Sleep Deficiency Is Associated with Higher Next-Day Generalized Tonic-Clonic Seizure Risk

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Rationale

Epilepsy patients are advised to maintain an adequate amount of sleep every day to reduce seizure risk. Despite the long-lasting notion that sleep deficiency may induce seizures, existing literature has not clarified the relationship between them with objective evidence. We performed a large-scale longitudinal observational ambulatory study to investigate sleep deficiency and the occurrence of seizures using wearable monitoring.

Key Points

- Overall, sleep deficiency marginally increases GTCS risk.
- The clinical significance varies significantly between patients.
- The above two observations hold across age groups.
- New results on patient-specific sensitivity to sleep deficiency!

Results

After excluding naps, insufficiently labeled false alarms, and other low-quality data, 80,424 seizures (median=34, range 3 to 373) and 287,048 sleep episodes (mean=118, range 60 to 537) were recorded from 2,350 patients. Overall, significantly elevated GTCS risks were found after undersleep compared to appropriate sleep among all age groups: less than 7 hours for ages 25 to 60 (p< 0.001, MoE=2.68%), less than 8 hours for ages 13 to 17 (p< 0.001, MoE=3.14%), and less than 9 hours for ages 6 to 13 (p<0.001, MoE=2.68%). Oversleep is not followed by any significant change in risk in any age group.

We computed three corresponding risk values for each patient: the percentage of next-day containing at least one GTCS following undersleep (R1), oversleep (R2), and appropriate sleep (R3). Two-tailed paired t-tests assessed if the population-level difference between every pair of risk values (empirically Gaussian) was significant with the Holm-Bonferroni method. The magnitude of effect (MoE) was computed as the average of percentage difference among all patients.

Conclusions

These results suggest that sleep deficiency detected by wearable devices can be informative in identifying seizure risk among a wide range of age groups. The overall elevated GTCS risk is statistically significant but of small clinical magnitude. However, patient-specific vulnerability varies significantly. These results suggest that future work should focus on identifying patients sensitive to sleep deficiency, which is empowering and actionable for both the caregivers and patients.

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Methods

Patients diagnosed with epilepsy characterized by generalized tonic-clonic seizures (GTCS) wore a smart wristband at home for at least three months. The total sleep time (TST) of each sleep episode was computed by an FDA-cleared activity-based rest detection algorithm. Sensor data from the wristband was also used to detect GTCS events using an FDA-cleared algorithm.

The adequate amount of sleep humans should get each day varies by age, and we followed the age groups and TST bounds suggested by the National Sleep Foundation, the American Academy of Sleep Medicine, and the Sleep Research Society. Subsequently, we labeled each sleep episode as oversleep (above the suggested upper TST bound), undersleep (below the suggested lower TST bound), or appropriate (within the suggested TST bounds). Data from a patient were analyzed for next-day GTCS only if they had at least 30 sleep episodes in each of the three categories.

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