CIED-Detected Sleep Apnea

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COI Disclosure

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The authors have no financial conflicts of interest
to disclose concerning the presentation

Disclosure

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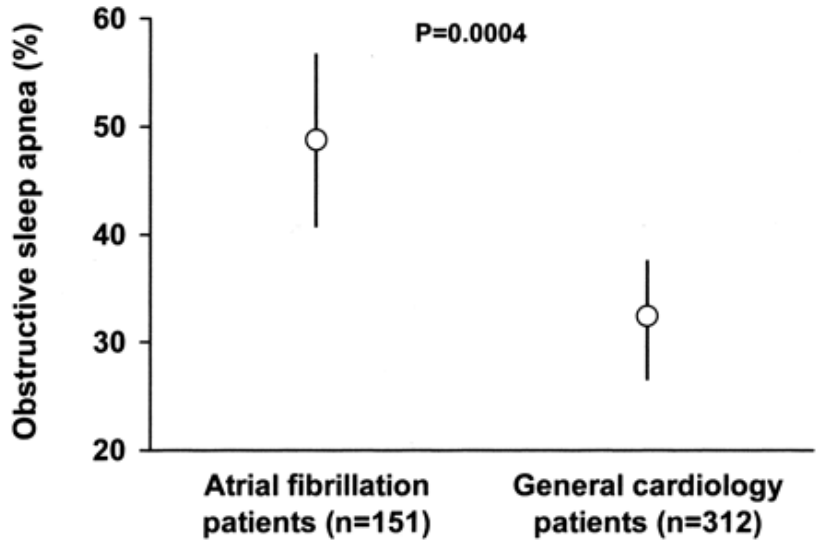
- Consulting: Jazz Pharmaceuticals, Caretaker Medical Inc.
- No relevance to this talk

Sleep Apnea (SA) is Common

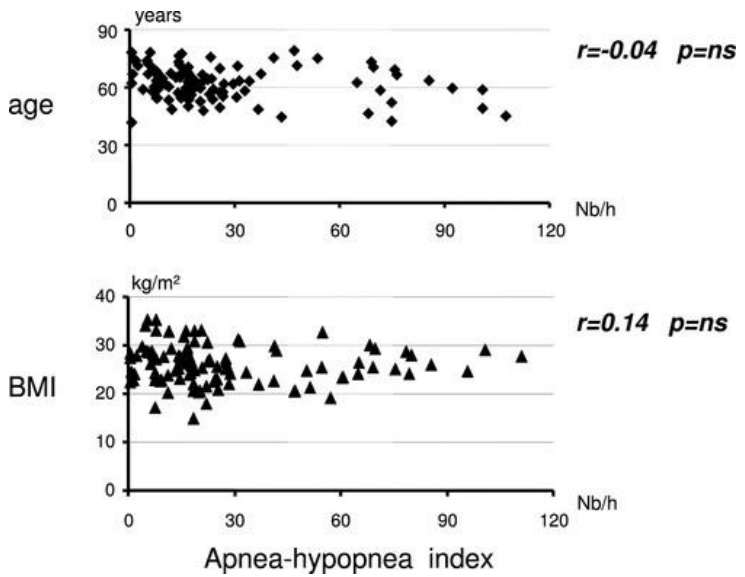
- SA is common in patients with cardiovascular disease (CVD) including cardiac arrhythmias (AF) and heart failure (HF)



Gami et al. Circulation 2004

Sleep Apnea (SA) is Common – Patients with CIED

- SA is common in patients with cardiac implantable electronic device (CIED): 60%
  - HF: 50%; AV block 58%; SND 68%
- No relationship between BMI and AHI (severity of SA)

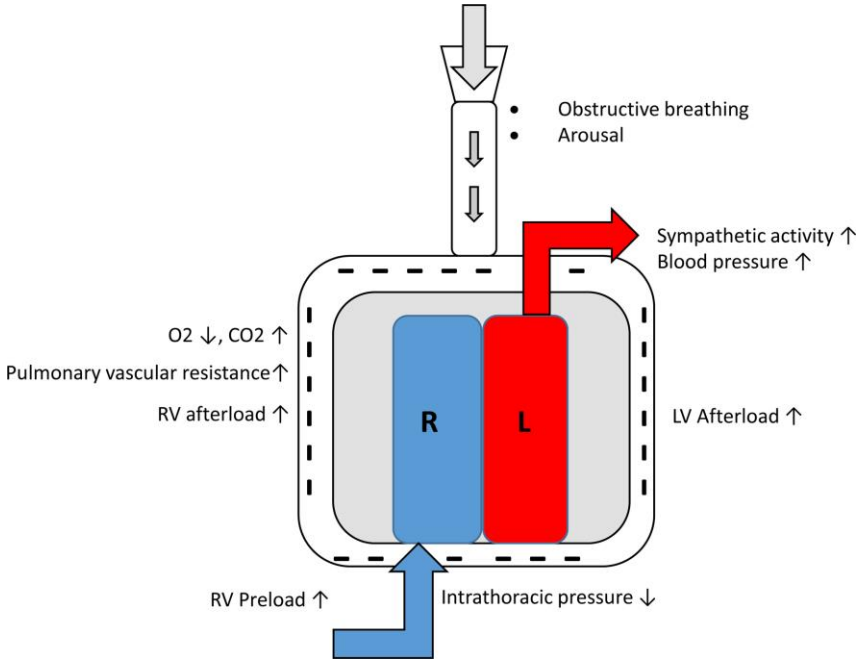


Apnea hypopnea index (AHI)

Garrigue et al. 2007 Circulation

Sleep Apnea (SA) and Health

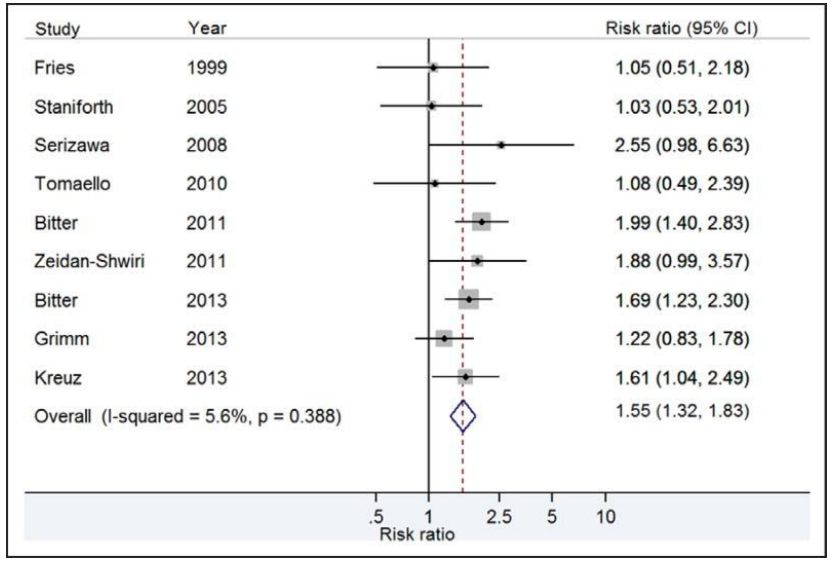
- SA impairs sleep quality (drowsiness, fatigue, poor concentration) – poor quality of life, high risk of accident
- SA has a negative impact on CV health and cardiometabolic health
- SA is implicated in neurocognition/dementia



Kwon et al. 2019 Sleep Med Res

Sleep Apnea (SA) and Cardiac Arrhythmia

- SA may increase the risk of AF
- SA increases the risk of AF recurrence post ablation
- SA has been implicated in malignant arrhythmias

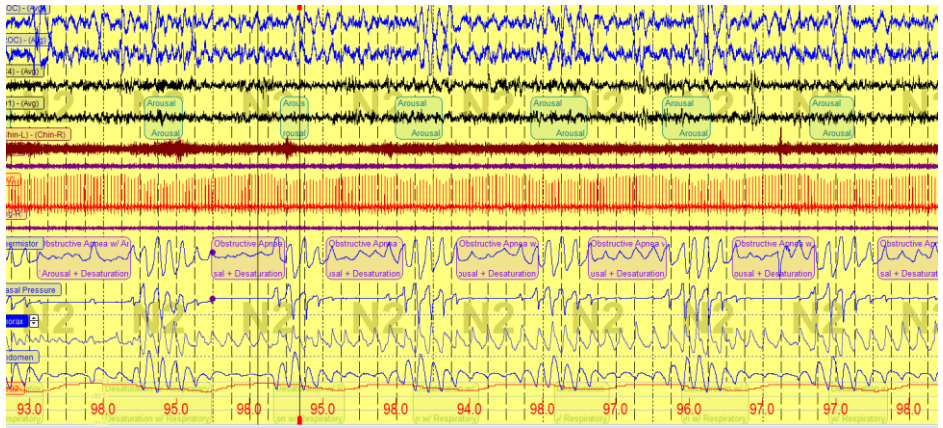


Risk of appropriate implantable cardioverter-de fibrillator therapy in patients with sleep-disord ered breathing (SDB) vs those without SDB.

Kwon et al. 2017 Circ EP

Traditional sleep apnea evaluation by in-lab PSG

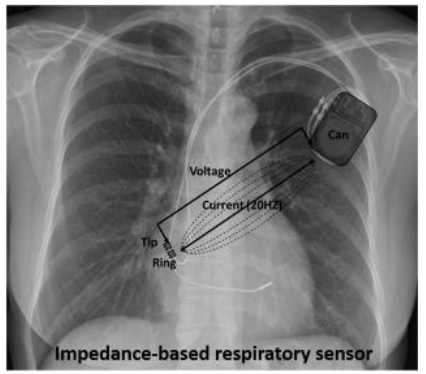
- Inconvenient
- Labor intense, time-consuming
- High cost
- Single night



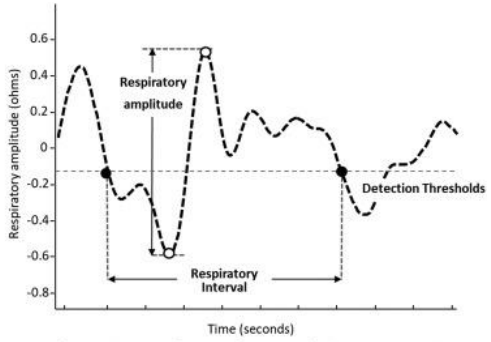
Gwak et al. 2019 IJC

CIED detects respiration

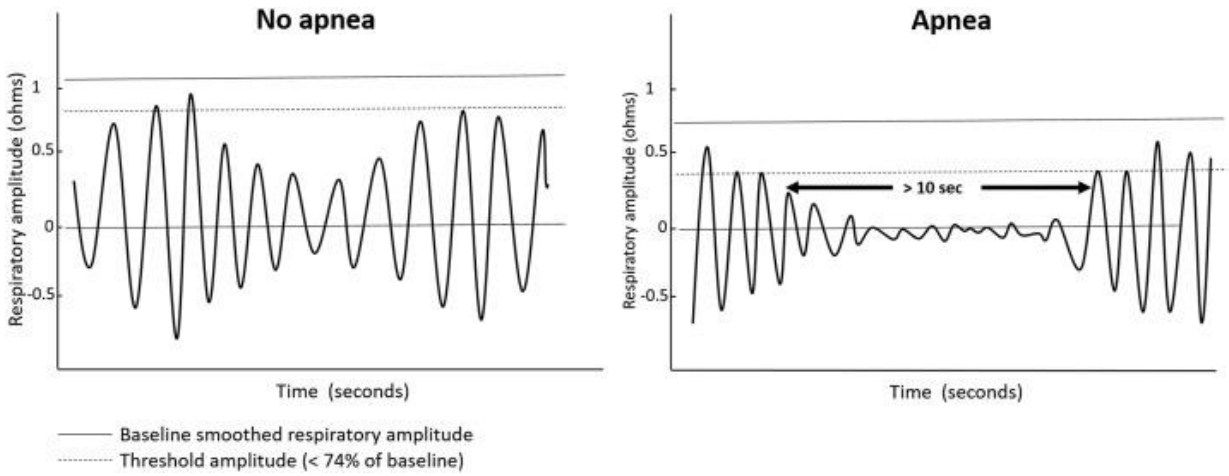
- CIED can detect respiration
  (e.g., basis for rate-responsive pacing)
- Uses thoracic impedance



Impedance-based respiratory sensor

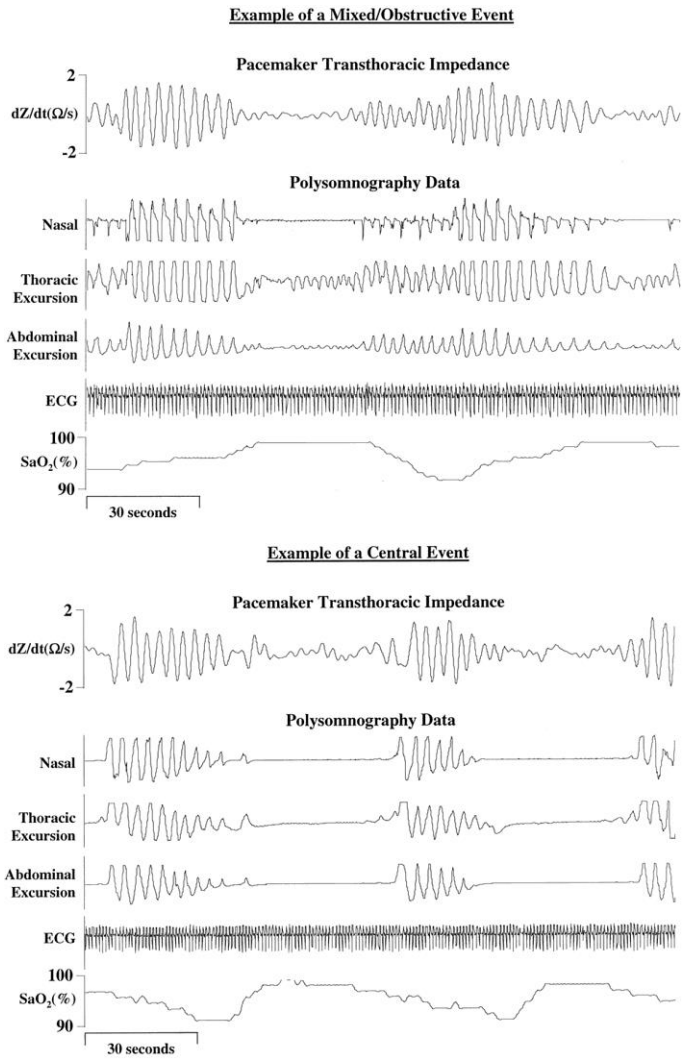


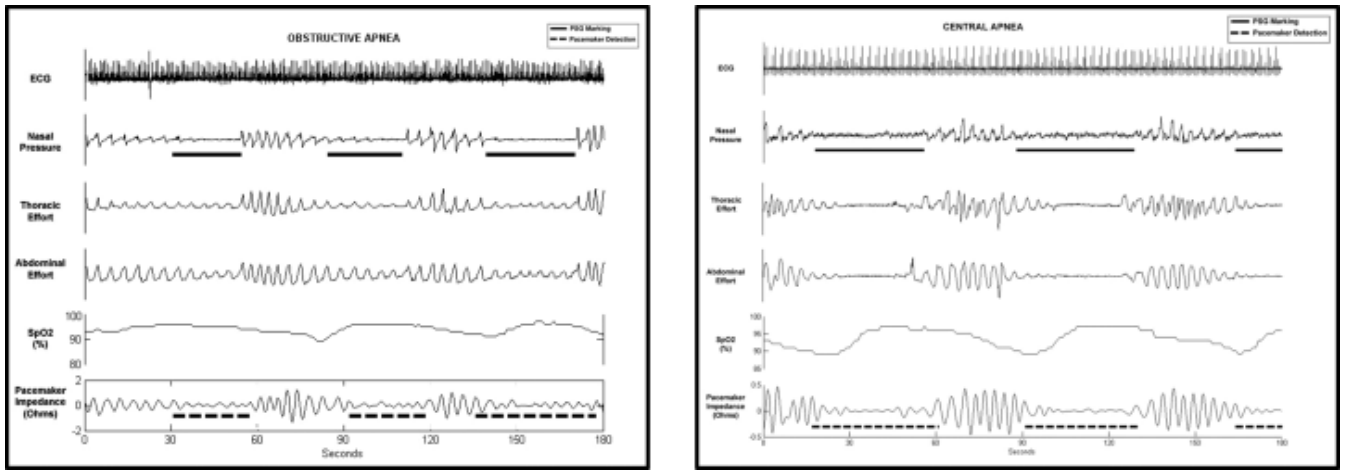
Thoracic impedance changes during respiration



Gwak et al. 2019 IJC

Impedance-based apnea (or SA) detection





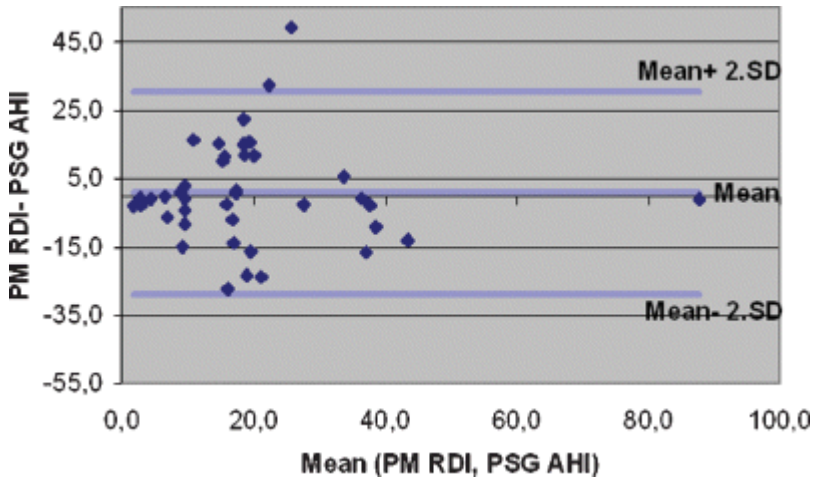
Obstructive sleep apnea (OSA) and central sleep apnea (CSA) event example
The algorithm identified patients with advanced SDB with 82% sensitivity and 88% specificity.

Scharf et al. 2004 Circulation; Shalaby et al. 2006 PACE

CIED SA detection

- Respiratory disturbance index (RDI) by CIED is correlated with apnea-hypopnea index [AHI] by concurrent polysomnography (PSG)

- **Correlation is reasonably good**



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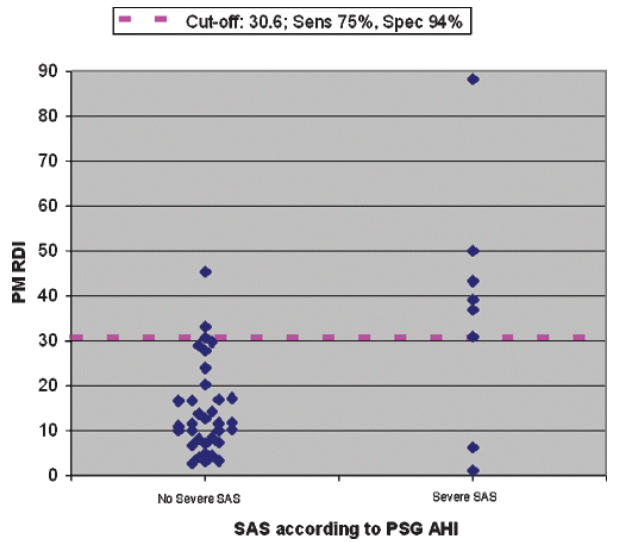
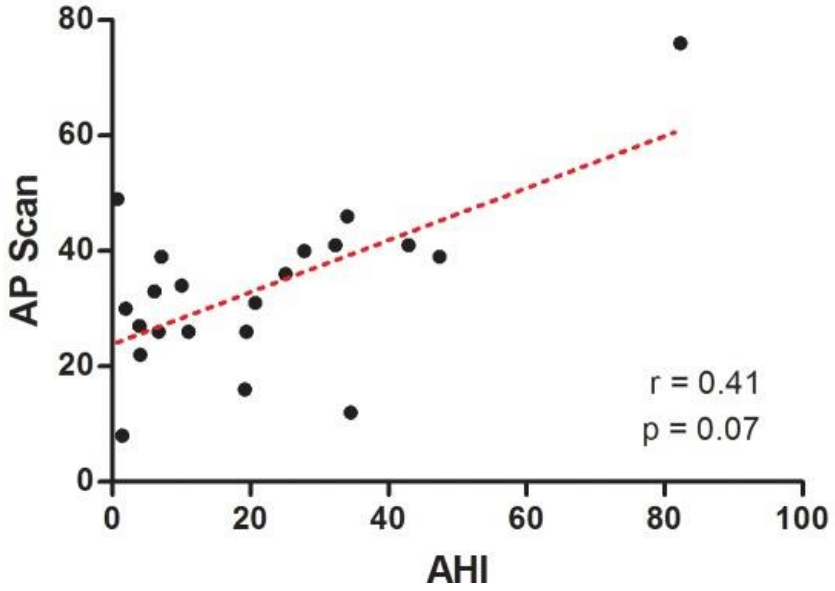


Defaye et al. 2004 JCE

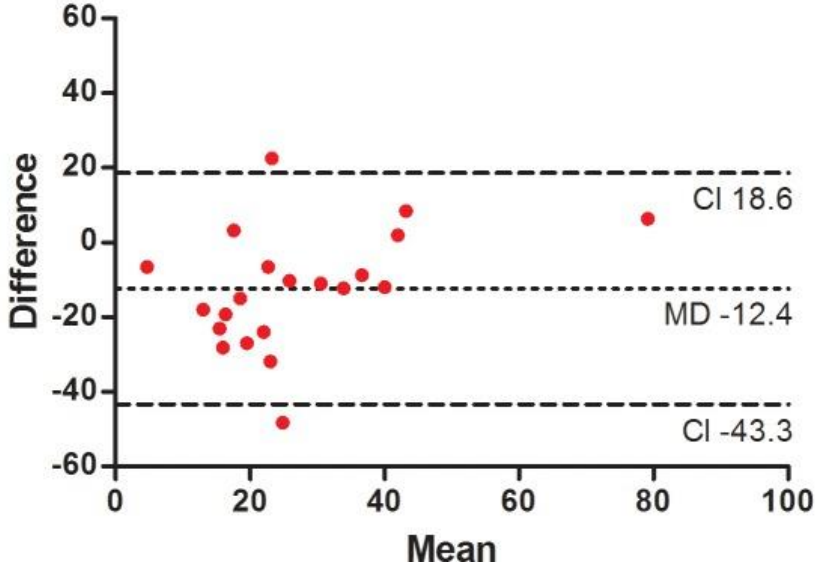
UPGRADE Study

- CRT upgraded HF patients
- Boston Scientific AP scan
- Correlation was poor against PSG

Correlation between AP scan® and AHI evaluated by the PSG



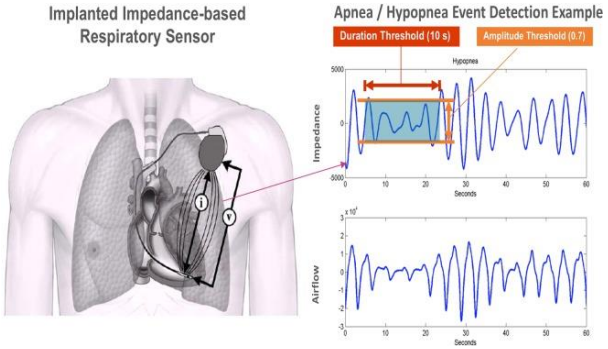
Bland-Altman plot for comparison of AP scan® and AHI

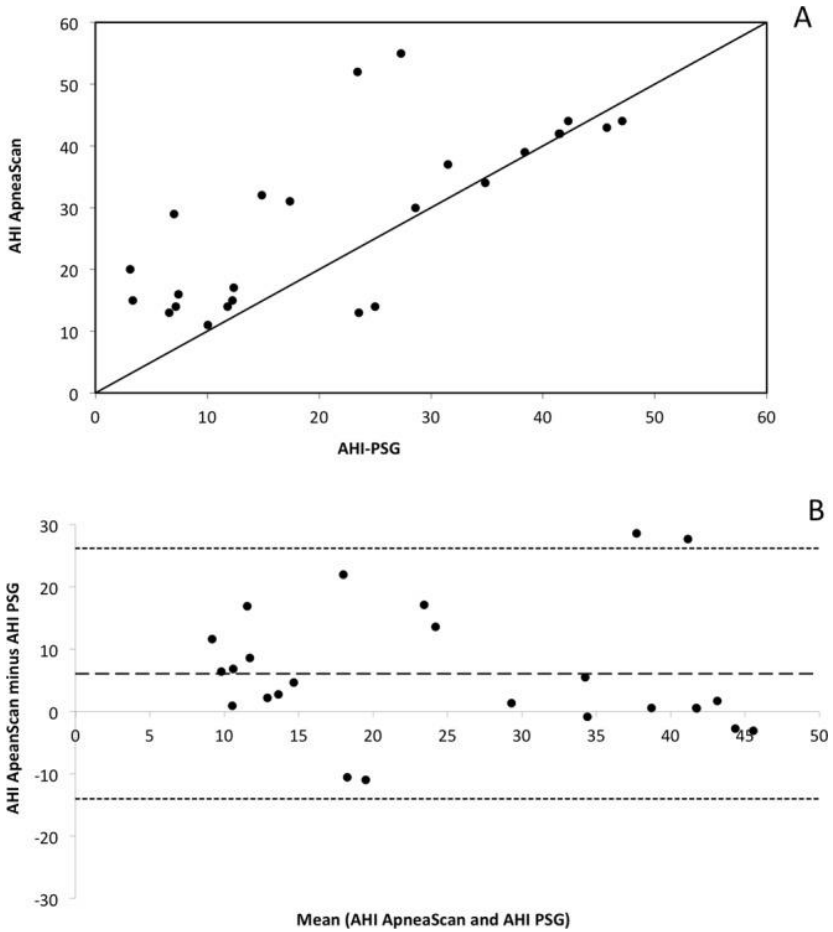


Barbieri et al. 2018 PLoS one

AIRLESS study

- ICD or CRT-D
- Boston Scientific AP scan
- Correlation was good against PSG

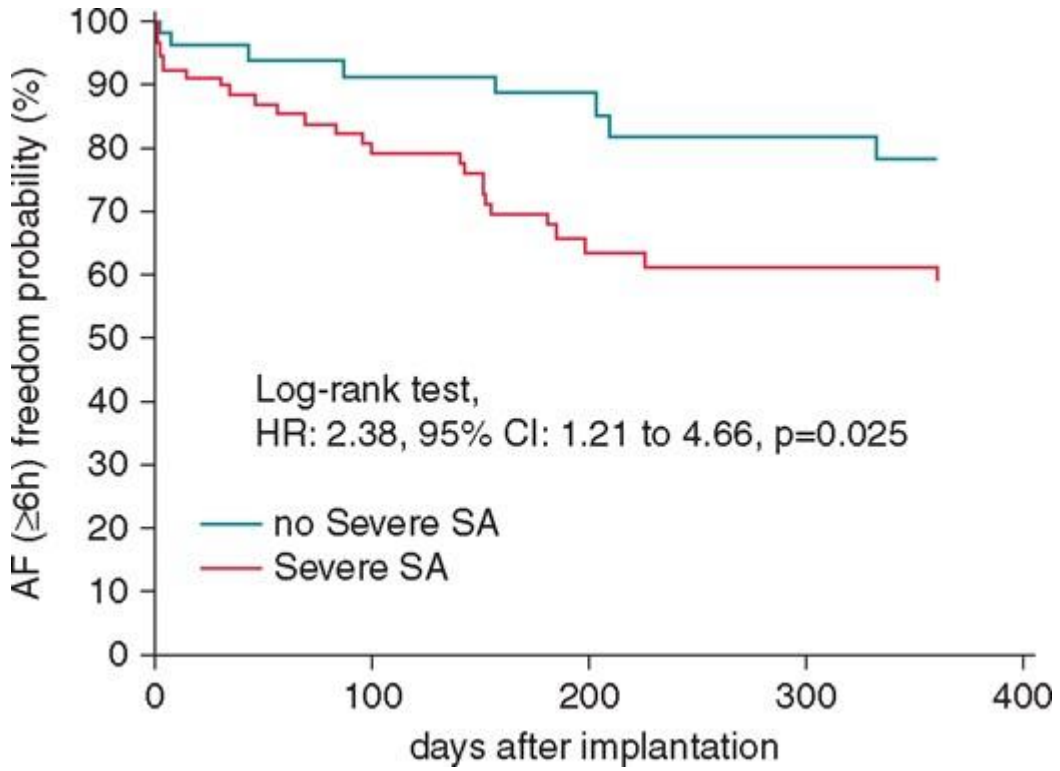




Defaye et al. 2019 Sci Rep

Clinical Implications of CIED-detected SA: AF

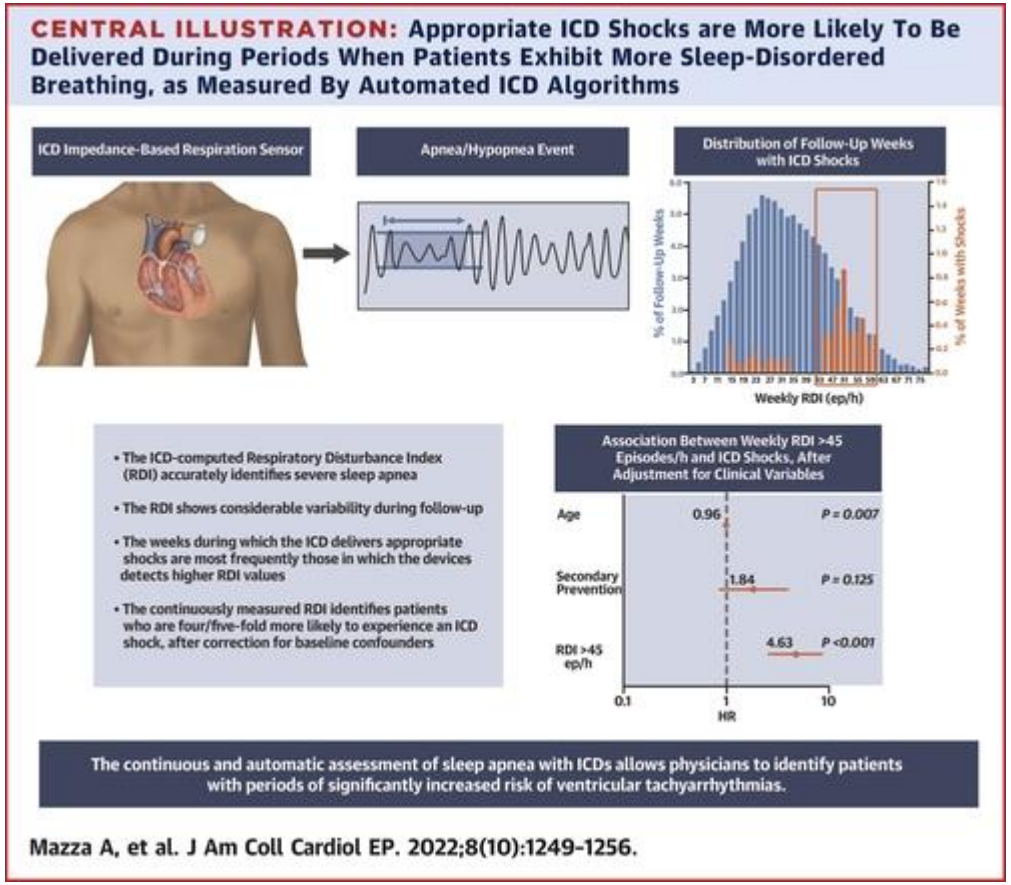
- PPM detected SA and new-onset AF?
- Severe SA was associated with a higher risk of new-onset AF (log-rank test, hazard ratio: 2.80; 95% CI: 1.10–7.10; P = 0.047).



Mazza et al. 2017 Europace

Clinical Implications of CIED-detected SA: ICD shock

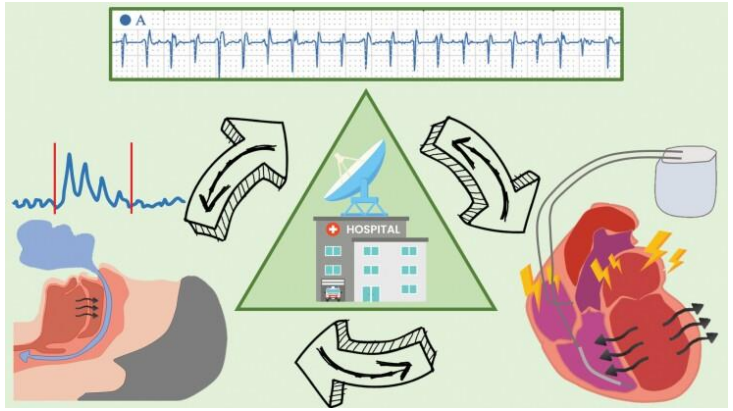
- ICD detected SA and appropriate ICD shock in HF patients?
- During 2-year follow-up, 14% had ICD shock
- Continuously measured weekly mean RDI of ≥45/h was associated with ICD shock (HR: 4.63; 95% CI: 2.54-8.43; P < 0.001),

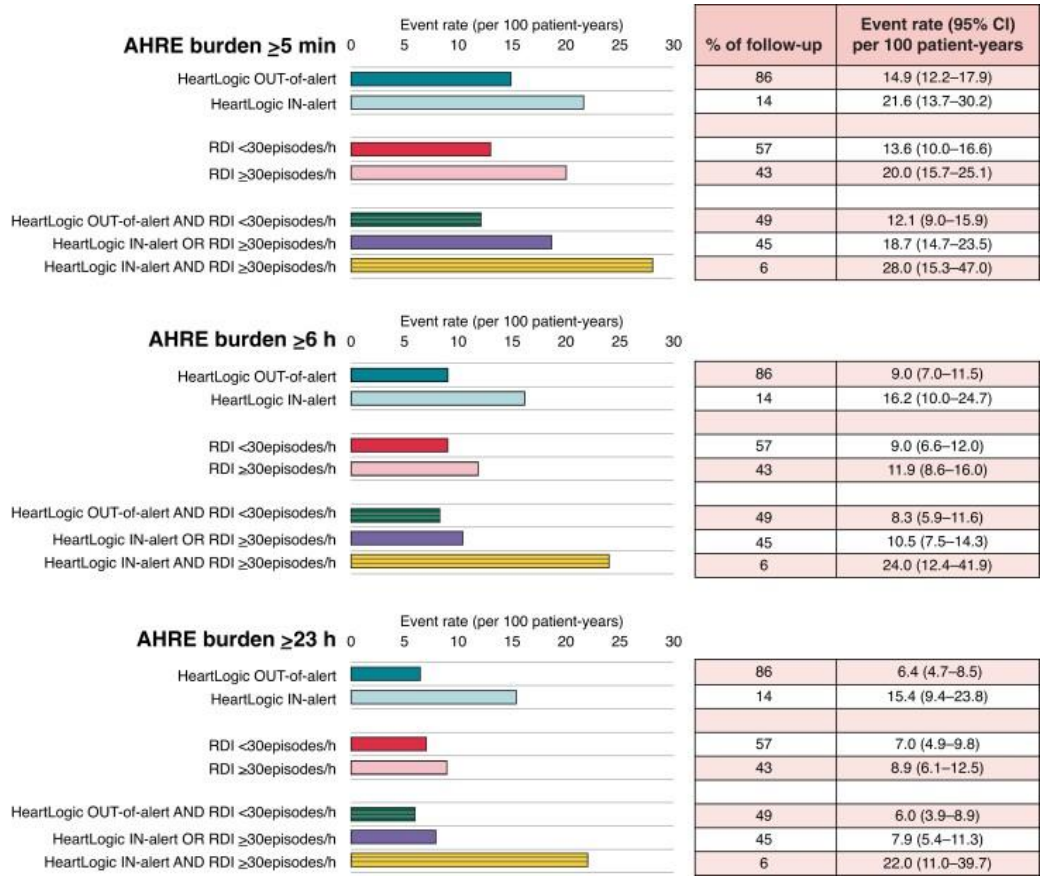


Mazza et al. 2022 JACC EP

Clinical Implications of CIED-detected SA: AHRE

- HF state (HeartLogic index>16) and SA index on atrial high rate events (AHRE)?
- HF patients with ICD
- HF state + Severe OSA state increases the risk of AHRE burden





% of follow-up	Event rate (95% CI) per 100 patient-years
86	14.9 (12.2–17.9)
14	21.6 (13.7–30.2)
57	13.6 (10.0–16.6)
43	20.0 (15.7–25.1)
49	12.1 (9.0–15.9)
45	18.7 (14.7–23.5)
6	28.0 (15.3–47.0)

% of follow-up	Event rate (95% CI) per 100 patient-years
86	9.0 (7.0–11.5)
14	16.2 (10.0–24.7)
57	9.0 (6.6–12.0)
43	11.9 (8.6–16.0)
49	8.3 (5.9–11.6)
45	10.5 (7.5–14.3)
6	24.0 (12.4–41.9)

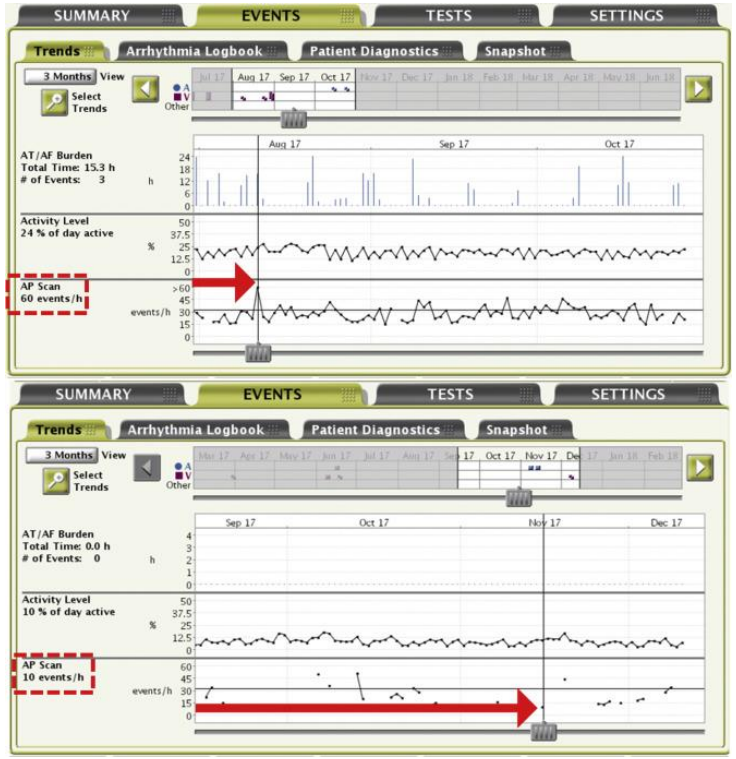
% of follow-up	Event rate (95% CI) per 100 patient-years
86	6.4 (4.7–8.5)
14	15.4 (9.4–23.8)
57	7.0 (4.9–9.8)
43	8.9 (6.1–12.5)
49	6.0 (3.9–8.9)
45	7.9 (5.4–11.3)
6	22.0 (11.0–39.7)

Bertini et al. 2023 Europace

Clinical Implications of CIED-detected SA – Other Outcomes

DEvice-Detected CArdiac Tachyarrhythmic Events and Sleep-disordered Breathing

- CIED detected sleep apnea – Prognosis?
- Prospective multi-center observational study (Korea)
- n~600 with CIEDs (AP Scan™) without AF
- Outcomes: AF, AF complications, ventricular arrhythmia
- 2 years follow up



Gwak et al. 2019 IJC

Challenges and Gaps

- RDI/ AHI are not always the best indicator of SA severity

- CIED algorithms do not account for other important physiological consequences of SA
    - Hypoxemia? Sympathetic responses?

- Studies have used different definitions of SA
    - Use the average? or worst? index during the period?
    - How do you account for variability?
    - How do you quantify the true burden of CIED-derived SA?

Challenges and Gaps

- Physiological consequences of SA are important
- Total count of apneas does not adequately account for the severity of each event

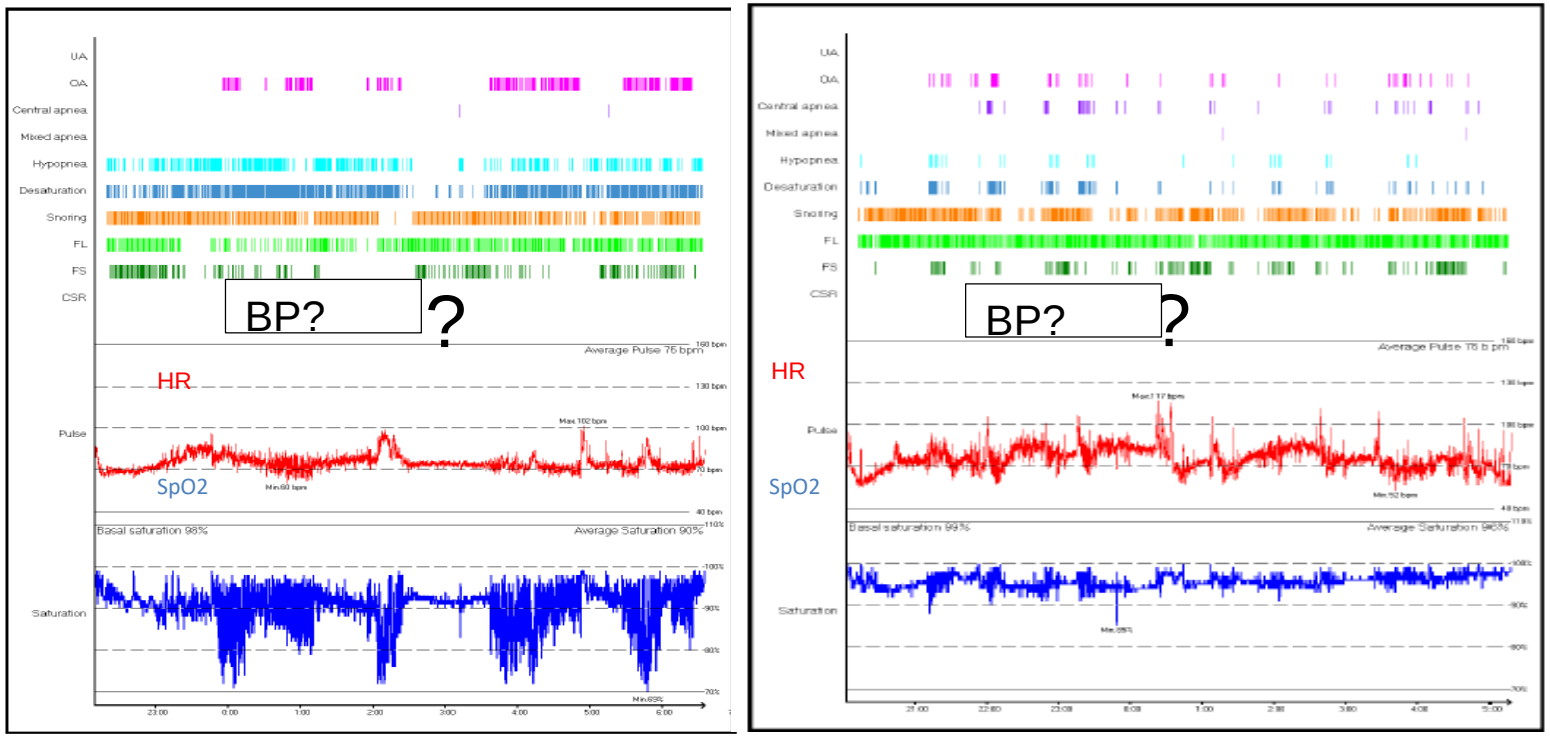


Illustration of portable sleep study summary depicting results from two different patients with similar degree of OSA severity by AHI. Highlighting marked difference in degree of oxygen desaturation between the two p atients with similar apnea hypopnea index. SpO2 (in blue): pulse oximeter-derived peripheral oxygen saturat ion, HR (in red): heart rate. “BP?” (blood pressure) points out that it is not part of the routine sleep study.

Challenges and Gaps

- For example, blood pressure (BP) responses to SA event varies markedly

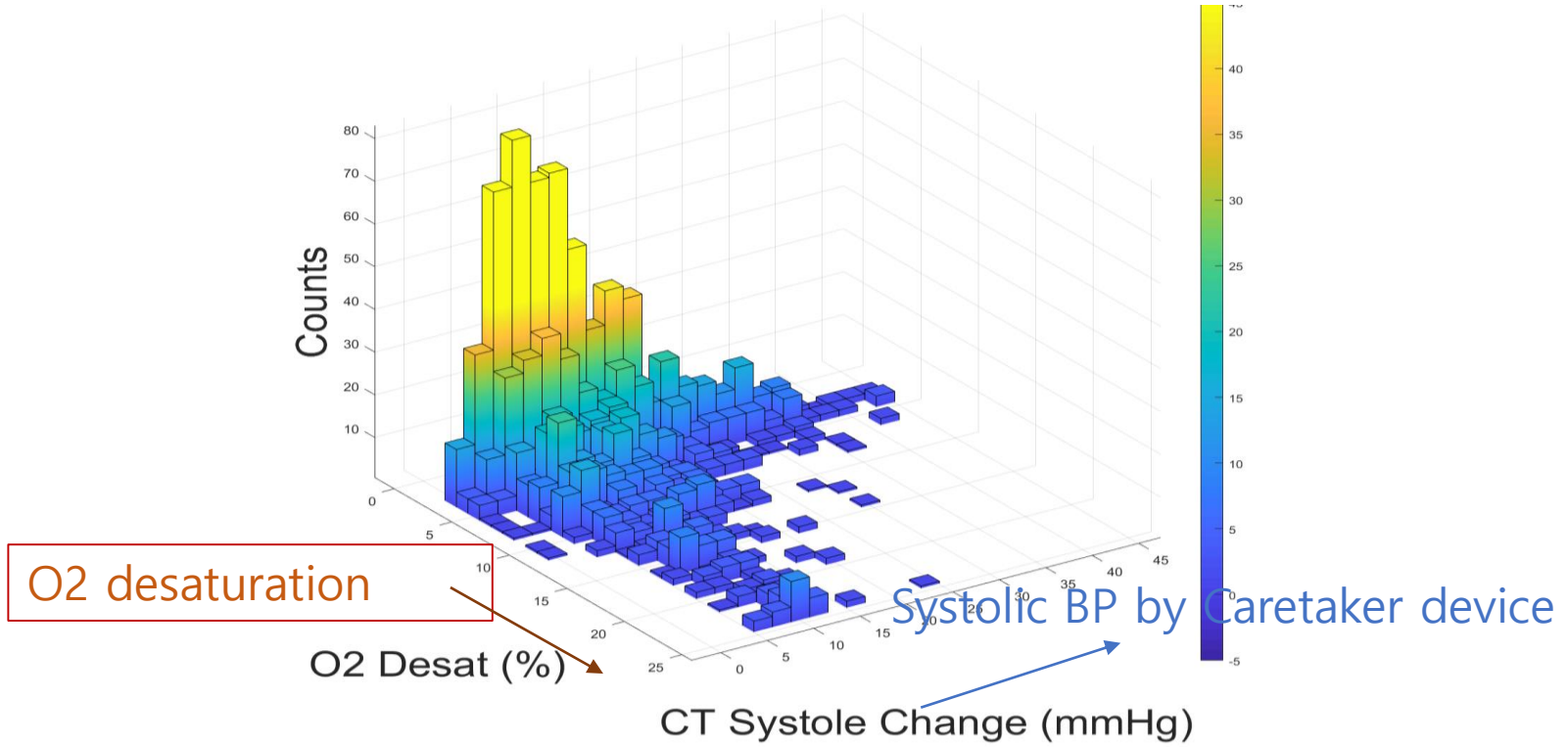


Figure CT Systole: Systolic BP change measured by b-b BP monitoring device (Caretaker™); O 2 Desat: Degree of O2 desaturation.

Kwon et al. 2021 J of Hypertension

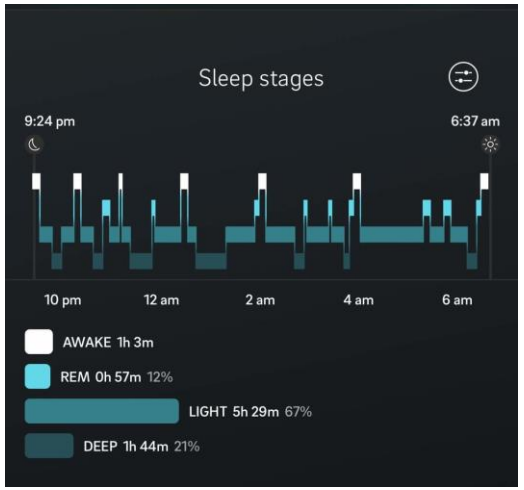
SA Detection by Wearables

Sleep apnea detection via Wearable devices

- Emerging devices allow for convenient longitudinal monitoring with high-quality data (respiratory + heart rate signals)
- Potential for patients without CIED (and CIED)

Sleep Monitoring Wearables

- New technologies enable convenient, comfortable and longitudinal monitoring of sleep (and sleep apnea)



Oura Ring

Conclusion

- CIED enables the detection of SA longitudinally
- CIED detected SA severity is reasonably correlated with that of PSG
- CIED detected SA has clinical implications
- Emergence of wearable devices offers an opportunity to apply the concept to non-CIED populations

Acknowledgement

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Comments and Questions: yhkwon@uw.edu