Role of Devices in SUDEP Prevention
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Learning Objectives

• Review principles of devices for SUDEP prevention
• Review examples of candidate devices
Devices for SUDEP Prevention

• Devices to prevent fatal complications of seizures
• Devices to detect seizures and notify caregivers
  – Identify most vulnerable period
  – May be tied to intervention
Devices to prevent fatal complications of seizures

- Anti-suffocation pillows
- Never have been tested
- Class I medical device in UK (not approved as such in US)
Principles of Seizure Detection Devices

Sensors

Transmitter

Intervention?
Seizure Detection Methods

EEG features

- **Pros**
  - High sensitivity & specificity is possible
  - Could detect non-convulsive seizures

- **Cons**
  - Application/maintenance of electrodes
  - More invasive solutions (subdural, epidural electrodes) may not be broadly applicable
Seizure Detection Methods

Motor Activity

- Methods
  - Accelerometers (Nijsen et al 2005)
  - Mattress sensors
  - Surface EMG (Conradsen et al 2011)
  - Video motion detection (Karayiannis et al, 2005)

- Pros
  - Inexpensive
  - Non-invasive

- Cons
  - Detects only convulsive seizures
  - Some methods (mattress devices, video) restricted to a specific site (e.g. bedroom)
  - May be some issues with specificity
Seizure Detection Methods
Other Physiological Parameters

- **Heart rate**
  - HR elevates with majority of seizures with characteristic slope (e.g. Mosely et al, 2011; Opherk et al 2002; Nei et al, 2000)

- **Pulse oximetry**
  - SaO decreases in 44% of generalized seizures in children (Mosely et al, 2010) and 33% of partial-onset seizures in adults (Bateman et al, 2008)

- **Galvanic Skin Response/Electrodermal Activity**
  - Measure of sympathetic system function (sweat glands)
  - Increased EDA seen with CPS and SGTC in children (Poh et al, 2010)
Seizure Detection Methods

Other Physiological Parameters

• Pros
  – Inexpensive
  – Non-invasive

• Cons
  – May lack specificity
Seizure Detection Methods

Multimodal Detectors

- Combining parameters – e.g. HR and accelerometry – may yield improved performance
  - Fail safe mechanism
  - Can improve specificity
  - Another dimension to “tune” detection algorithms to specific individual
Examples

• Several detection/alarm devices currently commercially available
  • Designed to detect seizure-related motion
  • None are FDA-approved to detect seizures
  • Marketed as activity-detectors

• Several additional devices in development
Motion Detection Devices – Mattress Device

- **Medpage™ Model MP5**
  - Vibration sensing device
  - Designed for under-mattress use
  - Single study (Carlson et al, 2009) demonstrated high sensitivity GTCS, though many false alarms. PPV = 3%

- **Emfit® Movement Detector**
  - Under mattress piezo-electric device
  - Small study of 22 pts in EMU (Narechania et al, AES 2011): PPV 36% for GTCs, no FP during sleep but 1 FN

http://www.medpageusa.com/MP5.html
http://www.emfit.com
Motion Detection Devices – Watches & Phones

- **SmartWatch™**
  - Wristwatch with accelerometer & GPS
  - Linked to smartphone
  - Study of 40 pts in EMU (Lockman et al, 2011), PPV = 3% for GTCS, all but one FP occurred during wakefulness

- **EpiLert**
  - Wristwatch with accelerometer
  - Not commercially available yet
  - Study of 31 pts (Kramer et al, 2011), PPV = 71%, missed 2 of 22 convulsive sz

- **EpDetect phone app**
  - Uses phone native accelerometers & GPS/SMS messaging
  - No performance reports available

http://www.biolertsys.com

http://www.smart-monitor.com/
Multimodal Devices

Poh et al, 2010

- Electrodermal activity + accelerometer
  - In 80 children, tuned algorithm detected 15/16 GTCS; ~ 1 FP per day of recording per pt (Poh et al, 2012)

http://web.media.mit.edu/~zher/research.html
Multimodal Devices

- RTI Device under development (see Pitruzello et al. PAME poster #15)
  - Detection variables include position, motion, HR, resp rate & EMG
Multimodal Devices?
Impact on Clinical Care and Practice

• Devices using simple sensors (and combinations of sensors) can detect GTCS and potentially alert caregivers
  • Ambulatory use has not been tested
  • Long term compliance unknown
• Larger studies are needed
  • False positive rates may impact useability
Impact on Clinical Care and Practice

• Unknown if seizure alarms can prevent SUDEP
  • Can cascade of events after terminal seizure be aborted?
• Solutions needed for patients who live alone and non-convulsive seizures
Partner Organizations

- American Epilepsy Society
- CURE Epilepsy
- Epilepsy Foundation
- Epilepsy Therapy Project
- SUDEP Aware
- FACES (Finding a Cure for Epilepsy & Seizures)
- Danny Did Foundation
- RTI International
- ICE Epilepsy Alliance
- CDC (Centers for Disease Control and Prevention)
- National Institute of Neurological Disorders and Stroke
- LGS Foundation
- Lennox-Gastaut Syndrome
- The Pittsburgh Foundation