

Single-center Single-reader Prolonged Pediatric Routine EEGs and Long-Term Outcomes



Emily Gost^{1,2}, Laura C Swanson MD, PhD^{1,2}, Cynthia Stack MD^{1,2}, Joyce Y. Wu MD^{1,2}

¹Department of Pediatrics, Ann & Robert H. Lurie Children's Hospital of Chicago, ²Northwestern University Feinberg School of Medicine



INTRODUCTION

Routine EEGs (rEEG) serve as an essential diagnostic tool for individuals suffering from epilepsy. They provide medical professionals with crucial information to accurately diagnose the condition, can aid in the distinguishing specific types of epilepsies, and create a suitable treatment plan. However, there is a growing concern about the tendency to overinterpret EEGs, often leading to misdiagnosis¹. Interictal discharges are commonly misinterpreted but serve as a significant marker for diagnosing epilepsy. Studies show that around 1.9-3.5% of interictal discharges are missed on pediatric routine EEGs compared to 0.5% on adult EEGs².

This unique circumstance at our institution provides insight into single-reader predictive values for pediatric, routine EEGs (rEEGs) compared to multiple readers that are commonly utilized at large institutions. This research is essential to enhance the diagnostic accuracy of pediatric rEEGs.

Methods

In a retrospective cohort study of children that completed a standardly prolonged (61 min) rEEG during the calendar year 2014 at our institution (n=1837), all interpreted by the same experienced board-certified pediatric clinical neurophysiologist (CS), key characteristics and outcomes from electronic medical records in the intervening years up to 2023 were extracted to include pre- and post-Covid-19 pandemic years. Seizure outcomes were categorized as: 1) never developed epilepsy with follow-up, 2) no follow-up, 3) developed epilepsy on anti-seizure medication (ASM), 4) developed epilepsy off ASM, and 5) Single event concerning for seizure, no formal diagnosis of epilepsy. Additional factors including referring provider, age at time of rEEG, rEEG features interictal discharges and slowing, and epilepsy etiology were documented when available.

References

- Benbadis SR, Beniczky S, Bertram E, MacIver S, Moshé SL. The role of EEG in patients with suspected epilepsy. *Epileptic Disord.* 2020 Apr 1;22(2):143-155. doi: 10.1684/epd.2020.1151. PMID: 32364504.
- JJ. Pillai, M.R. Sperling. Interictal EEG and the diagnosis of epilepsy. *Epilepsia*, 47 (s1) (2006), pp. 14-22

RESULTS

Table 1. Demographics and clinical characteristics

Average age at time of rEEG	7.05 years
Males	49.56%
Abnormal rEEG	37.67%
rEEG with seizure captured	3.69%
Percent of individuals diagnosed with epilepsy	51.3%
Percent of individuals without epilepsy*	34.5%

*excludes deceased individuals, or those with an isolated event

Table 2. Abnormal rEEG association with Epilepsy Diagnosis**

Positive Predictive Value	84%
Negative Predictive Value	59%
Sensitivity	64%
Specificity	80%

**Statistics calculated only for individuals with confirmed follow-up (n=630), excludes deceased individuals or those with an isolated event

Percentage of rEEG referrals

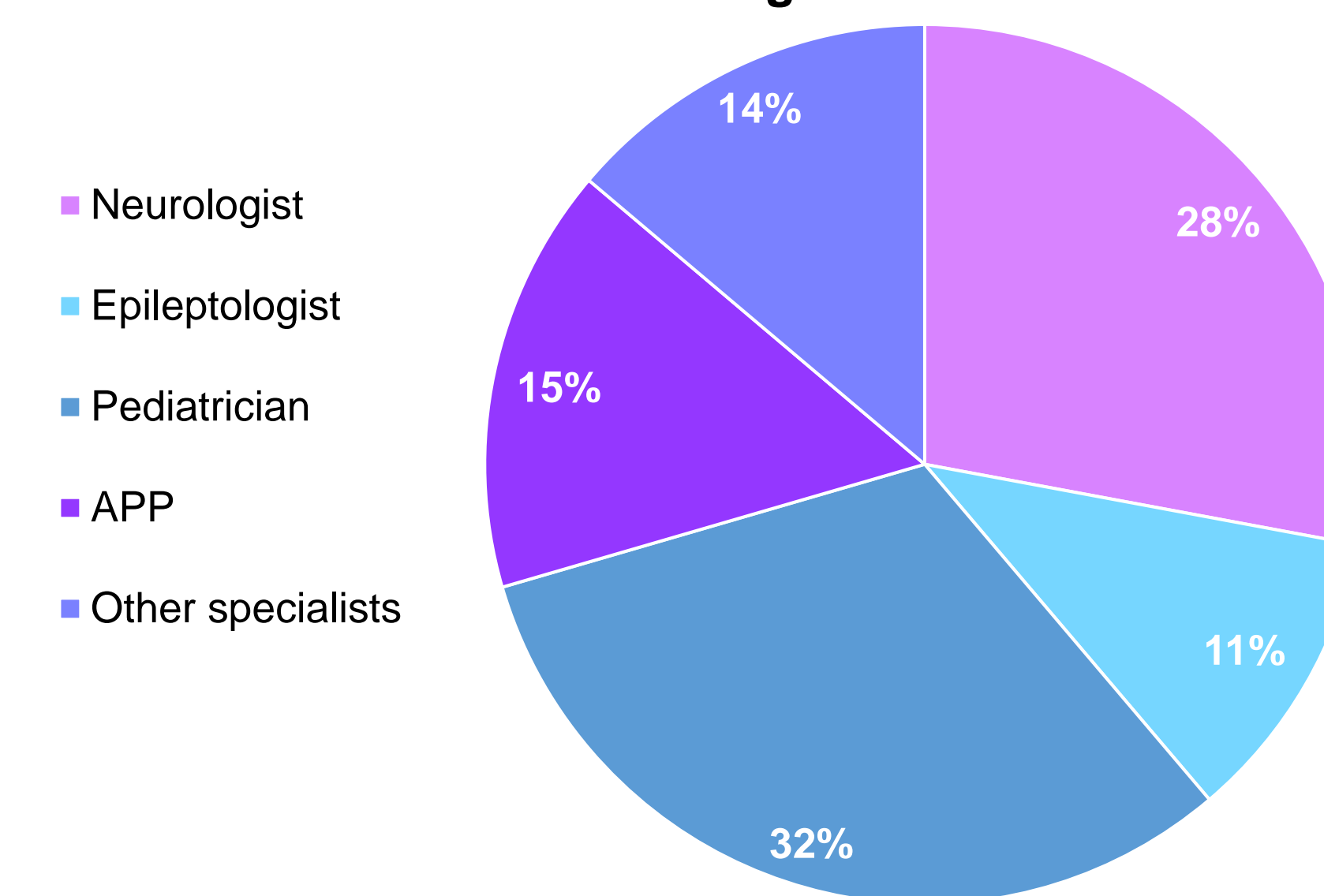


Figure 1. Percentage of rEEGs referred by the indicated specialties out of total completed rEEGs in the calendar year of 2014.

Likelihood of Abnormal rEEG by Referral Specialty

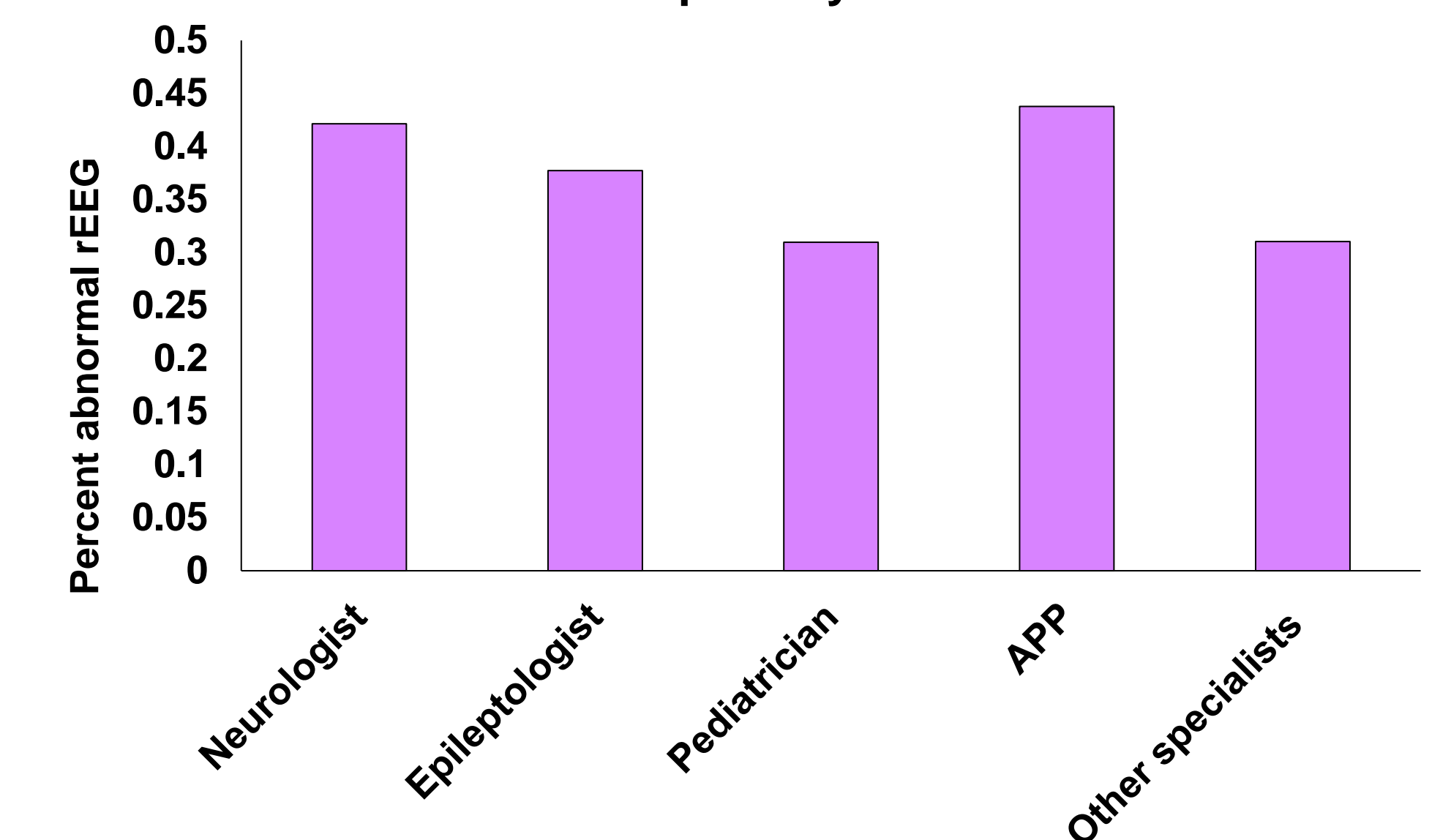


Figure 2. Percentage of rEEGs designated "abnormal" by the indicated specialties out of the total completed rEEGs in the calendar year of 2014.

Likelihood of Specific rEEG Features Based on Clinical Outcomes

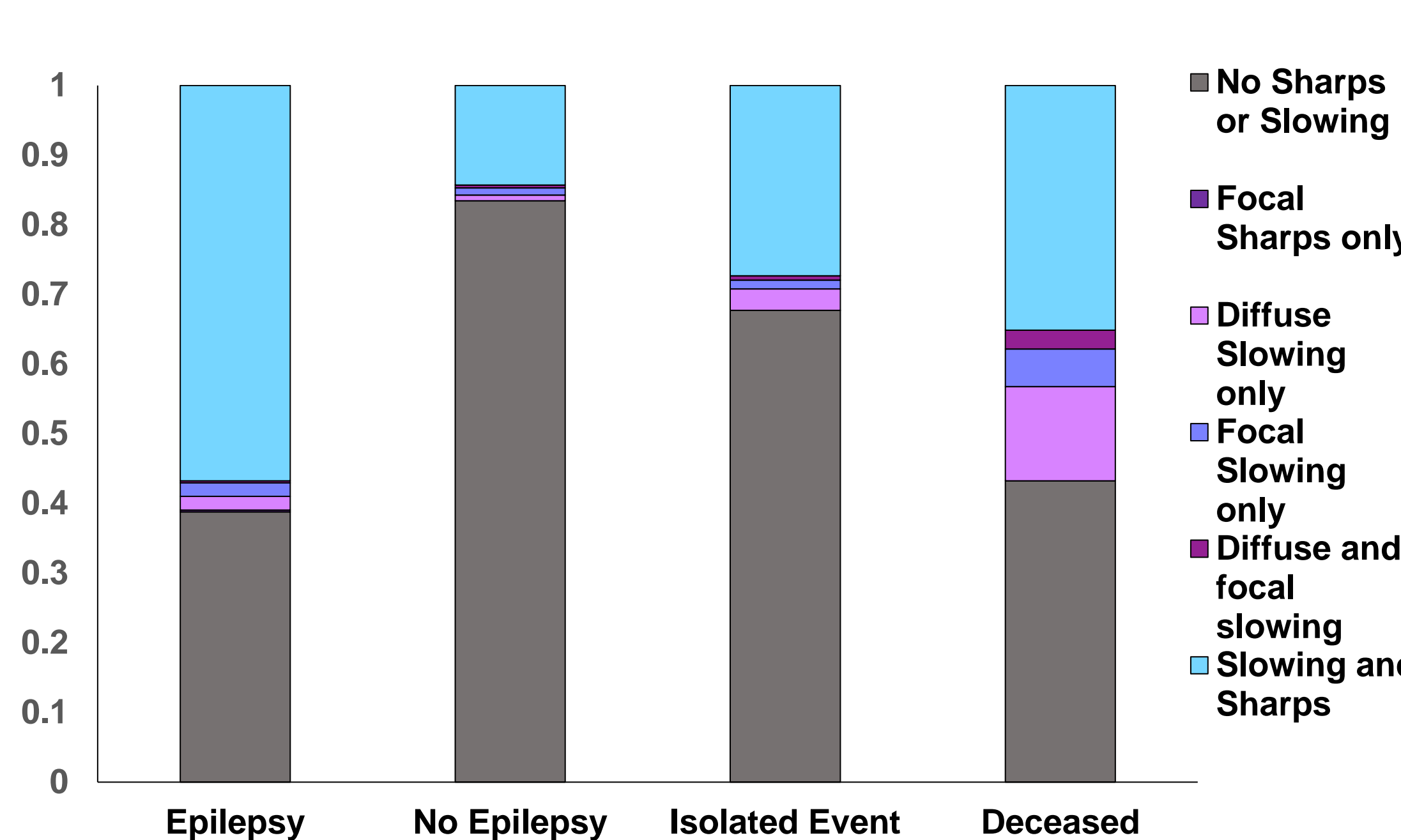


Figure 3. Specific findings on rEEG in the calendar year of 2014 based on clinical outcome: diagnosis of epilepsy (irrespective of ASM status), confirmed follow up with no epilepsy diagnosis, an isolated event concerning for seizure, or a deceased individual. Of note, no rEEGs contained only generalized sharps without slowing, or focal and generalized sharps without slowing.

Epilepsy Etiology

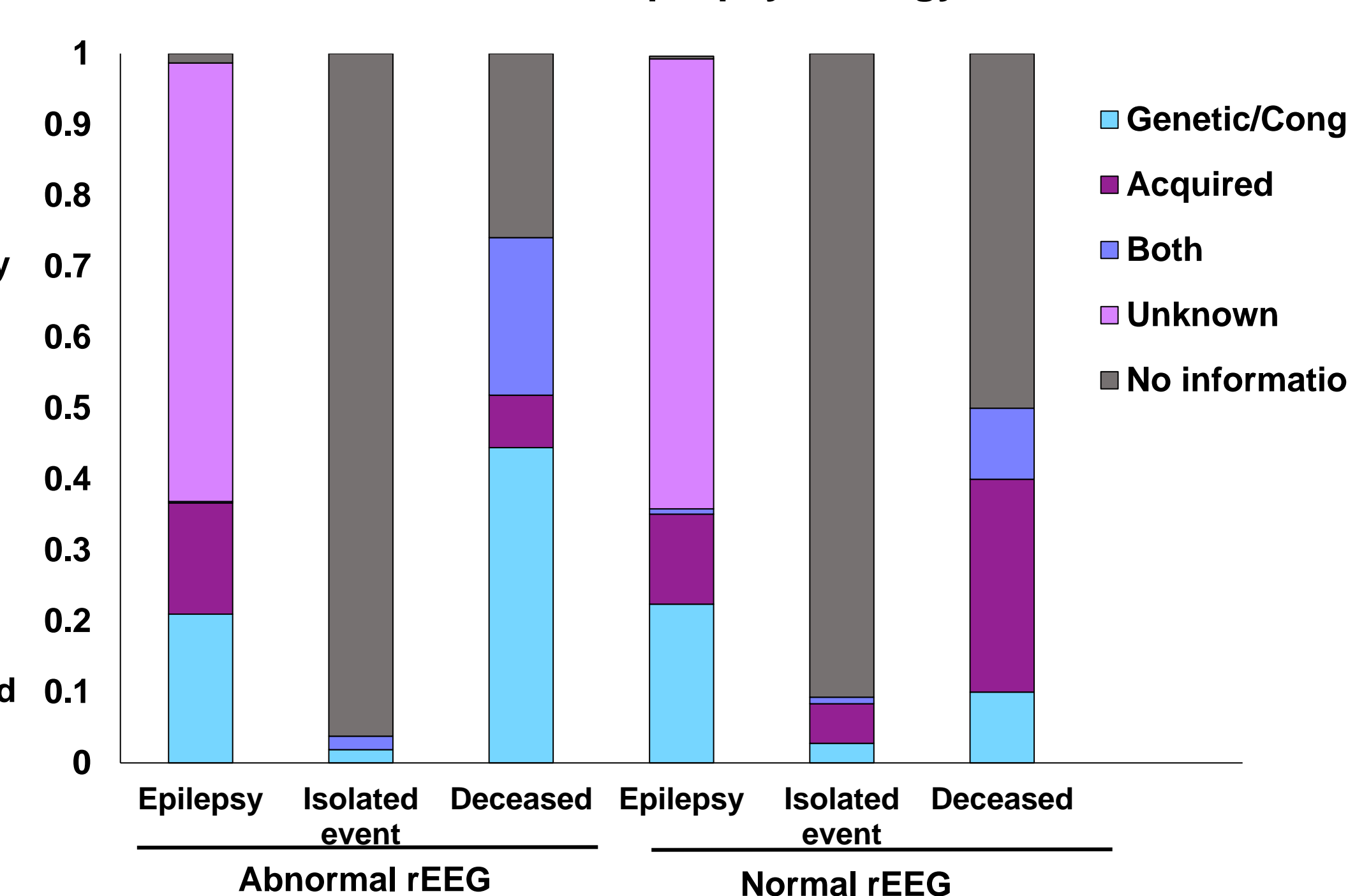


Figure 4. Documented etiology of seizures based on clinical outcome and rEEG status.

Likelihood of Abnormal rEEG Based on Clinical Outcomes

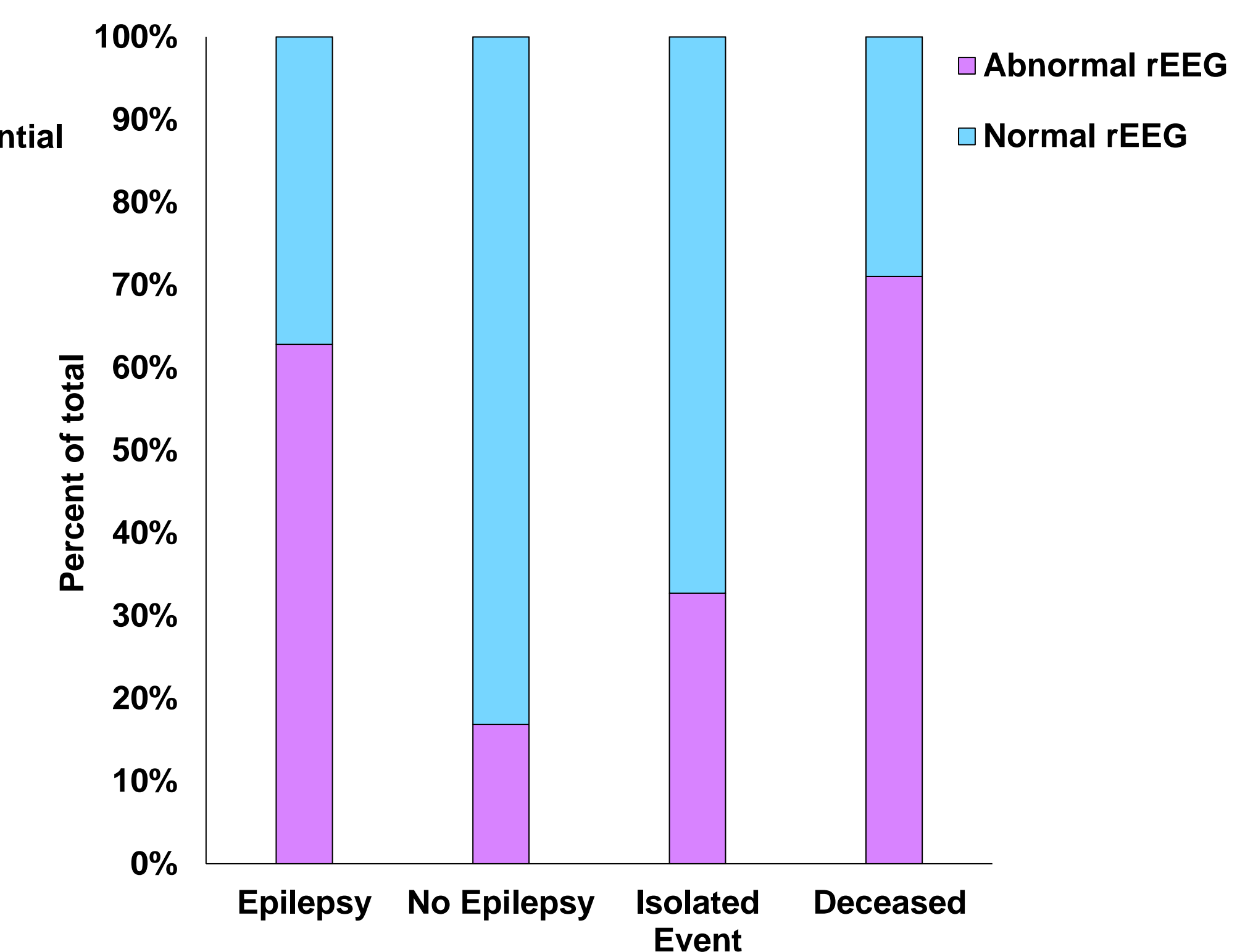


Figure 5. Percent of abnormal rEEGs in the calendar year of 2014 based on clinical outcome: diagnosis of epilepsy (irrespective of ASM status), confirmed follow up with no epilepsy diagnosis, an isolated event concerning for seizure, or a deceased individual.

Results

In the total cohort (n= 1837 rEEGs), age at the time of rEEG ranged from 1 day to 26 years median age 7.05 years, with a rEEG duration standardly prolonged at 61 minutes. About 37% of rEEGs were abnormal with one or more abnormalities (interictal spikes 87.4%, slowing 96.9%, seizures during EEG 12.5%, hypersarrhythmia 1.3%), and 62% were normal. Approximately 34.2% of patients were lost to follow-up. In the subset with follow-up (n=630), an abnormal rEEG had a positive predictive value of 84% of developing epilepsy, and a normal rEEG had a negative predictive value of 59%, along with 64% sensitivity and 80% specificity. Additionally, a mortality rate from all causes of 3.04% was noted in the overall cohort.

Conclusion

Capitalizing on the unique single-center single-reader at a high-volume tertiary children's hospital with long-term outcome, this study may elucidate more precise rEEG predictive values and patient outcomes than prior studies. More work is needed to improve pediatric rEEG diagnostic and outcome prediction