication lists ($p = 0.001$). However, there was no significant change in the number of intubations ($p = 0.17$).

Table 2 Comparison of Interventions Before and After PNES BPA Implementation

Intervention	t_1 median, IQR, range	t_2 median, IQR, range	Raw *p* value	FDR-adjusted *p* value
ED visits	1, 4, 0-31	0, 1, 0-25	<0.0001	<0.0001
Hospital admissions	1, 2, 0-12	0, 0, 0-6	<0.0001	<0.0001
ICU admissions	0, 0, 0-10	0, 0, 0-2	<0.0001	<0.0001
Intubations	0, 0, 0-9	0, 0, 0-1	0.03	0.03
ASMs	2, 1, 0-7	1, 2, 0-5	<0.0001	<0.0001
Rescue BZDs	0, 1, 0-37	0, 0, 0-17	<0.0001	<0.0001

Abbreviations: ASMs = antiseizure medications; BPA = best practice alert; BZDs = benzodiazepines; ED = emergency department; FDR = false discovery rate; IQR = interquartile range; PNES = psychogenic nonepileptic seizures; t_1 = 12-month period before first BPA trigger; t_2 = 12-month period after first BPA trigger.

Table 3 Dichotomized Comparison of Interventions Before and After PNES BPA Implementation

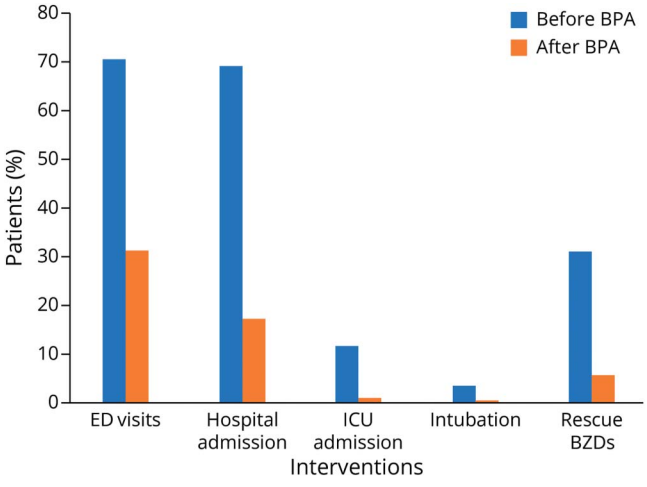
Intervention	t_1, n (%)	t_2, n (%)	Raw *p* value	FDR-adjusted *p* value
ED visits				
0	52 (29)	121 (68)	<0.0001	<0.0001
≥1	125 (71)	56 (32)		
Hospital admissions				
0	52 (31)	145 (82)	<0.0001	<0.0001
≥1	122 (69)	32 (18)		
ICU admissions				
0	155 (88)	174 (99)	<0.0001	<0.0001
≥1	21 (12)	2 (1)		
Intubations				
0	168 (97)	173 (>99)	0.03	0.03
≥1	6 (3)	1 (<1)		
Rescue BZDs				
0	119 (69)	163 (94)	<0.0001	<0.0001
≥1	54 (31)	10 (6)		

Abbreviations: BPA = best practice alert; BZDs = benzodiazepines; ED = emergency department; FDR = false discovery rate; PNES = psychogenic nonepileptic seizures; t_1 = 12-month period before first BPA trigger; t_2 = 12-month period after first BPA trigger.

Discussion

Psychogenic nonepileptic seizures are common, with frequent occurrences in the hospital environment that are not exclusive to the neurology or psychiatry units. The levels of familiarity with FND and functional seizures, their presentation, and treatment vary among different health care units and teams.[11,13] Patients with PNES are at risk of aggressive care escalation and potentially iatrogenic interventions.[6,18] This retrospective study at a single large epilepsy center suggests that the use of an EMR BPA can be an effective strategy to reduce these iatrogenic interventions, including hospital and ICU admission, intubations, use of rescue BZDs, and outpatient ASMs.

Figure 2 Percentage of Patients Receiving Interventions Before and After PNES BPA Implementation



PNES = psychogenic nonepileptic seizures.

Previous studies have shown that diagnosing PNES can decrease care utilization, including a decrease in ED visits in the 6 months, 2 years, and 6 years after diagnosis.[5,22] Using the first time the PNES BPA is displayed in our system as a surrogate for the time of PNES diagnosis, this study shows a reduction in ED visits in the 12 months after making the diagnosis, supporting previous findings.

As expected, the effect of the intervention was less obvious in patients with concomitant PNES and epilepsy who were more likely to present to the ED after the intervention, although those patients also showed improvement in other outcome measures similar to the group with pure PNES. We demonstrate the safety of the EMR intervention with no missed intubations, unrecognized status epilepticus, nor deaths documented.

BPAs are an effective way to communicate and educate diverse health care teams about the presentations, needs, and risks of specific populations, such as patients with PNES. Previous studies have shown effectiveness of BPAs in reducing health

Table 4 Comparison of Interventions Before and After PNES BPA Implementation, Excluding Patients Potentially Affected by the COVID-19 Pandemic

Intervention	t_1 median, IQR, range	t_2 median, IQR, range	*p* Value
ED visits	1, 3, 0–31	0, 1, 0–25	<0.001
Hospital admissions	1, 2, 0–11	0, 0, 0–6	<0.001
ICU admissions	0, 0, 0–4	0, 0, 0–1	0.001
Intubations	0, 0, 0–2	0, 0, 0–0	0.17
ASMs	2, 1, 0–7	1, 2, 0–5	<0.001
Rescue BZDs	0, 1, 0–22	0, 0, 0–3	<0.001

Abbreviations: ASMs = antiseizure medications; BPA = best practice alert; BZDs = benzodiazepines; ED = emergency department; IQR = interquartile range; PNES = psychogenic nonepileptic seizures; t_1 = 12-month period before first BPA trigger; t_2 = 12-month period after first BPA trigger.

care utilization in other areas of medicine.[19,20] Teams at our institution are familiar with other EMR BPAs that previously existed for high-risk patient populations and have accepted the PNES alerts throughout the hospital environment.

Limitations of our study include its scope as a single-center study. We collected data on all medical care utilization and interventions regardless of their relation to PNES to minimize subjectivity across multiple chart reviewers. We also expected that other medical comorbidities would remain relatively constant in the periods before and after the PNES BPA. We included patient presentations and admissions to other hospitals that were linked through the CareEverywhere system, but it is likely not a comprehensive collection of resource utilization data from all other institutions in our city.

Our study design does not allow for a direct conclusion that the EMR BPA is causative for the improvement in our cohort. One potential confounding factor in particular is differentiating the effects of the PNES BPA from those of making the diagnosis of PNES, which alone has been shown to decrease ED visits.[5] Diagnosis alone may also reflect the decrease in number of ASMs prescribed while the effects of the BPA may be more accurately seen in provider-driven health care utilization, i.e., use of rescue medications, intubations, and hospital or ICU admissions. Furthermore, we have limited options to offer to patients with FND, which may discourage them over time to seek ED and inpatient care; this is not unique to our institution.

The COVID-19 pandemic and resulting stay-at-home orders issued are other potential confounders because patients were less likely to present to hospitals during that time. To

Table 5 Dichotomized Comparison of Interventions Before and After PNES BPA Implementation, Excluding Patients Potentially Affected by the COVID-19 Pandemic

Intervention	t_1, n (%)	t_2, n (%)	*p* Value
ED visits			
0	43 (31)	97 (71)	<0.001
≥1	94 (69)	40 (29)	
Hospital admissions			
0	46 (34)	122 (82)	<0.001
≥1	91 (66)	25 (18)	
ICU admissions			
0	123 (90)	135 (>99)	0.001
≥1	13 (10)	1 (<1)	
Rescue BZDs			
0	92 (69)	126 (95)	<0.001
≥1	41 (31)	7 (5)	

Abbreviations: BPA = best practice alert; BZDs = benzodiazepines; ED = emergency department; PNES = psychogenic nonepileptic seizures; t_1 = 12-month period before first BPA trigger; t_2 = 12-month period after first BPA trigger.

TAKE-HOME POINTS

- Patients with psychogenic nonepileptic seizures (PNES) are often misdiagnosed and subject to aggressive interventions and costly diagnostic testing in the emergency department (ED) and inpatient setting.
- After the implementation of an institution-wide electronic medical record (EMR) best practice alert (BPA) for patients with PNES, there was a reduction in ED visits, hospital and intensive care unit admissions, intubations, and use of rescue benzodiazepines.
- An EMR BPA can be a safe and effective tool in preventing iatrogenic interventions and reducing acute health care utilization in patients with PNES.

account for these factors, we reanalyzed the data excluding the patients with dates within 12 months of March 21, 2020, the date of Chicago's first stay-at-home order at the start of the pandemic. Adjusted results for the remaining 106 patients were comparable with the original results with a reduction in all variables except number of intubations, of which there was no significant change.

In conclusion, our study demonstrates that the implementation of an EMR BPA can be safe and effective in reducing potentially iatrogenic interventions and acute health care resource utilization for patients with PNES. These alerts can be used as an educational tool to communicate the presentation, risks, and needs of a vulnerable patient population within the hospital setting.

In the future, we would like to follow these patients further to facilitate access to the resources that are likely to help them overcome their conditions. In pediatric patients, providing specialized care through a multidisciplinary team in a PNES clinic has been shown to decrease health care utilization.[23] Studies like this one will contribute to highlight the needs of this population and hopefully to the expansion of treatment services that will allow them to recover and thrive.

Author Contributions

S. Yin: drafting/revision of the manuscript for content, including medical writing for content; major role in the acquisition of data; study concept or design. L. Wolkiewicz: major role in the acquisition of data; study concept or design. B. Ouyang: analysis or interpretation of data. A. Bermeo-Ovalle: drafting/revision of the manuscript for content, including medical writing for content; study concept or design.

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