Telemedicine Project Proposal

María del Carmen Cortés, María Martínez, Marta Sánchez, Paula Blanco and Claudia Blanco

"Cameron Boyce, the 20-year-old Disney Channel star, died from sudden unexpected death in epilepsy (SUDEP), as confirmed by the Los Angeles County coroner's office in the United States."

Epilepsy is a chronic neurological disorder characterized by the brain's predisposition to generate seizures. A seizure is an abnormal, excessive, and synchronous discharge of cortical neurons, producing motor, sensory, cognitive, emotional, or autonomic symptoms depending on the brain region involved.

The exact cause of epilepsy is not fully understood, and it is unlikely that a single explanation exists. However, seizure activity in the brain can sometimes trigger changes in breathing or heart rhythm. SUDEP is a rare but recognized complication of epilepsy, responsible for the death of approximately 1 in every 1,000 adults with epilepsy each year.

There are many different types of epilepsy depending on their underlying physiology. For this project, however, we focus on **nocturnal frontal lobe epilepsy (NFLE)**. This is a focal epilepsy in which seizures occur primarily during sleep, particularly during light non-REM stages. NFLE is characterized by very brief but strongly motor episodes: abrupt movements, unusual postures, shouting, or even jumping out of bed. These events are frequently mistaken for parasomnias such as sleepwalking or night terrors. Although the seizures are short, they may occur repeatedly throughout the night, disturbing sleep and, in some cases, posing a life-threatening risk. NFLE can occur at any age, but it is more common in children, adolescents, and young adults, often beginning in childhood or adolescence and persisting into adulthood.

Why nocturnal monitoring matters

Night-time monitoring is particularly important in these patients because:

- Many seizures go unnoticed, as the patient often has no recollection of them.
- Monitoring helps distinguish epilepsy from parasomnias, since seizures produce more abrupt physiological changes (cardiac, respiratory, motor).
- It provides an objective record of seizure frequency and patterns, avoiding reliance solely on patient memory or caregiver observations.
- Long-term follow-up is improved by offering objective data on disease progression and treatment response.

Selected biomarkers

The monitoring system will focus on two key physiological signals:

- **Electrocardiogram (ECG):** In many cases, heart rate increases minutes before a seizure. These changes may present as sudden tachycardia, alterations in heart rate variability, or, less commonly, bradycardia and sinus pauses. Reviewing ECG recordings—especially during the night—helps confirm whether a suspicious nocturnal episode coincided with an autonomic change. This strengthens the likelihood that it was a seizure rather than a parasomnia, which is a frequent diagnostic challenge in NFLE.
- **Accelerometer:** Accelerometry is especially relevant because NFLE seizures are typically highly motor, brief, and repetitive, involving sudden jerks or abnormal postures of the arms, legs, or trunk. These patterns can be confused with parasomnias. An accelerometer can detect and record such abnormal movements during sleep, providing objective information on seizure frequency and characteristics, even when the patient is unaware. This assists physicians in distinguishing epileptic seizures from other sleep disorders and in evaluating the true nocturnal seizure burden to better tailor treatment.

System overview

The goal of this telemonitoring system is to provide continuous overnight monitoring for patients with nocturnal frontal lobe epilepsy (NFLE). Throughout the night, ECG data and accelerometer readings will be collected. These recordings can later be reviewed by the patient's physician to assess seizure frequency and severity and to adjust treatment as needed.

Additional components

We plan to implement the following core and optional features:

- **Graphical user interface** (up to 7.5 points)
- **Custom-built database** (1 point)
- **Doctor's application** (2 points)
- **User authentication with username and password** (1 point)

If time allows after completing these features, we would also explore the possibility of real-time signal analysis to generate alerts for the patient or physician.