

COMBINED EEG MONITORING IN HIGH-RISK CRITICALLY ILL NEONATES: A Pilot Study

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BACKGROUND

- ❖ Critically ill neonates are at high risk of central nervous system insults, including seizures
 - Seizures may result in permanent neurological disability if untreated
- ❖ Up to 90% of neonatal seizures are clinically undetectable¹
- ❖ Electroencephalography (EEG) increases recognition of neonatal seizures and brain injury (Fig. 1)
- ❖ Amplitude-integrated EEG (aEEG) is the standard of care in the CHEO NICU
 - Recent review suggests aEEG has low sensitivity and specificity → therefore should not be the mainstay for diagnosis and management of neonatal seizures²
- ❖ Continuous EEG (cEEG) is the gold standard of seizure monitoring
 - However, cEEG is expensive and resource intensive

- ❖ **Primary objectives**
 1. Assess the feasibility of implementing concurrent aEEG and cEEG monitoring in CHEO NICU
 2. Describe the sensitivity and specificity of aEEG relative to cEEG monitoring in critically-ill high risk neonates
- ❖ **Hypothesis**
 - The use of an algorithm combining cEEG with aEEG monitoring increases the sensitivity and specificity of seizure detection in critically ill high-risk neonates, as compared to the current standard of care

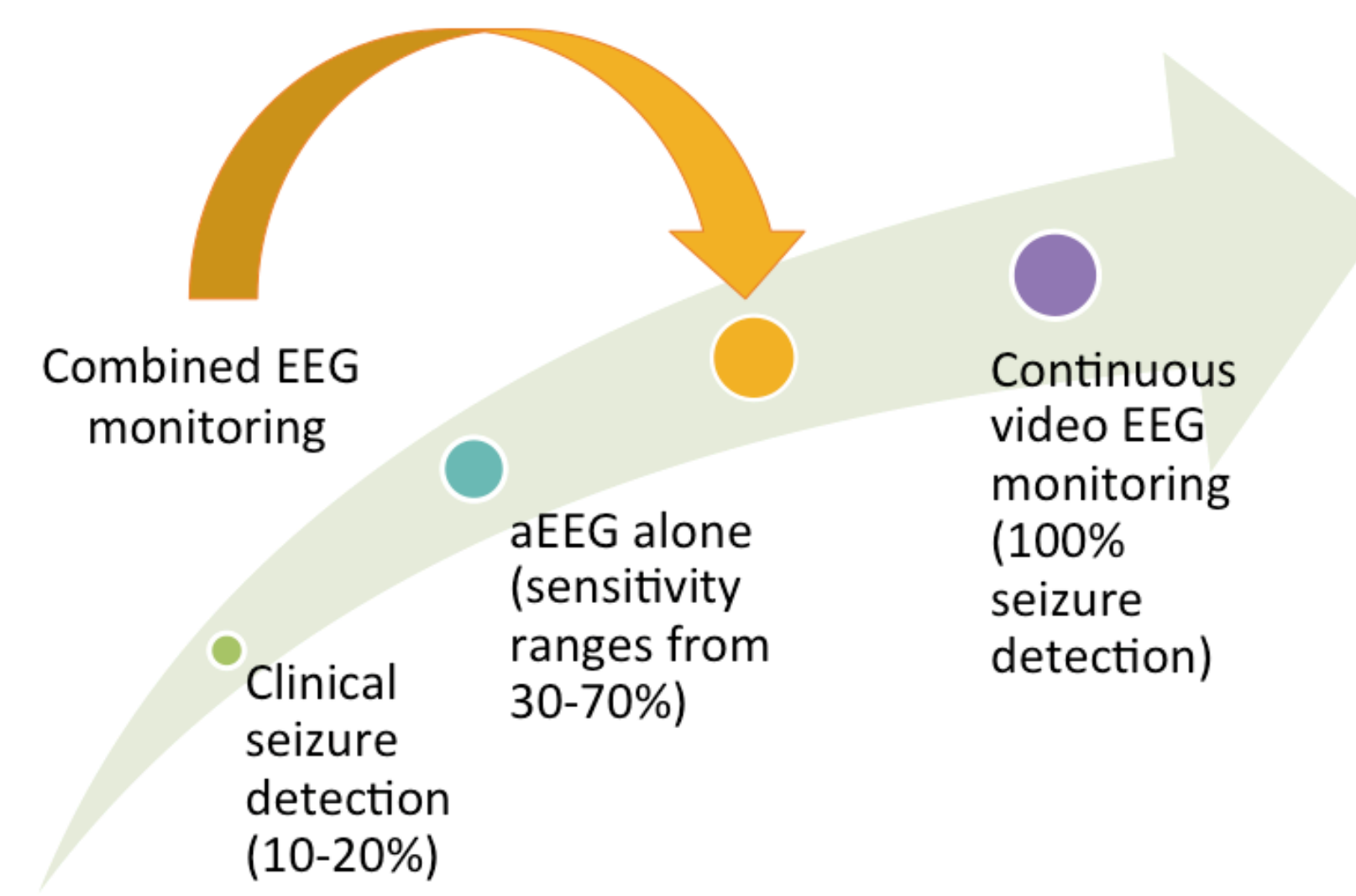


Figure 1. Spectrum of seizure monitoring in neonates

METHODS

- ❖ **Study Design**
 - Prospective observational cohort
 - Ethics approval obtained from CHEO REB May 2016
- ❖ **Screening and Recruitment**
 - Study team members identified eligible participants facilitated by circle of care:
 - Neonates admitted to CHEO NICU with clinical events suggestive of seizures or receiving therapeutic hypothermia
 - Consecutively, prospectively recruited
 - Demographic information including gestational age and admitting diagnosis recorded
- ❖ **Monitoring**
 - Neonates received aEEG (Olympic BrainZ BRM3 Monitor) monitoring as soon as clinically indicated
 - Four needle electrodes inserted into the patient's scalp
 - cEEG applied as soon as EEG technologist and machine available
 - 9 gold cup cEEG electrodes according to the modified 10-20 International system using full neonatal montage
 - T₀ of recording was established as the time at which both sets of EEG leads had been applied concurrently
- ❖ **Data Collection**
 - Bedside care team recorded clinical observations of seizure-like events and anti-epileptic drug administration
 - aEEG read and interpreted by neonatologists or another member of the bedside care team
 - cEEGs were interpreted by a staff neurologist with experience in neonatal EEG reading
 - Data captured included:
 1. Time and duration of seizures as per clinical observation, aEEG and cEEG
 2. Time and duration of background activity abnormalities as per aEEG and cEEG
 3. Other relevant findings (e.g. localization) as per aEEG and cEEG
- ❖ **Analysis**
 - Data transcribed from the paper case report forms into an online database hosted by REDCap
 - Patient and seizure characteristics summarized using descriptive statistics
 - Estimated sensitivity and specificity was calculated accompanied by a 95% confidence interval obtained using the Wilson-score method
 - The proportion of cEEG monitoring that provided treatment and clinically relevant information that were not available from aEEG was calculated along with 95% confidence intervals

RESULTS

- ❖ 10 neonates were recruited over a 9 month period (Figure 2); patient characteristics summarized in Table 1
 - Average gestational age was 38 weeks + 4 days (SD 28 days; range 27wks-41wks+2 days)
 - Average age upon enrollment was 6 days (SD 5 days; range 2-16 days)
 - Enrolled patients were treated with an average of 4 medications (SD 2 medications; range 1-7)
 - 9 of 10 patients received antiepileptic medications to abort seizure activity (range 1-3 drugs)
 - **Combined monitoring was established for 8 patients**
- ❖ **Combined EEG Monitoring**
 - Median delay to establishment of combined monitoring was 990 minutes (range 27-2942 minutes)
 - In only one case, cEEG was applied first before aEEG
 - Median duration of combined monitoring was 1293 minutes (range 35-1450 minutes)
 - Some discordance noted between seizure and background abnormality information available from aEEG vs. cEEG monitoring
 - More data needed to comment on sensitivity and specificity of aEEG vs. cEEG

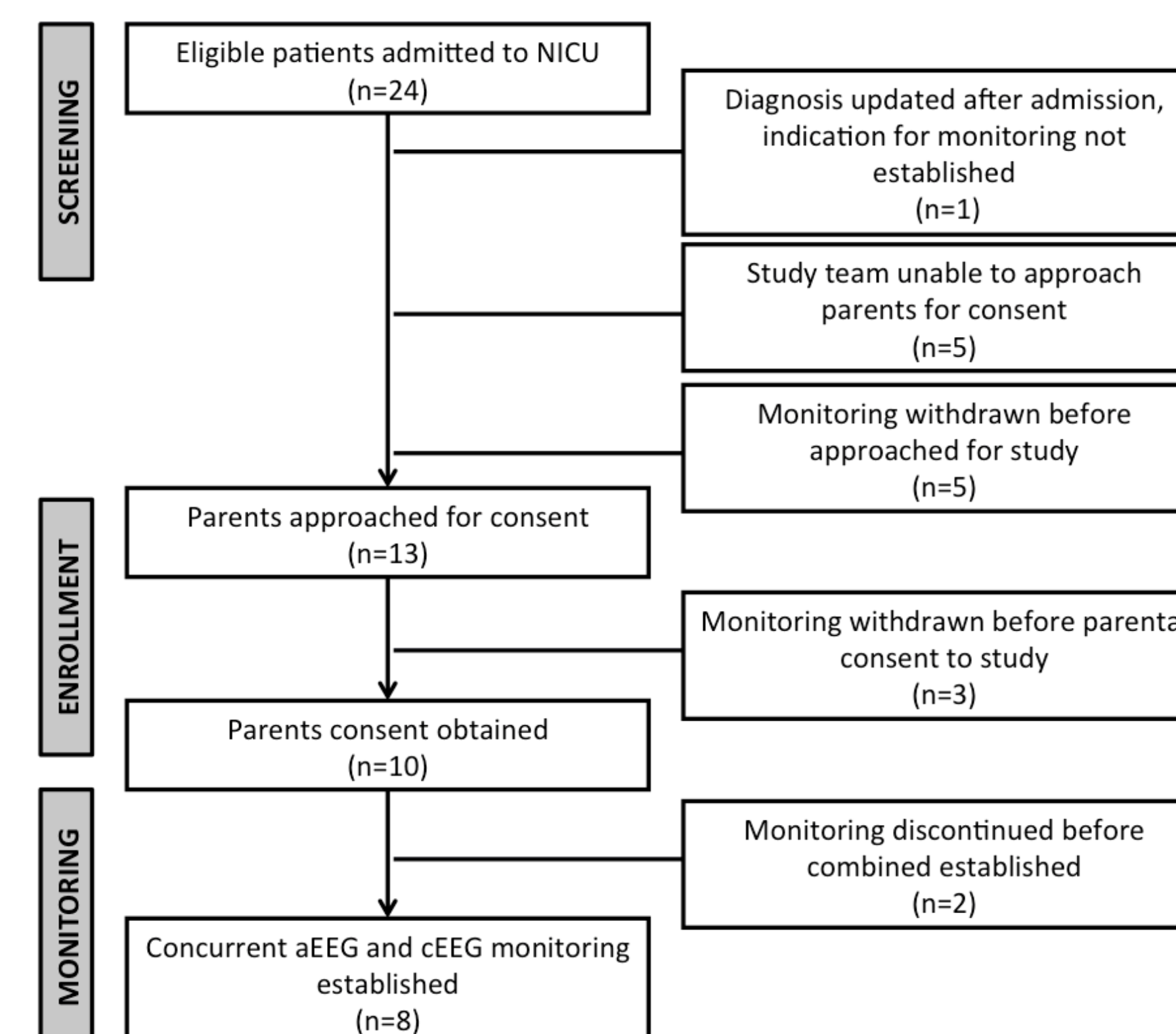


Figure 2. Pilot project recruitment

Table 1. Participant Characteristics

ID	Sex	GA	Apgar at 1 min	Apgar at 5 min	Admission Diagnosis	Number of Medications	Duration of Combined Monitoring (min)
1	F	39+1	9	9	Seizures	1	34
2	M	40+2	8	8	Respiratory Distress	1	-
3	F	39+5	7	9	R/O Genetic Condition	4	1419
4	F	38+4	8	9	Apnea, R/O Sepsis, Seizures	2	-
5	M	41+2	2	9	R/O Meningitis, Seizures	2	885
6	M	39+6	9	9	Seizures	2	1150
7	M	39+0	1	1	HIE	4	1450
8	M	41+3	8	6	R/O Seizures and Meningitis	5	1290
9	M	27	3	4	Prematurity, cerebral/interparenchymal hemorrhages, CLD	7	1296
10	F	39+3	1	4	HIE, R/O Seizures & R/O sepsis	1	1367

DISCUSSION

- ❖ **Combined EEG monitoring in the CHEO NICU is feasible**
- ❖ More data needed to establish preliminary values of sensitivity and specificity of aEEG monitoring for seizure detection in neonates admitted to CHEO NICU
 - Some evidence of discord between aEEG and cEEG findings
 - Current sample size not adequate for calculations
 - Specificity values will need to be addressed once we reach target enrollment and in future studies
- ❖ **Work supports need for multi-centre study to achieve target sample size**
- ❖ This project represents the first stage of a multi-phase program of research on neonatal EEG monitoring (Fig. 3)
 - Has informed a larger study at CHEO in collaboration with other centres to assess the feasibility and accuracy of a brain monitoring algorithm integrating both aEEG and cEEG (Fig. 4)
- ❖ Process of recruiting under unique deferred consent model currently being considered by REB

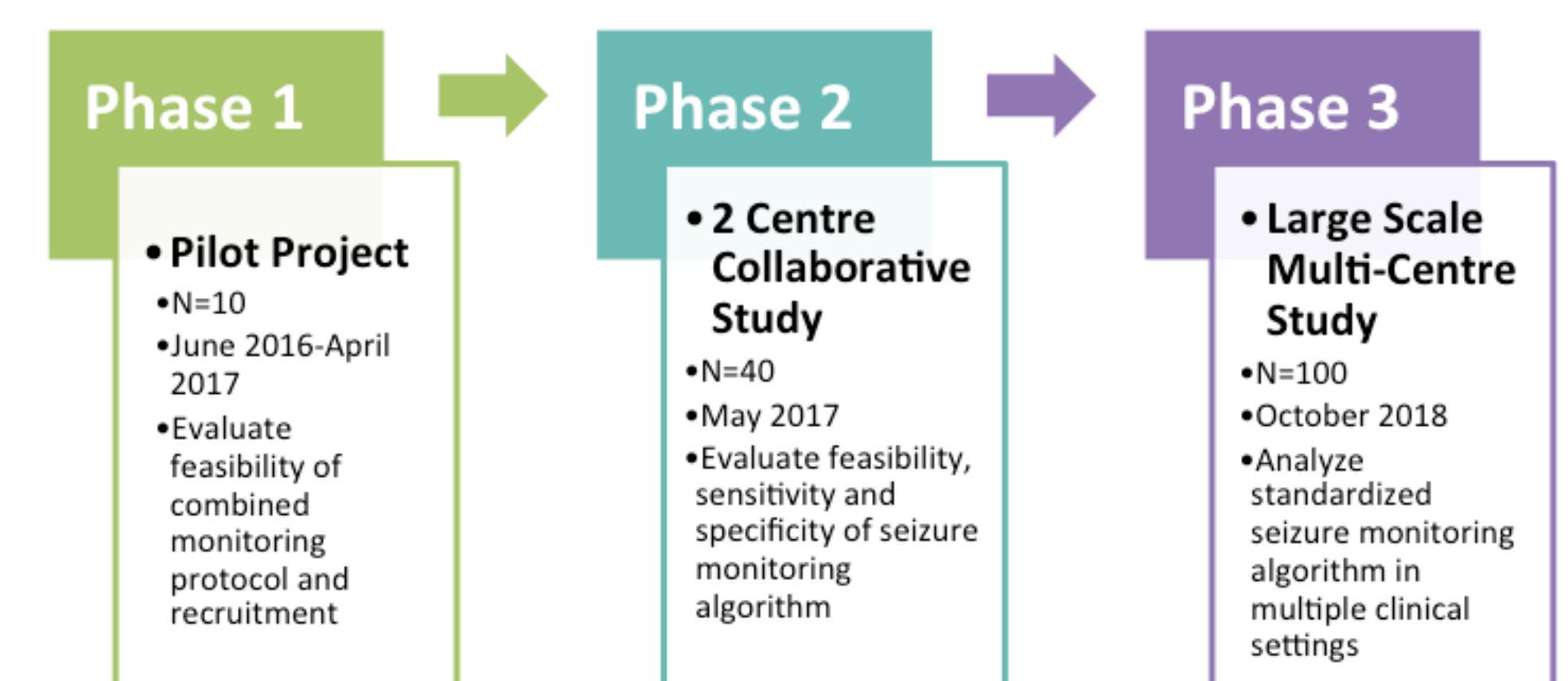


Figure 3. Program of research

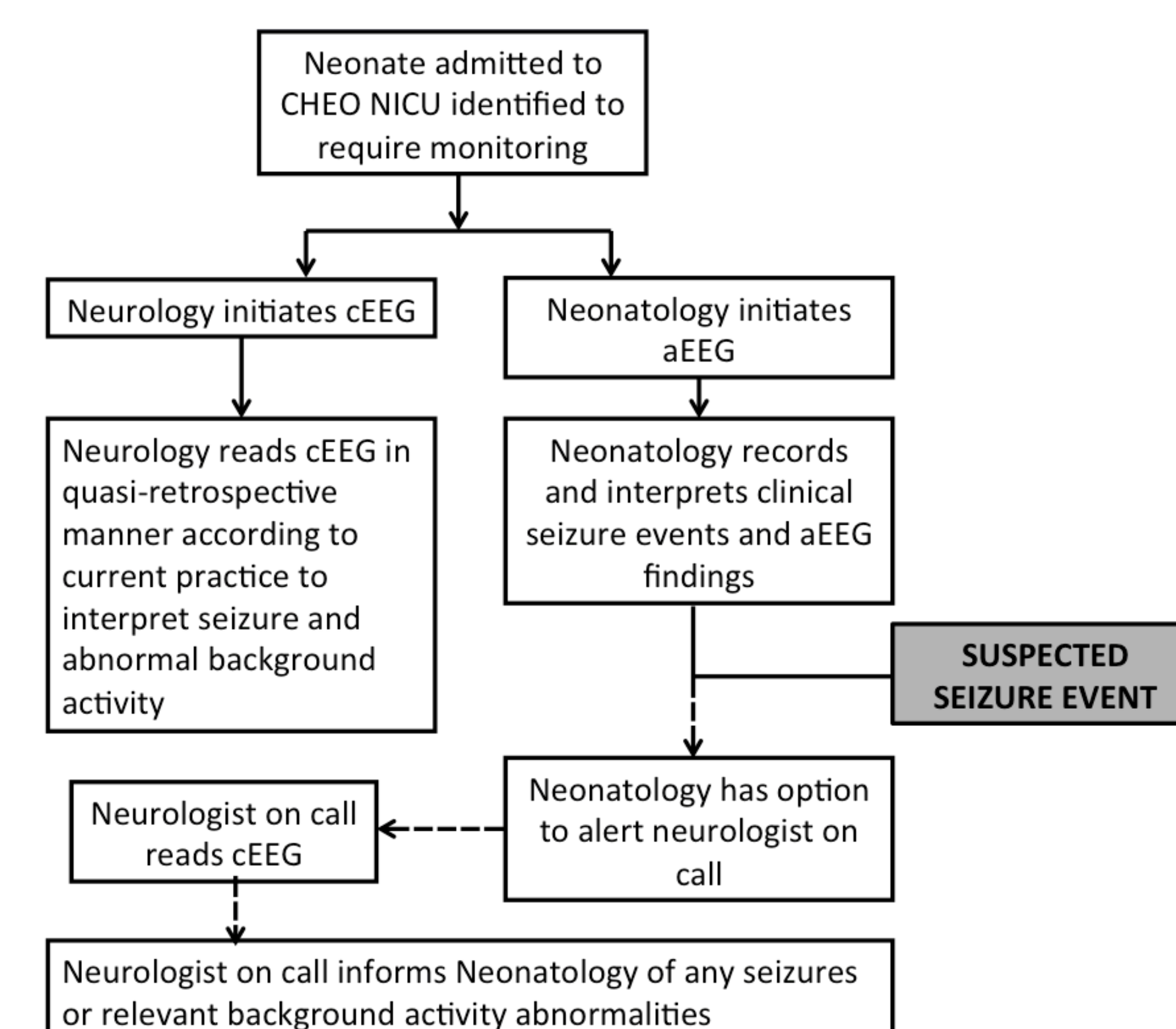


Figure 4. Combined seizure monitoring algorithm

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