Economic evaluation of a seizure detection device for refractory epilepsy

EE171

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Introduction

It is postulated that sudden unexpected death in epilepsy (SUDEP) is associated with clinically relevant physiological changes, including seizure and cardiorespiratory dysfunction, in the weeks prior to the collapse.

Objective

To conduct an early economic evaluation study and explore clinical characteristics of a wearable system that can monitor and alert for seizures and cardiorespiratory dysfunctions.

Methods

- **Study Design:** Markov model in a simulation study.
- **Data source:** The Premier Healthcare Database and published literature.
- **Study population:** We modeled different severe refractory epilepsy target populations based on their background annual rate of healthcare resource utilization.
- Our Markov model quantified transition probabilities between years without recurrent seizures, years with recurrent seizures, and death.
- We modeled multiple events as a function of underlying health state, including emergency department (ED) visits, hospitalizations, and epilepsy monitoring unit (EMU) admissions.
- **Model parameters:**
  - We modeled device-related parameters, including reductions in the rates of outpatient visits, EMU admissions, ED visits, and hospitalizations associated with the device.
  - We modeled a false positive (FP) rate for the device.
- **Analysis:**
  - Time horizon of lifetime.
  - Discounting future costs and health gains at 3%.
- **Study outcome:**
  - Incremental direct and indirect costs.
  - Incremental health-related quality of life in terms of quality-adjusted life years (QALYs).
  - Incremental cost-effectiveness ratio (ICER).

Methods (Cont.)

We tested different target populations and device characteristics.

We conduced a threshold analysis for the background rate of ED visits and relative rate of ED visits associated with the device.

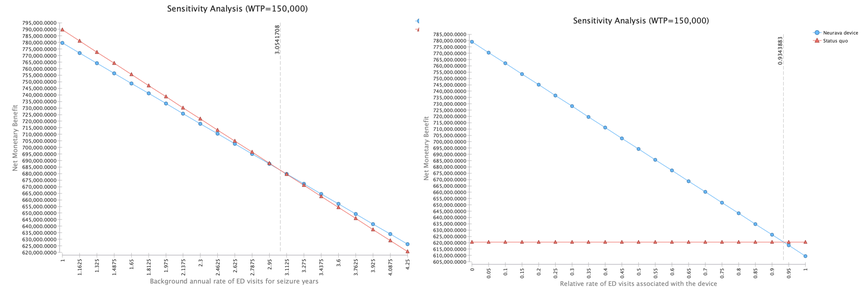
Table 1. Model input parameters

Parameter	Value	Reference
Starting age of cohort, years old	35	
Probability of getting seizure	0.254	Literature
Probability of seizure relapse		
Year		Literature
1	8%	
2	4.7%	
3	4.7%	
4	4.7%	
5	4.7%	
6	1.6%	
Rate of ED visit for patients without seizure, per person-year	0.4	Literature
Rate of ED visit for patients with seizure, per person-year	4.2	We back-calculated this rate based on assuming a target population with a very severe drug-resistant, refractory epilepsy that has an average 3.5 annual rate of ED visits, annual rate of ED visit for epilepsy patients with who were seizure free in the previous year (0.4), and the prevalence of patients with epilepsy that were seizure free (0.17) and were not seizure free (0.83) in the previous year.
Probability that an ED visit results in a hospitalization	11%	Literature
Annual mortality rates	Age-dependent based on US Life Tables	Literature
Relative rate of mortality associated with seizure	5.4	Literature
Intervention effects		
Relative rate of ED visits	0.9	Assumption
Relative rate of outpatient visits	0.8	Assumption
Relative rate of hospitalizations	0.8	Assumption
False positive rate	5%	Assumption
Utility values		
Utility value for seizure free state	0.96	Literature
Utility value for no seizure free state	0.75	Literature
Utility decrement for ED visit	0.0022	Assumed 0.8 utility decrement for a day ED visit
Utility decrement for hospitalization	0.0057	Assumed 0.8 utility decrement for a hospitalization that lasts on average 2.6 days
Costs, 2024 USD		
Direct cost of ED visit	$1,577	Literature
Direct cost of hospitalization	$5,957	Literature
Indirect cost of ED visit	$342	Calculated based on average annual wage of $50,000, and one day average length of stay for an ED visit
Indirect cost of hospitalization	$888	Calculated based on average annual wage of $50,000, and 2.6 days average length of stay for a hospitalization
Direct cost of outpatient	$332	Literature
Direct cost for epilepsy	$27,166	Literature
Indirect cost of epilepsy patients without seizure	$18,496	Literature
Indirect cost of epilepsy patients with seizure	$45,058	Literature
Intervention cost	$1,000	Assumption

Results

- For epilepsy patients with an average annual rate of 3.6 ED visits/patient, a seizure detection device that: 1) costs $1,000 per patient-year, 2) reduces rate of ED visits by 10%, 3) reduces rates of outpatient visits and hospitalizations by 20%, and 4) has a false positive rate of 5%, would save $1,862 in money and increase QALYs by 0.027, with an incremental net monetary benefit of $5,831.
- **Figure 1** shows the threshold analyses for the background rate of ED visits and the relative rate of ED visits associated with the seizure device.

Figure1. Threshold analysis for the background rate of ED visits and the relative rate of ED visits associated with the seizure device.



Conclusion

For severe refractory epileptic patients with multiple recurrent seizures, a wearable seizure detection device could be potentially cost-effective from a societal perspective.

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