# Epilepsy Épilepsie CANADA
## FUND RESEARCH FIND A CURE

## 2020 Donors'
# RESEARCH REPORT

Epilepsy Canada is committed to keeping its donors updated on the work that is progressing because of their support. This year two significant research studies are ongoing because of the generous donations of Epilepsy Canada supporters. We are pleased to provide you with updates on the progress that is being made.

# Using Advanced imaging to predict medically-intractable epilepsy

Principal Investigator - A. Bernasconi, MD, Montreal Neurological Institute – Hospital, McGill University

*"Thanks to the funding received, through the Jay & Aiden Barker Breakthrough Grant from Epilepsy Canada, we have successfully developed methods that identify anomalies of brain structure that are not visible to the human eye and that modify the response to anti-seizures drugs."*

## Rational:

Epilepsy is one of the most common neurological disorders and affects 65 million people worldwide, with 2.4 million new cases diagnosed every year. About a third of patients do not respond to medication despite the current availability of over two-dozen antiepileptic drugs, with an estimated 100,000 patients in Canada. Drug-resistant epilepsy is a serious chronic condition associated with high risk for psychosocial impairment, cognitive decline,and mortality.

Currently, drug-resistant epilepsy cannot be predicted at disease onset and is ascertained only after multiple drug trials have failed. The only treatment for these patients is epilepsy surgery.

*Dr. Bernasconi the lead researcher at McGill*

## Objective:

We aim at designing artificial intelligence algorithms that use magnetic resonance imaging (MRI) data to predict drug-resistance at time of the diagnosis of epilepsy.

## Progress:

Our first goal was to use markers of brain structure and function as well as models of brain networks to distinguish patients with DRE patients from those responding to medication. Thanks to the funding received from Epilepsy Canada, we have successfully developed methods that identify anomalies of brain structure that are not visible to the human eye and that modify the response to anti-seizures drugs. In other words, we showed that particular combinations of the brain structural makeup and networks predispose some patients to become resistant to medications. Results of this research have been presented at international epilepsy conferences and will be soon published in scientific journals.

## Future research plans:

We plan to investigate the chemistry of the brain on which drugs directly act using MRI-spectroscopy. These exams will be performed on a powerful 7 Tesla scanner, a type of MRI available in only a few other centers across Canada, the only one in Quebec. This scanner allows examining multiple chemical compounds that play a central role in signal transmission between brain cells, which cannot be studied otherwise. Importantly, some of these compounds relate to abnormal brain excitability that causes seizures. Results from this research will provide novel insights into the mechanisms of drug-resistant epilepsy. In practical terms, the availability of objective MRI-based predictors at disease onset will allow doctors to know which patients will benefit from medication only versus those who will not respond to medication and should thus be referred for epilepsy surgery. Also, our research may guide the development of personalized first-line anti-seizure drugs.

## Seizure Prediction Research:

"*Dr. Dang K. Nguyen, at the University of Montreal Hospital Center (CHUM), has and continues to make tremendous progress in the field of seizure prediction based on intracranial electroencephalography recordings (EEG) and advanced machine learning techniques.*"

Dang K. Nguyen, MD, PhD
Neurologist, CHUM
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Epilepsy, one of the most prevalent neurological conditions, affects nearly 260 000 Canadians. Despite the continuous global progress being made in neurosurgery and pharmaceutical research, over a third of patients continue to suffer from uncontrolled seizures. According to a patient survey conducted by the Epilepsy Foundation, the unpredictability of seizures is the most detrimental aspect of living with epilepsy. This has motivated global efforts towards the study of seizure initiation and the development of personalized seizure forecasting algorithms which would predict seizures before they occur and thus offer a life-changing solution to patients with uncontrolled epilepsy.

## Seizure Prediction Research - Continued -

Thanks in part to funding from Epilepsy Canada our group, led by Dr. Dang K. Nguyen, at the University of Montreal Hospital Center (CHUM), has and continues to make tremendous progress in the field of seizure prediction based on intracranial electroencephalography recordings (EEG) and advanced machine learning techniques. Our interdisciplinary team, composed of medical experts and engineers, has designed and tested connectivity analyses, advanced signal processing techniques, and machine learning classification algorithms to automatically identify the period preceding clinical seizures from intracranial EEG recordings of canine epilepsy.

Over the years, our findings have been published in 7 peer-reviewed journal articles, 8 peer-reviewed conference papers and have been presented orally at numerous international medical and engineering conferences.

Our continuous efforts have shown promise for the possibility of developing personalized implantable seizure advisory/abortion devices. However, a better understanding of epileptic brain networks and validation of algorithms on larger multi-center databases of intracranial EEG recordings as well as prospective studies are required to achieve reliable real-time seizure prediction. Thanks to the growing availability of mass storage technologies and high-speed computing, our group is continuously building a large dataset of continuous intracranial EEG from the CHUM's epilepsy monitoring unit, which will be used to improve and validate our prediction algorithms and begin to develop dedicated hardware for a real-time implantable device. We believe that our continuous collaborative efforts will lead to accurate and reliable seizure forecasting devices which will offer a novel treatment to patients suffering from uncontrolled epilepsy.

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