



St George's University Hospitals
NHS Foundation Trust

Epilepsy & Vagal Nerve Stimulation

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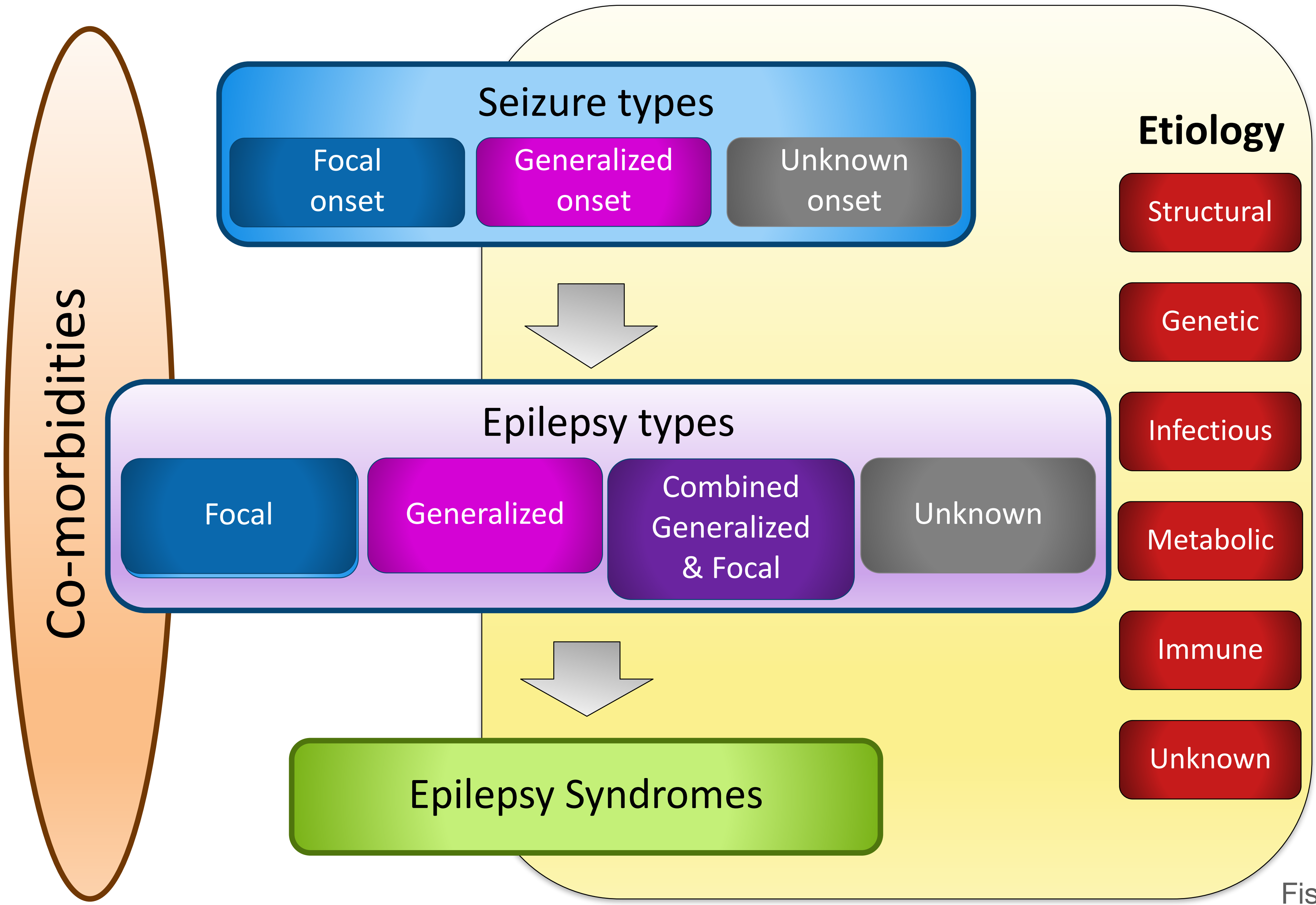


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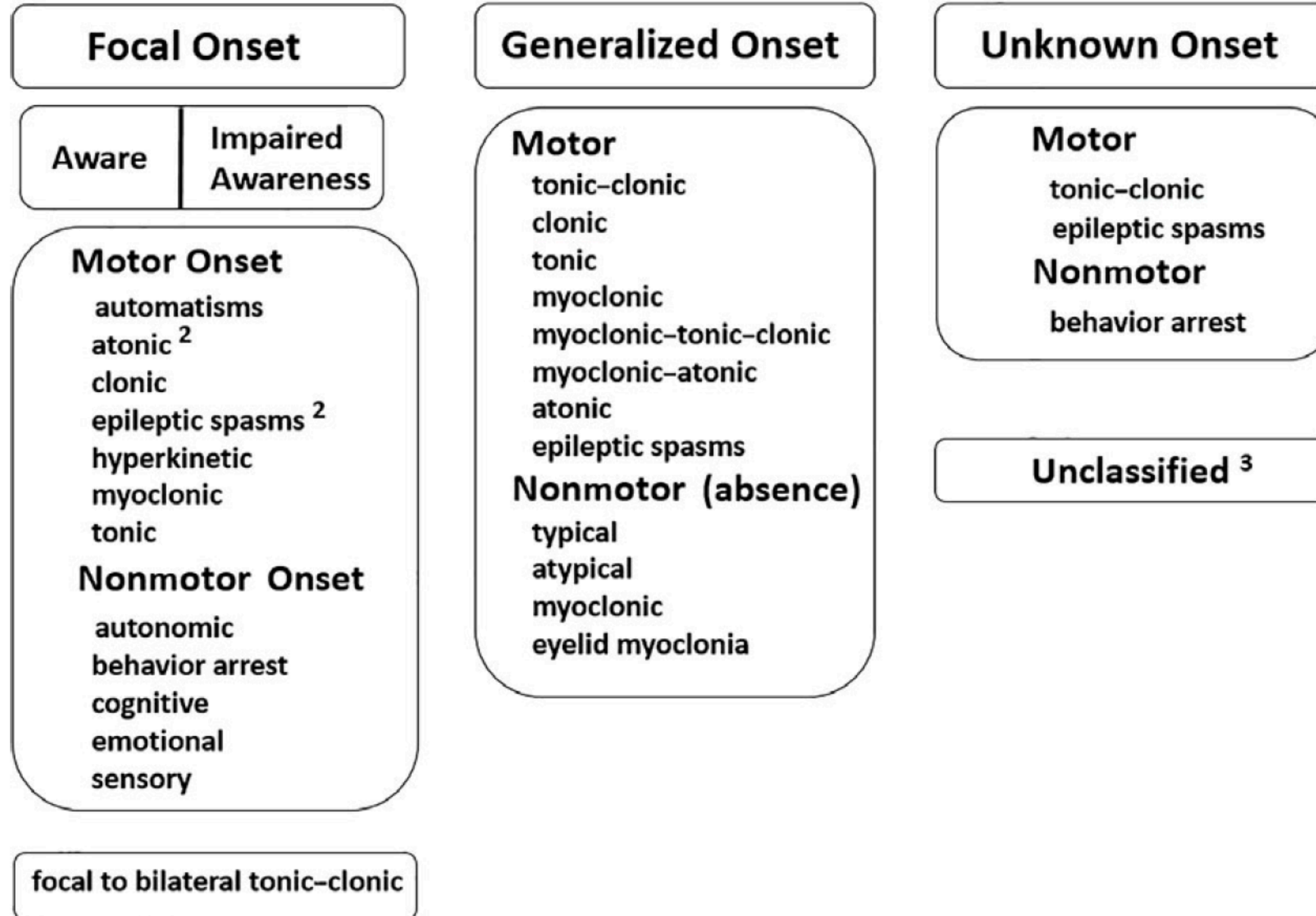
- Treatment
- Evidence
- Indications
- Evaluation
- Surgical technique
- Adverse effects
- Post-operative management

Epilepsy

- Definitions:
 - Seizure: *“unregulated synchronised electrical activity”*
 - Epilepsy: *“propensity to seizures”*
- Epidemiology
 - Incidence: 61 per 100,000 per year | Prevalence: 8 per 1000
- Global burden of disease
 - 48 million people, 0.5% of all disease, >16 million disability-associated life years, higher in LMIC
- Prognosis
 - 75% seizure controlled | 25% refractory [20% focal | 80% global]



ILAE 2017 Classification of Seizure Types Expanded Version ¹



Neurosurgical Interventions for Epilepsy

RESECTIVE

NEUROMODULATION

Temporal lobectomy
[Amygdalohippocampectomy]

Lesionectomy / topectomy

“Curative”

Hemispherectomy
Callosotomy
Multiple sub-pial transections

“Palliative”

Vagus Nerve Stimulation
Deep Brain Stimulation
Responsive neurostimulation

“Non-invasive”

Laser interstitial thermotherapy (LITT)
MR-guided Focussed Ultrasound (MRgFUS)
Gamma Knife Radiotherapy

Next generation

Advanced therapy
medicinal products (ATMPs)

INVESTIGATIVE

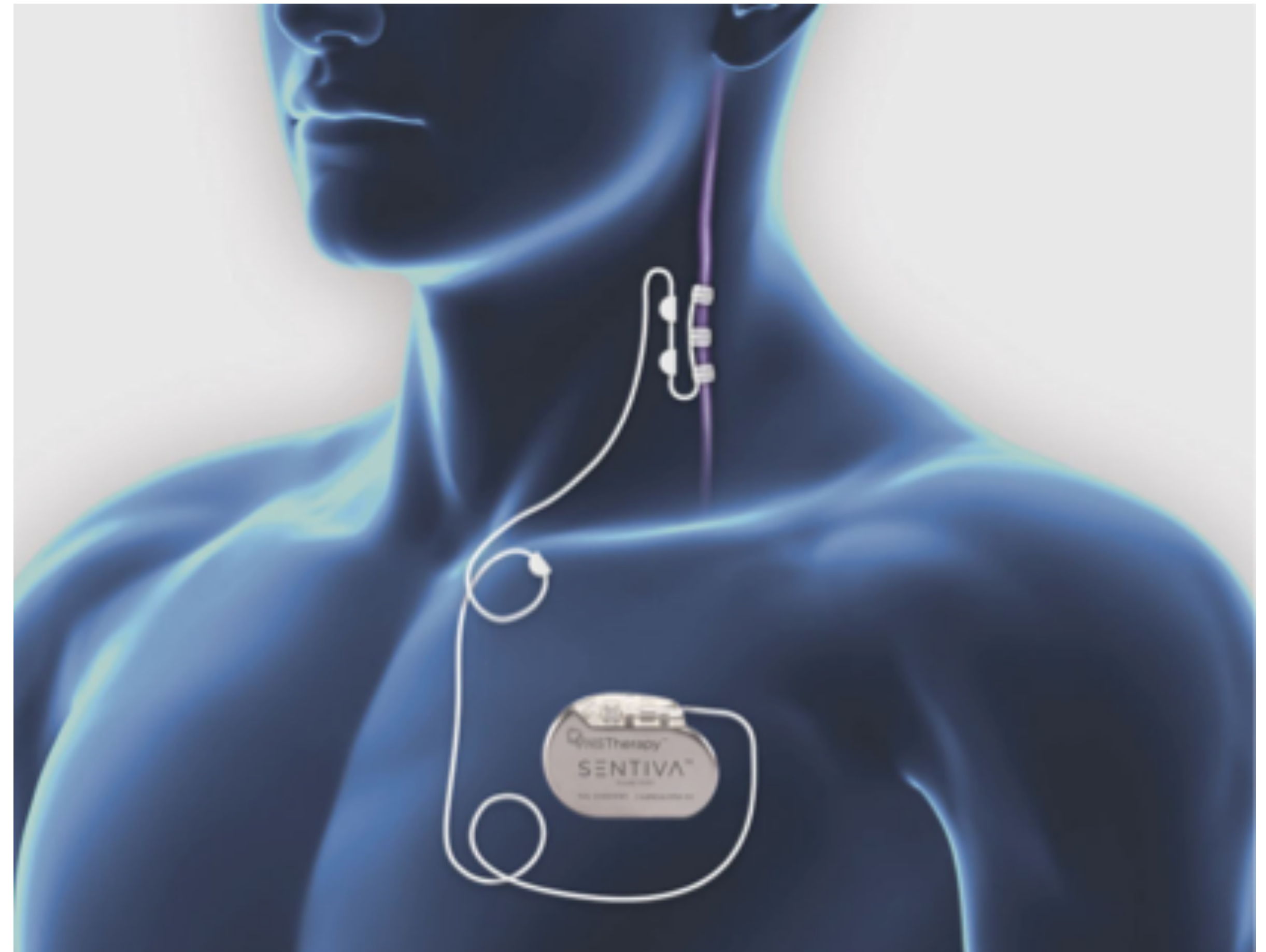
Stereo-electroencephalography (SEEG)
Subdural grids / strips (ECoG)
Awake stimulation

Vagal Nerve Stimulation

- “Stimulation” of limbs for relief of seizures (Galen)
- First described in 1880 by Corning
- Reinvigorated with animal models 1980s (Zabara)
- Approved 1988
- >100,000 implantations worldwide

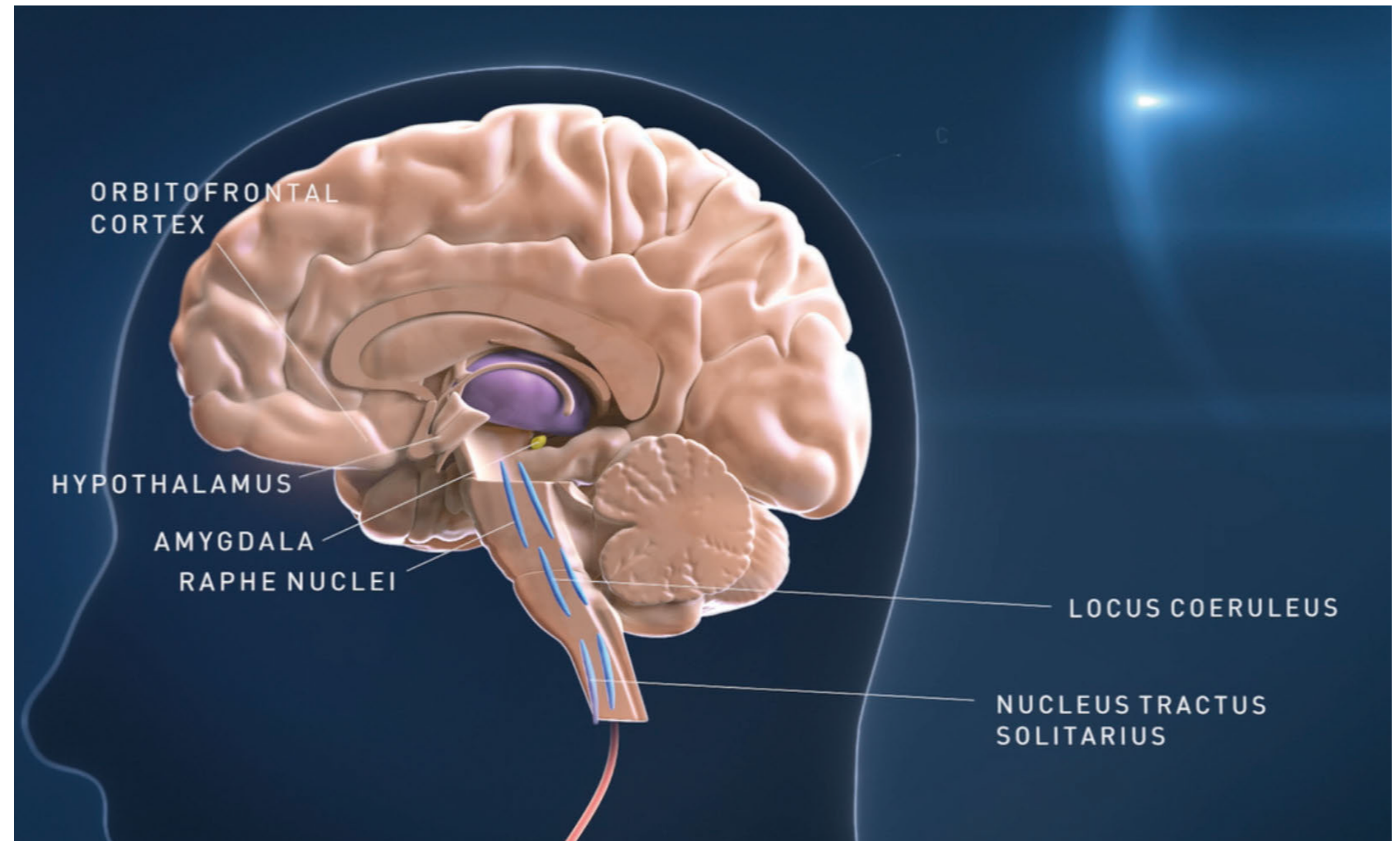
VNS by LivaNova

- Implantable
 - Electrode
 - Implantable Pulse Generator (IPG) [aka “battery”]
 - Anchoring devices
- Also programming system, patient controller, & wand

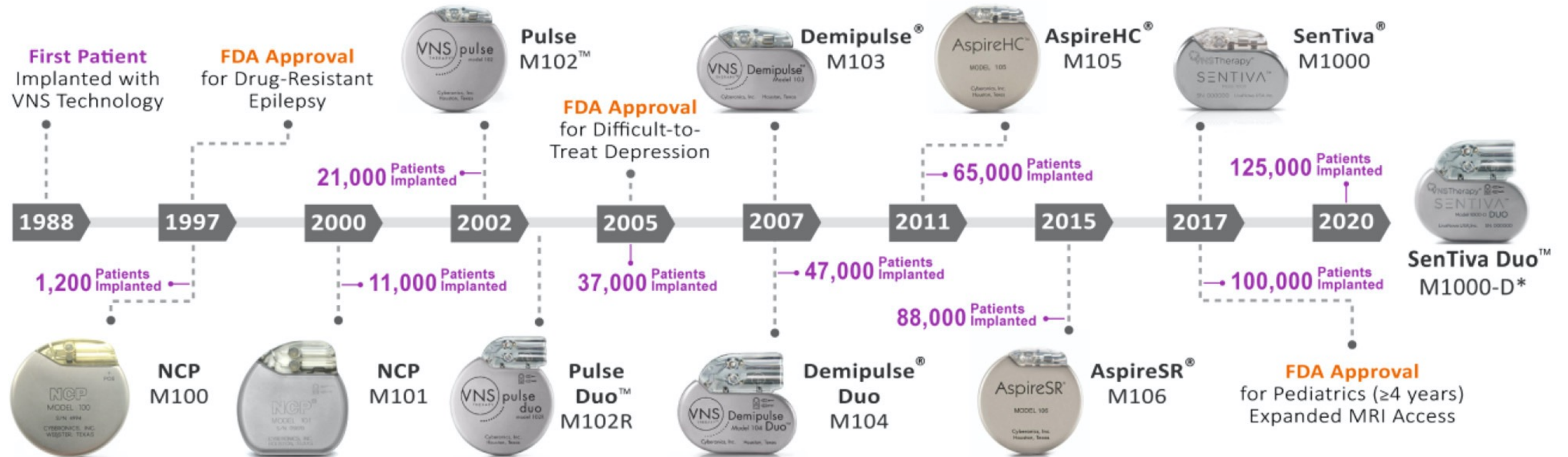


VNS: mechanism of action

- Microdialysis: increased hippocampal noradrenalin
- PET: diverse flow changes
- ECoG: increased P300 waveform predictive of response
- Conclusion
 - Vagal-LC-NA axis neuromodulation

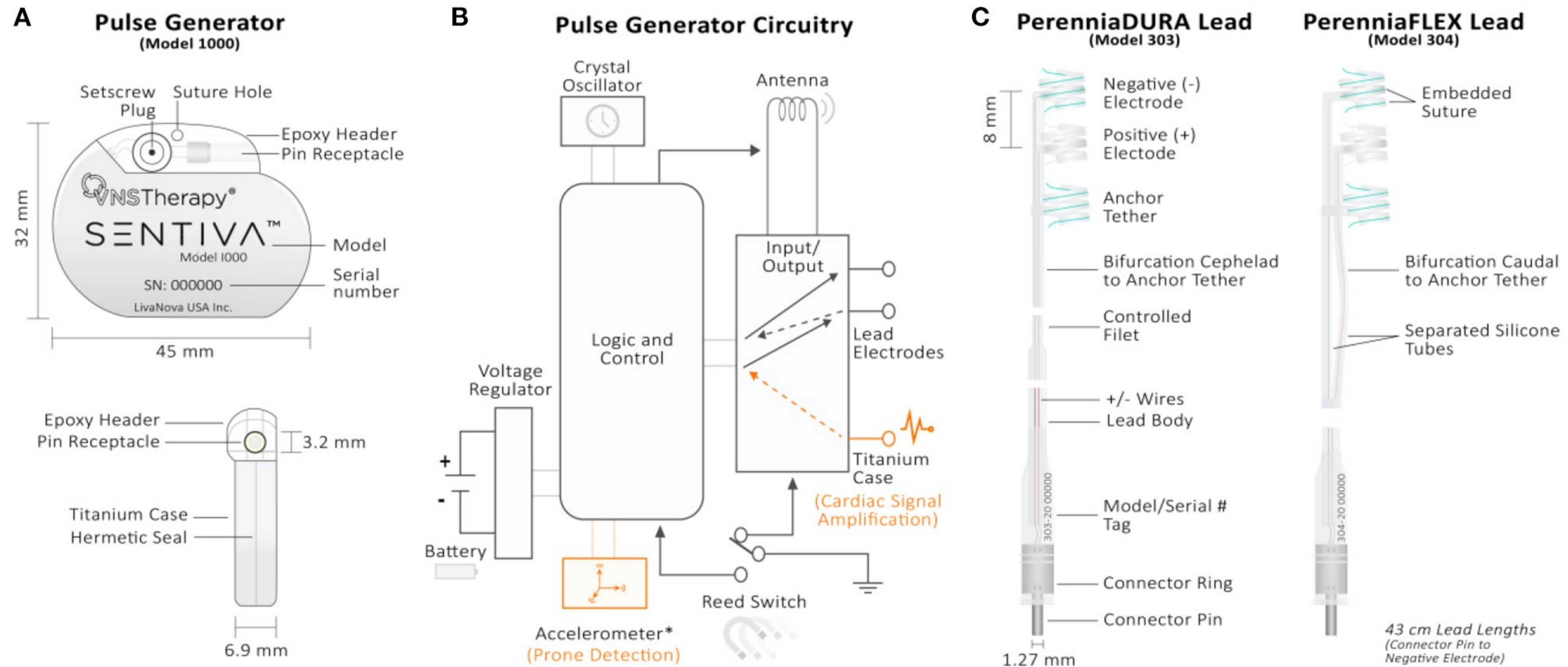


Device Evolution



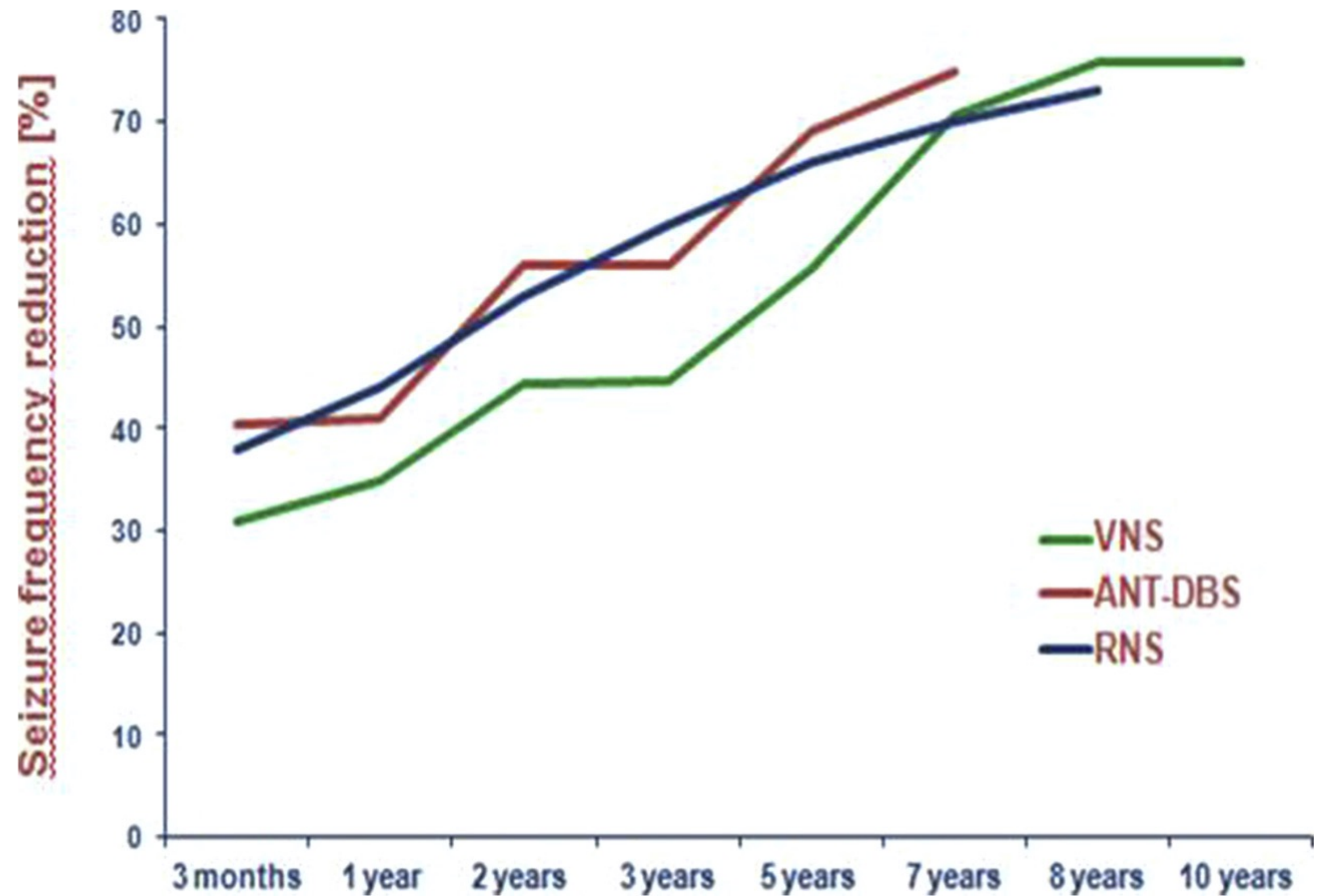
The Hardware

And why implantable pulse generator (IPG), not battery?



Evidence

- EO1-EO5 trials (n=440)
- Seizure reduction:
 - 8% seizure free
 - 90% in 15-22%
 - 50% in 64-91%
 - Also: less severe, shorter, faster recovery
- Also:
 - Mood, concentration, alertness, quality of life, SUDEP



Dibue-Adjei et al, 2019

Indications

- Refractory general or partial seizures
- NICE: CG137 (2012) & IPG50 (2004, children)
- FDA (1997): Also Morris et al, Epilepsy Curr, 2013
- Typically with no resective option
- NB: no other neuromodulatory options available in UK

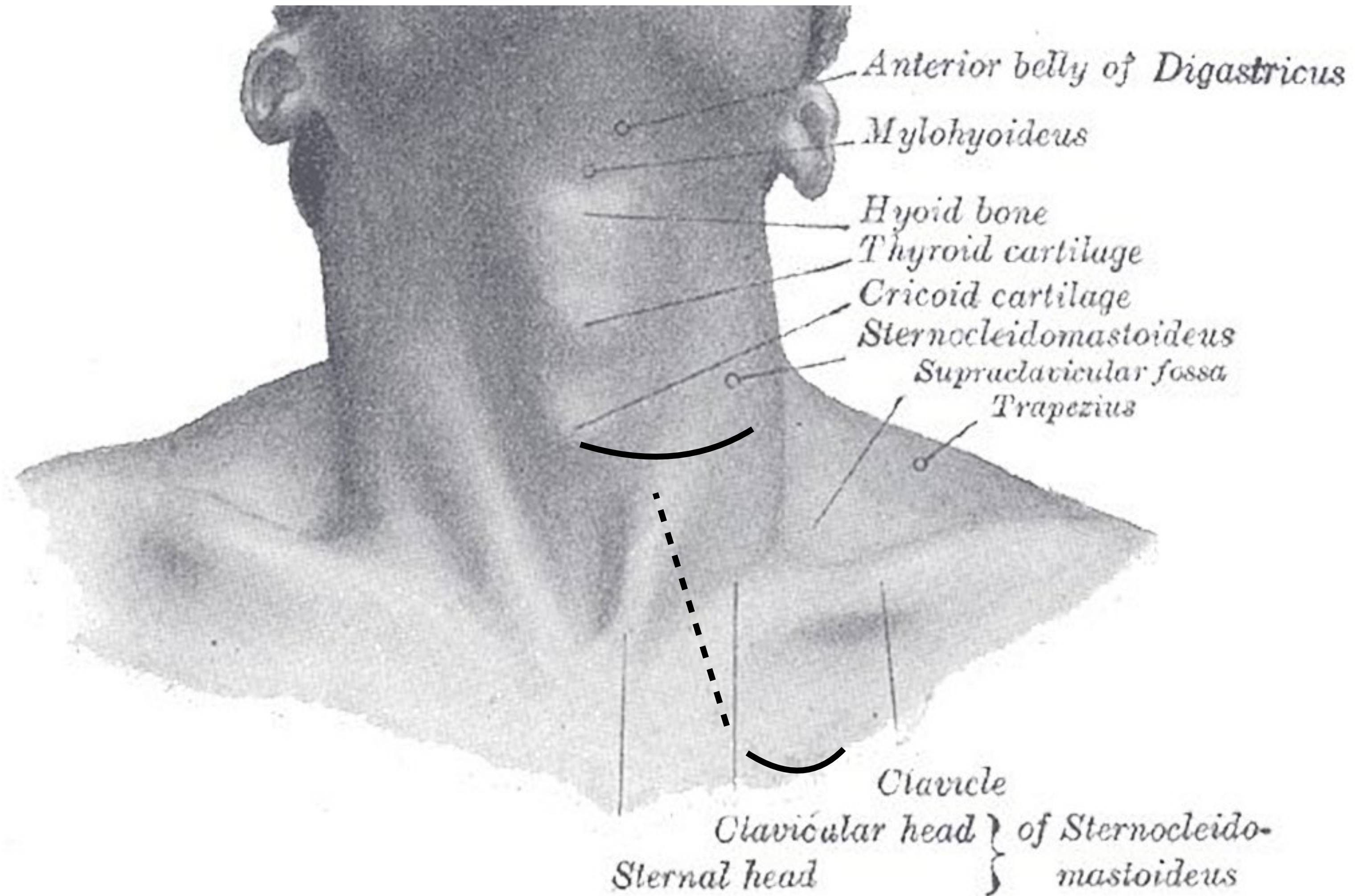
Pre-operative work-up

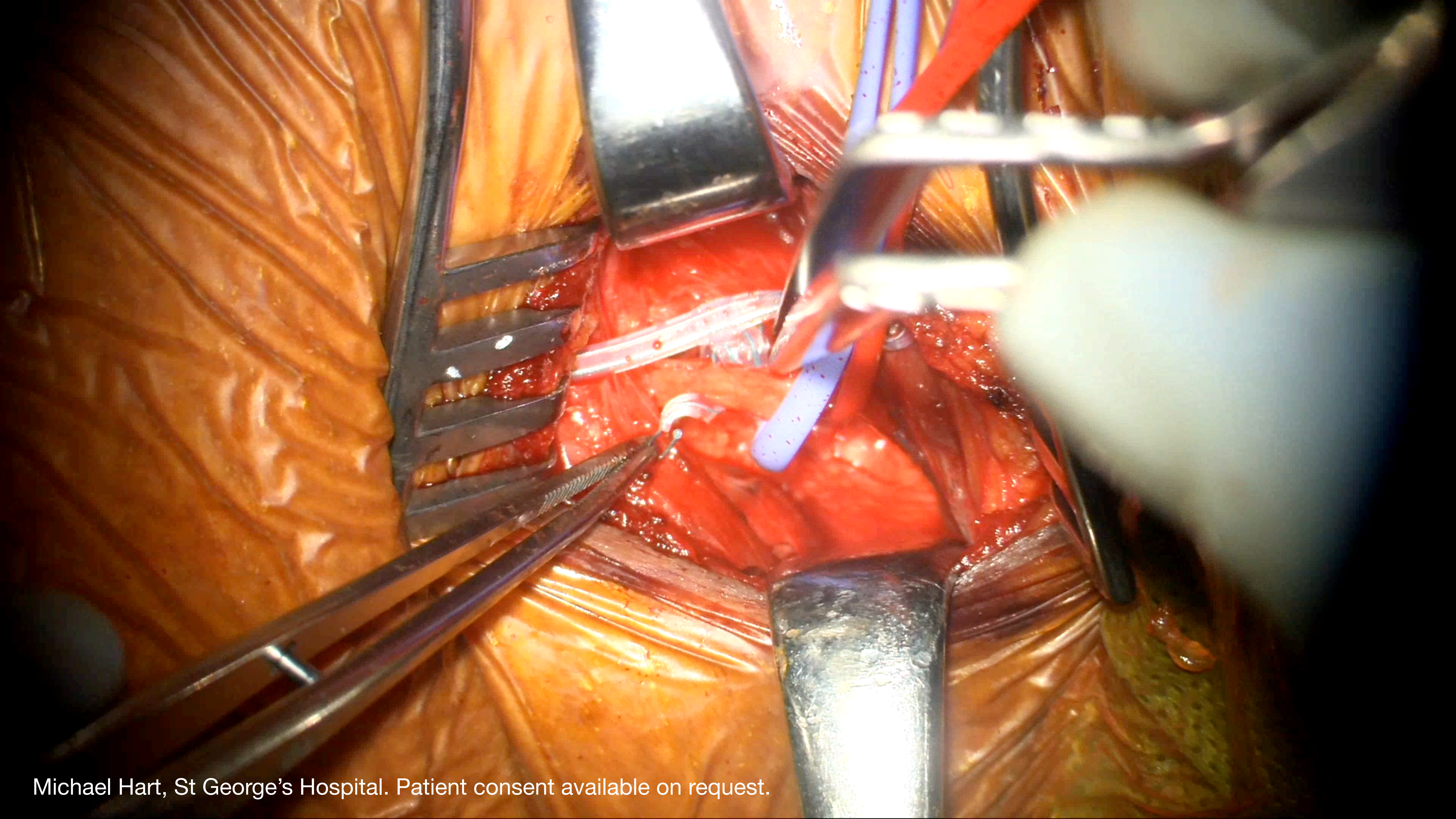
- Epilepsy MDT work-up
 - Options: medications, ketogenic diet, canna
 - Assessment: MRI, EEG, adjuncts, epileptologist
- Routine bloods & ECG
- Consider swallowing or sleep apnoea assessment
- Contraindications: regular MRI upper thoracic region, coagulopathy, arrhythmia, immunocompromise, professional voice use

Surgical Steps

- Make pocket
- Dissect vagus nerve: 40 mins
- Tunnel electrode
- Wrap nerve: 8-20 mins
- Secure with strain-relief loop
- Connect to IPG & check impedances
- Total: 90-120 mins

Surface Anatomy





Michael Hart, St George's Hospital. Patient consent available on request.

Neck dissection

- Undermine skin & site retractor
- Divide & undermine platysma & re-site retractor
- Define SCM
- Open pre-cervical fascia +/- manipulate omohyoid superiorly
- Palpate carotid & insert deep retractors
- Open carotid sheath
- Isolate vagus circumferentially 3cm+ (without branches)

Device Handling

- 3 loops: anchor - anode - cathode
- Align deep to platysma and in parallel medial to vagus
- Loop via pulling with ties either side of nerve - not handling device
- Gentle traction with ties, can gently manipulate nerve with adventitia, consider curved or right-angled instruments
- Strain relief loop in neck with 3 ties
- Redundant extension under IPG
- Consider adjuncts for infection e.g. vancomycin powder

Surgical Pearls

- Positioning
 - Supine on horseshoe, not too rotated or extended
- Skin marking
 - Chest incision can be smallest diameter
 - Neck centred low & over SCM
- Neck dissection
 - mobilise nerve branches
 - divide & cut vessels with early bipolar
 - use fascial planes
- Device handling
 - Use loops
 - Microscope optional
 - Tunnel deep to platysma & before securing

Operative Variations

- Single incision
- Dissection: divide or split platysma
- Visualisation: microscope, loops, nil
- Retractor type
- Nerve handling: vascular loops, sheet underlay
- Device handling: direction of wrapping, tunnel first or after wrapping nerve

Post-operative management

- Dressings off & wash & 48 hours
- No investigations or medications
- Potential day-case surgery (or overnight stay)
- Programming at 2-4 weeks & up to 2-4 months
- Annual follow-up for outcomes management & anti-convulsant review
- Battery replacement: 77% uptake, 4-8 years

Adverse effects

EO5 (n=195)

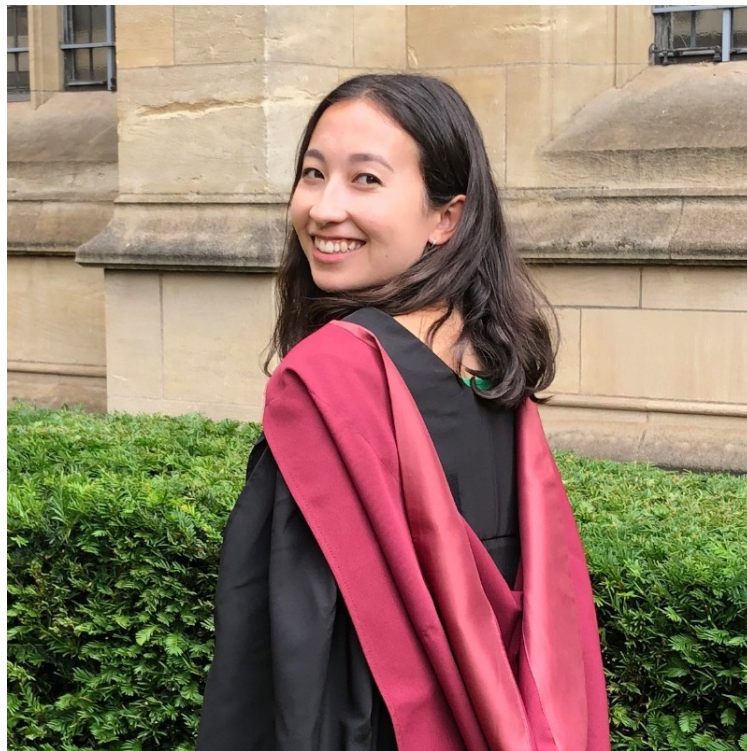
- Infection: 3-6% +/- device removal
- Acute
 - Haematoma
 - Recurrent laryngeal nerve injury
- Chronic
 - Wound issues <1%
 - Hardware malfunction <1%
- Reversible (& typically mild / early)
 - Voice alteration (37%), hoarseness (19%), throat pain (5%), dyspnoea (3%)
- Also headache, pharyngitis, depression, paraesthesia
- No cardiac or respiratory or GI effects

Summary

- Refractory epilepsy remains a major global health concern
- Variety of neurosurgical options of which VNS is most common
- Well-rehearsed technique
- Knowledge of neck anatomy paramount
- Surgical pearls for neck dissection, device implantation, & hardware management

Acknowledgements

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