


# Computer-Aided Analysis for the Detection and Classification of Epileptic Events

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# Background for Request for New ICD-10-PCS Code

- There is no ICD-10-PCS code to describe the analysis of epilepsy associated behavioral (semiologic) data using artificial intelligence (AI) software to aid in the detection and classification of epileptic events.
- The Nelli® Seizure Monitoring System has received Breakthrough Device Designation from the FDA.
- FDA 510(k) Clearance for the Nelli System is expected in Q1 2022.
- Proposed indication for use for Nelli System:

Nelli is intended for the automated analysis of audio and video data to identify seizures with a positive motor component in children and adults. Nelli provides objective summaries of behavioral components of identified events including velocity and acceleration of movements, seizure frequency, seizure duration, heart rate, and respiratory rate. Nelli provides audiovisual (AV) data for physicians to characterize seizures



U.S. FOOD & DRUG  
ADMINISTRATION

Exhibit D

October 9, 2020

Nexus Event Lab Oy  
 Ms. Dr. Sujith Shetty  
 Counselor  
 MANIX, LLC  
 7052 Hollow Lake Way  
 San Jose, California 95120

Re: Q201496  
 Trade Device Name: Nelli  
 Received: August 10, 2020

Dear Dr. Sujith Shetty:

The Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA) has received the above submission requesting designation as a Breakthrough Device. The proposed indications for use include:

"Nelli software is intended for the automated analysis of audio and video data to identify seizure events with a positive motor component in children and adults. The software provides objective summaries of semiological components of identified events (including velocity and acceleration of movements, seizure frequency, seizure duration, heart rate, and respiratory rate). Nelli software provides AV data for physicians to characterize seizures and perictal events."

We are pleased to inform you that your device and proposed indication for use meet the criteria and have been granted designation as a Breakthrough Device. Please refer to the FDA guidance document entitled "Breakthrough Devices Program", for more information regarding the program, available at <https://www.fda.gov/medical-devices/breakthrough-devices-program>.

We recommend you review the FDA guidance document for the Breakthrough Devices Program referenced above for the available mechanisms for obtaining feedback from the Agency on device development for designated breakthrough devices. When submitting any new requests, please reference Q201496. Any new submission should be provided as an eCopy, it should include the FDA reference number for this submission, and should be submitted to the following address:

U.S. Food and Drug Administration  
 Center for Devices and Radiological Health  
 IDE Document Control Center - WO66-G009  
 10903 New Hampshire Avenue  
 Silver Spring, MD 20993-0002

U.S. Food & Drug Administration  
 10903 New Hampshire Avenue  
 Silver Spring, MD 20993  
 (301) 795-8121

# Background

- The Jefferson Comprehensive Epilepsy Center is accredited by the NAEC as a level 4 epilepsy center, a level which represents the highest level of medical and surgical expertise to evaluate and treat patients with complex epilepsy.
- Over 1,900 patients per year admitted to the Jefferson Health System undergo video-EEG monitoring.
- Continuous video-EEG evaluation plays a crucial role in the diagnosis of epilepsy and seizure management, including pre-surgical evaluations and for critically ill patients.
- Video-EEG is performed in the epilepsy monitoring unit (EMU), the neuro ICU and on general hospital floors for inpatients admitted to Thomas Jefferson University Hospital.



# Why is automated, semiological (behavioral) analysis needed?

- Non-automated behavioral analysis is dependent on individual expertise and often does not provide objective event analysis.
- Better characterization of seizure behavior would matter
  1. Detect seizures that might be missed by nurses and EEG techs
  2. Better quantification of seizures and provide an objective measure of severity
  3. More efficient screening of the video than by humans with better characterization of behavior.
- Use of video EEG outside of EMU (e.g., in neuro ICU and on general ward) is more difficult and less reliable.
- Automated, behavioral analysis provides near real-time feedback in detecting seizures which can in turn improve the quality of event analysis, but is also important for patient's safety



# Semiology

- What is semiology?

Semiology represents the description of the signs and symptoms (the patient's behavior) occurring during an epileptic seizure.

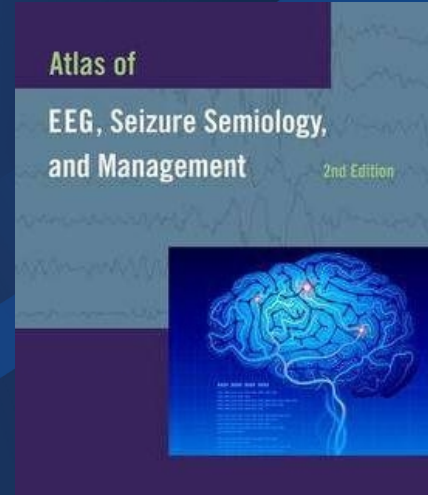
Semiology is a core feature of seizure classification systems.

Combined with EEG data, semiology is used to determine seizure type and to rule out other conditions which may imitate seizures.

- How is a semiological analysis different than other approaches which measure seizure related activity?

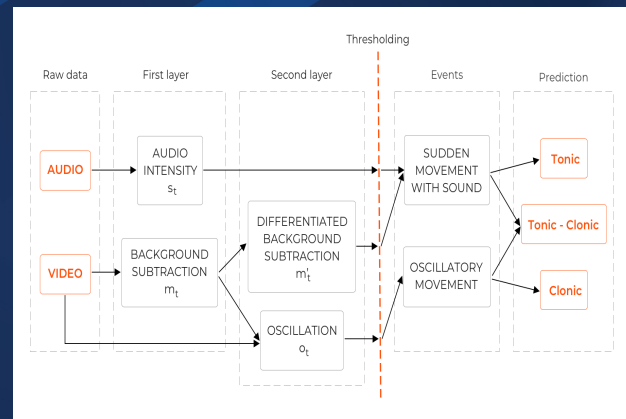
Semiological (behavioral) analysis of movements and sounds during video-recorded seizures enables the application of objective criteria for seizure detection and classification.

This enables an improved ability to recognize and describe epileptic seizures and the identification of the specific type of seizure occurring, substantially aiding the clinical diagnostic process.



# The Nelli® Seizure Monitoring System

- Nelli® is a smart solution for seizure detection and monitoring which enables the capture of patient behavior
- Uses video & audio capture to characterize motor seizure semiology
- Consists of a small patient AV recording unit, a cloud-based server and an online user interface
- Easy to use - does not require wearables or any special equipment
- Provides the benefits associated with AI (fast, automated)
- Can be used in conjunction with video EEG monitoring in all hospital settings (EMU, neuro ICU, general ward).



# Clinical Workflow

## Step 1: Data capture

## Step 2: Remote processing

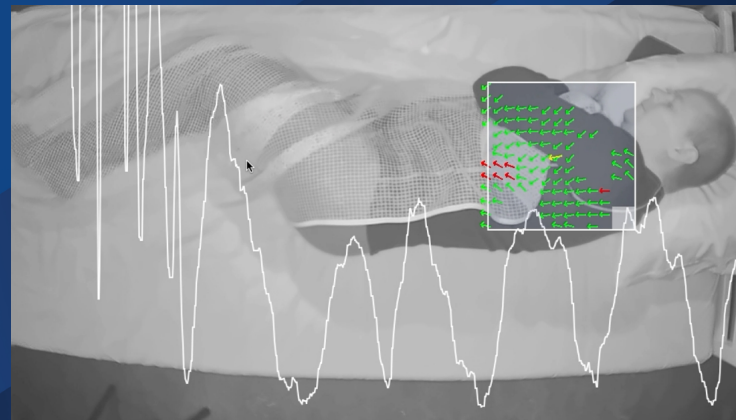
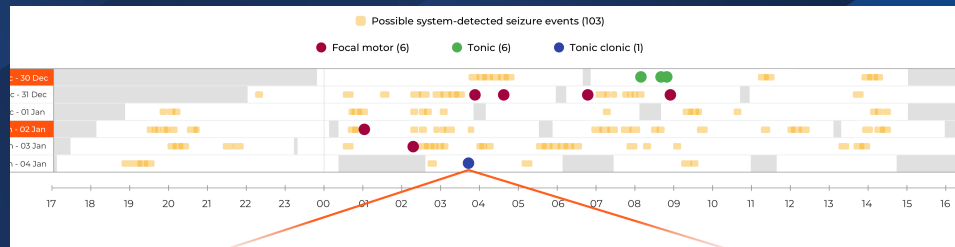
Data is transferred to a protected and secured storage environment. The captured data is processed through a machine learning model.

## Step 3: Technical review

Trained medical personnel review the results and confirm potential seizure events.

## Step 4: Interactive report + videos

The patient's report is accessed via the online dashboard and includes a detailed overview of events and enables video review of individual events.



# Clinical Data: Excellent Sensitivity

Prospective, Multicenter Comparative Clinical Trial in 334 patients

Thomas Jefferson University & Danish Epilepsy Center/Aarhus University, Denmark

Operating Characteristics	# Subjects	Gold Standard (vEEG) <sup>a</sup>	Sensitivity [CI] <sup>b</sup>	FDR/h [CI] <sup>c</sup>
Adults (22 85)				
Tonic Clonic Seizures	30	67	92% [0.79, 1.00]	0.025 [0.02, 0.031]
Major Motor Seizures	62	159	93% [0.85, 1.00]	5.1 [4.8, 5.5]
Minor Motor Seizures	27	95	92% [0.80, 1.00]	19.44 [18.57, 20.31]

Operating Characteristics	# Subjects	Gold Standard (vEEG) <sup>a</sup>	Sensitivity [CI] <sup>b</sup>	FDR/h [CI] <sup>c</sup>
Pediatric (6 21);				
Tonic Clonic Seizures	4	6	100% [0.88, 1.00] <sup>c</sup>	0.04 [0.02, 0.05]
Major Motor Seizures	15	39	91% [0.70, 1.00] <sup>b</sup>	8.5 [7.7, 9.3]
Minor Motor Seizures	16	64	88% [0.65, 1.00] <sup>b</sup>	19.9 [18.4, 21.4]

<sup>a</sup> Seizures identified by vEEG review during routine epilepsy monitoring unit admission

<sup>b</sup> Sensitivity and 95% confidence interval estimated using a repeated measures logistic regression model with random subject effects.

<sup>c</sup> FDR and 95% confidence interval are estimated using a repeated measures Poisson rates model with random subject effects.



# Summary

- The Nelli Seizure Monitoring System is used in conjunction with standard video EEG.
- Nelli provides automatized, objective semiological (behavioral) information about seizures which is not currently possible. It also identifies seizure in real time, reducing the time and work required to monitor and assess patients.
- While facilities can report inpatient video EEG monitoring using ICD-10-PCS code 4A10X4Z, this code does not include the recording and analysis of semiological data.

# Thank you



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