

School of Medicine

Bedtime stories on the role of heart rate changes during sleep



Abdulghani Sankari, MD, PhD

Email: asankari@wayne.edu

2023

Accreditation Statement

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of The American Academy of Sleep Medicine and the Michigan Academy of Sleep Medicine. The American Academy of Sleep Medicine is accredited by the ACCME to provide continuing medical education for physicians.

Conflict of Interest Disclosures for Speakers

Abdulghani Sankari, MD has no relevant financial relationships with ineligible companies to disclose.

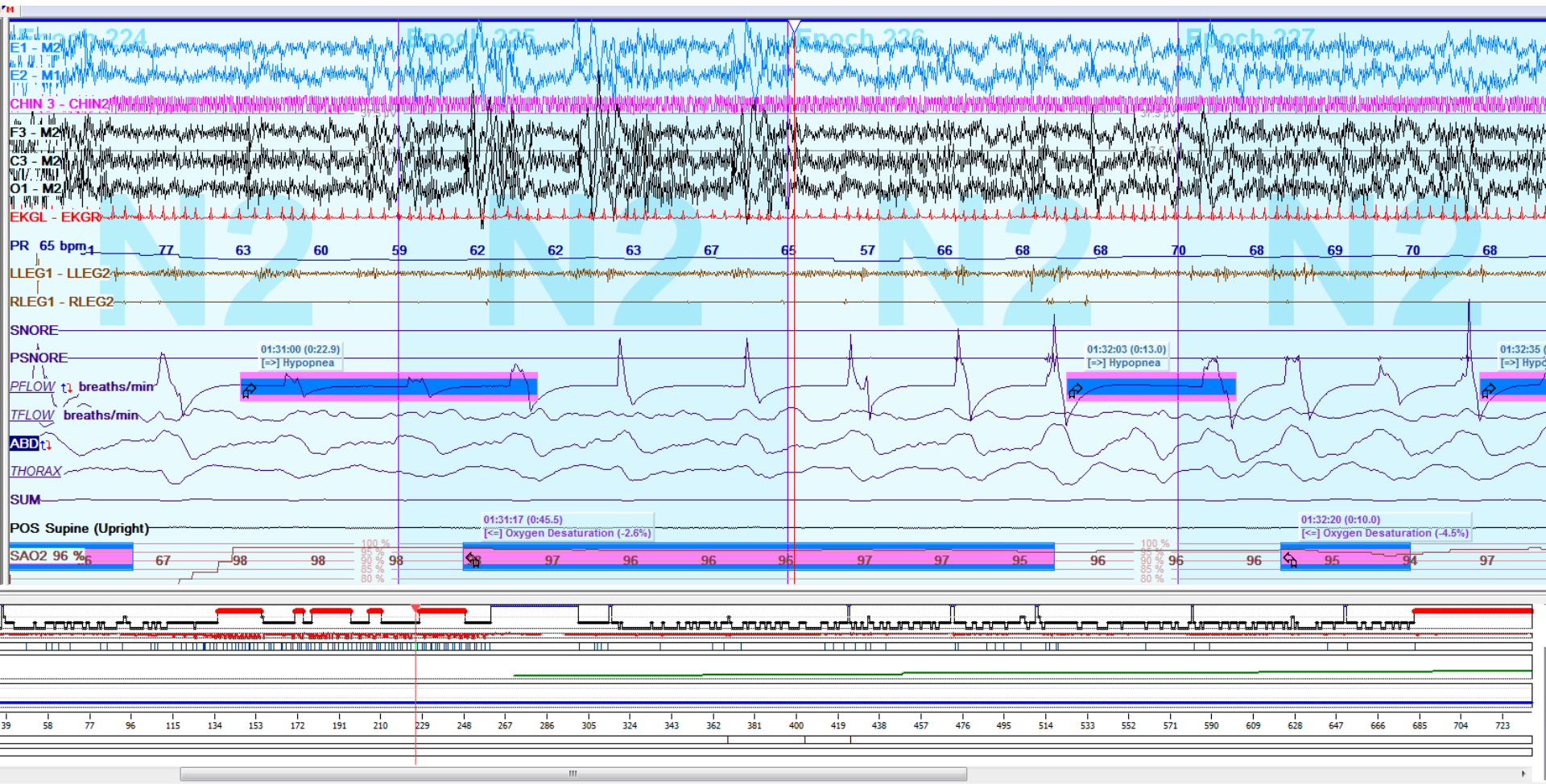
Learning Objectives

- Upon completion of this course, attendees should be able to...
 - To identify the role of heart rate changes during sleep on clinical outcomes.
 - To discuss the physiological mechanism of heart rate changes and cardiovascular disease.
 - To assess the role of heart rate response detection on OSA diagnosis.
 - Remember 10, 20, 28, 94

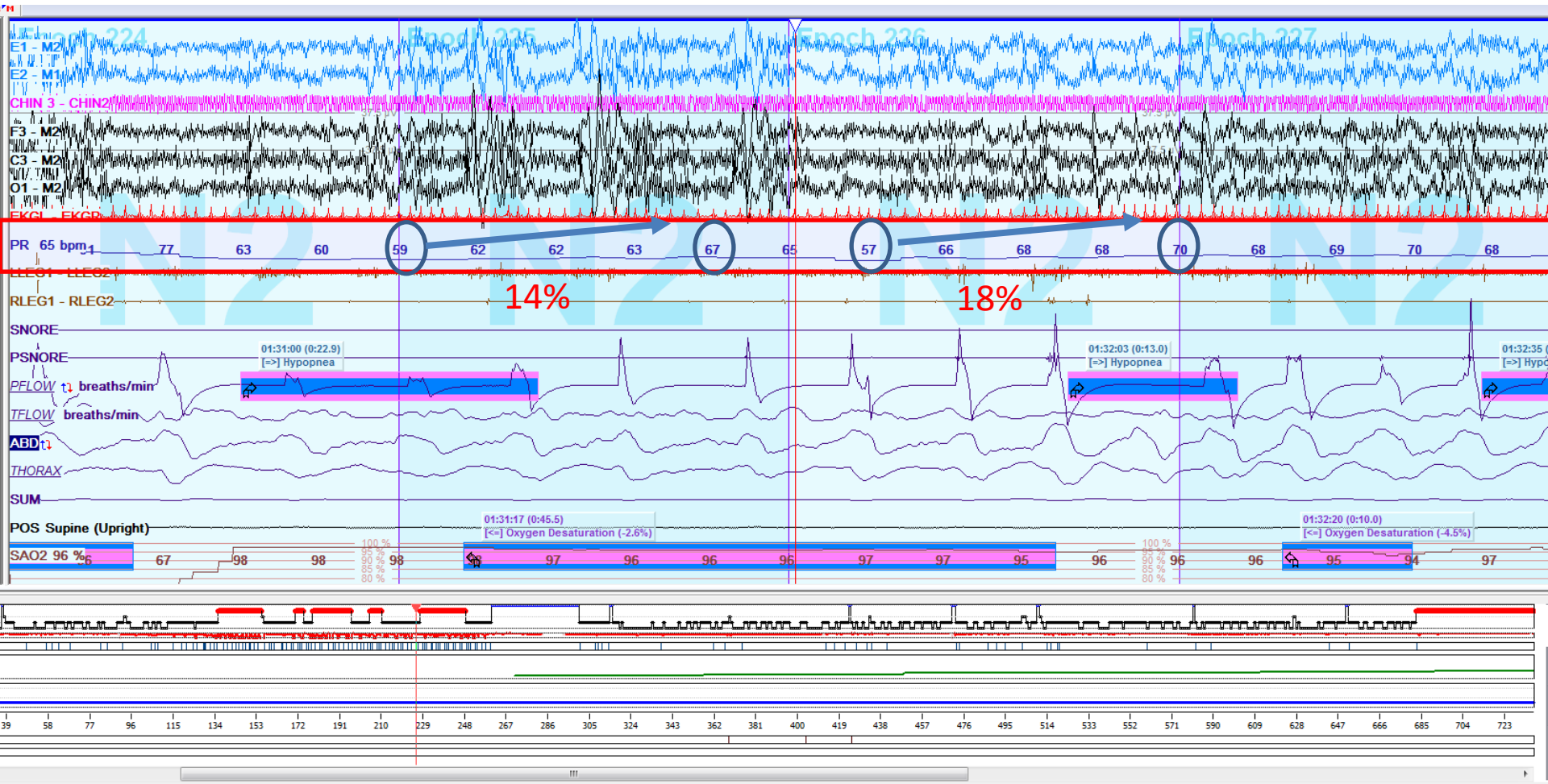
Case

- 50 yo man presented to clinic with loud snoring and day time sleepiness.
- ESS 15/24
- Mhx: HTN
- SH: 1 PPD smoking for 20 years
- VS: BMI 35 kg/m², BP 155/80 mmHg,
- Exam: Crowded oropharynx Mallampati class IV and trace LE edema.

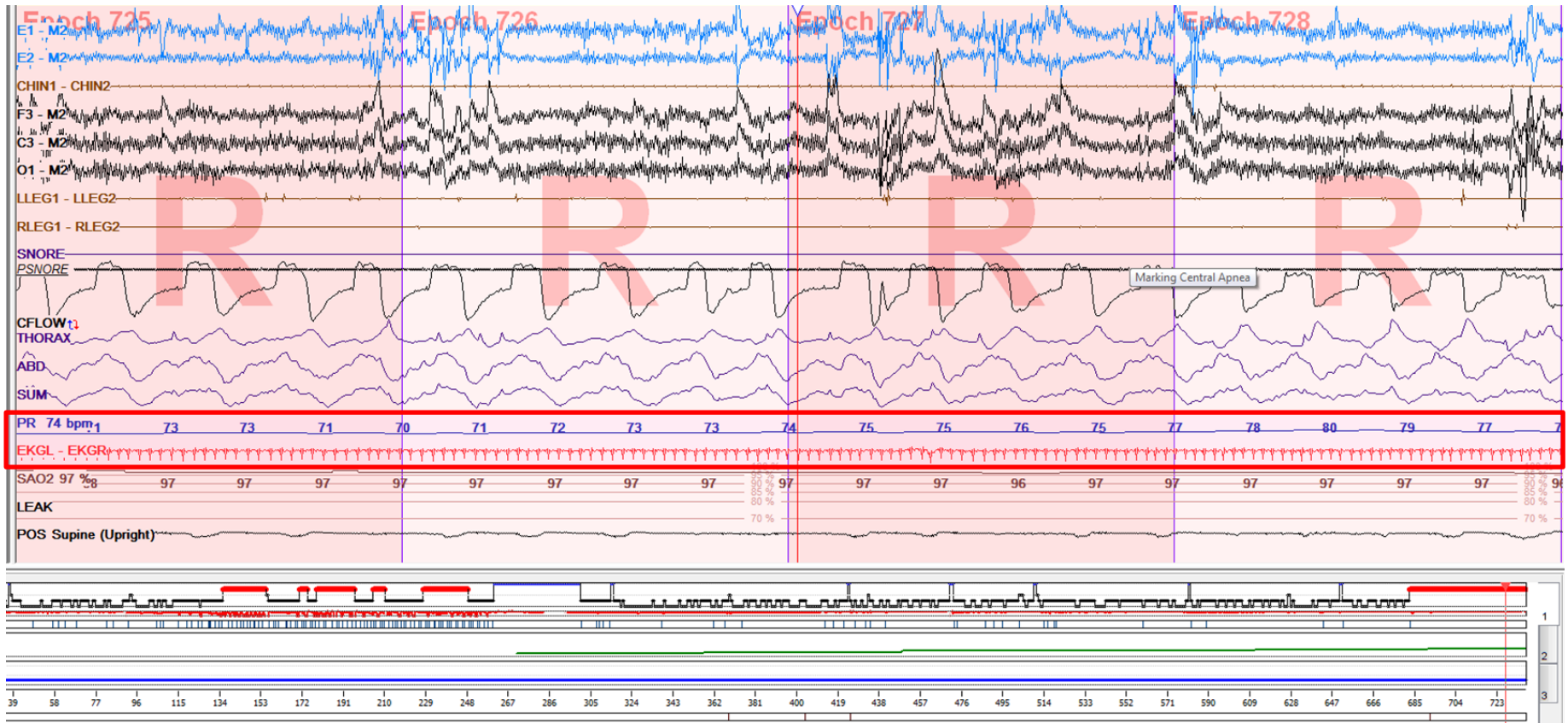
PSG/Split



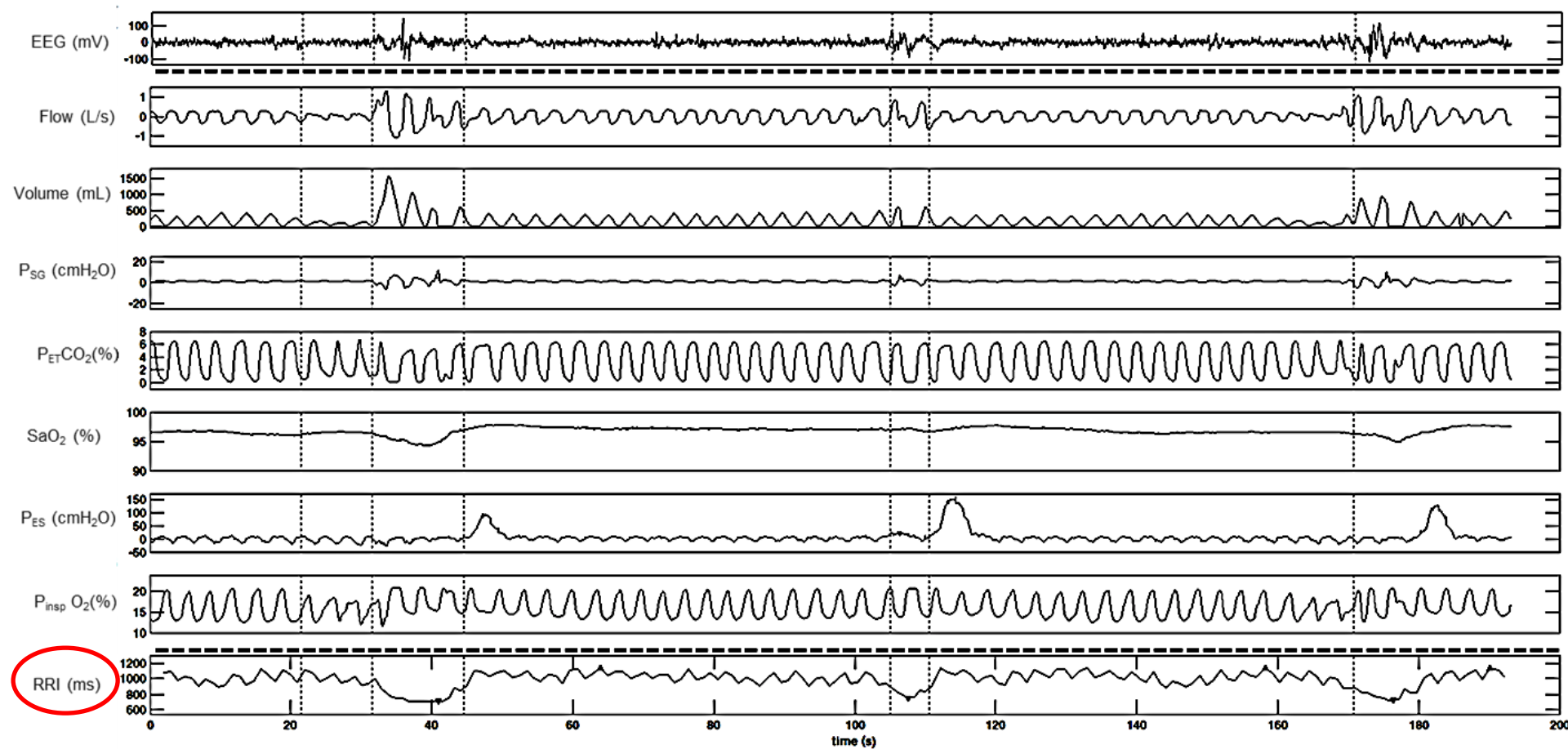
PSG/Split



On CPAP



A representative polygraph record of hypopneas with >3% desaturation and cortical arousals

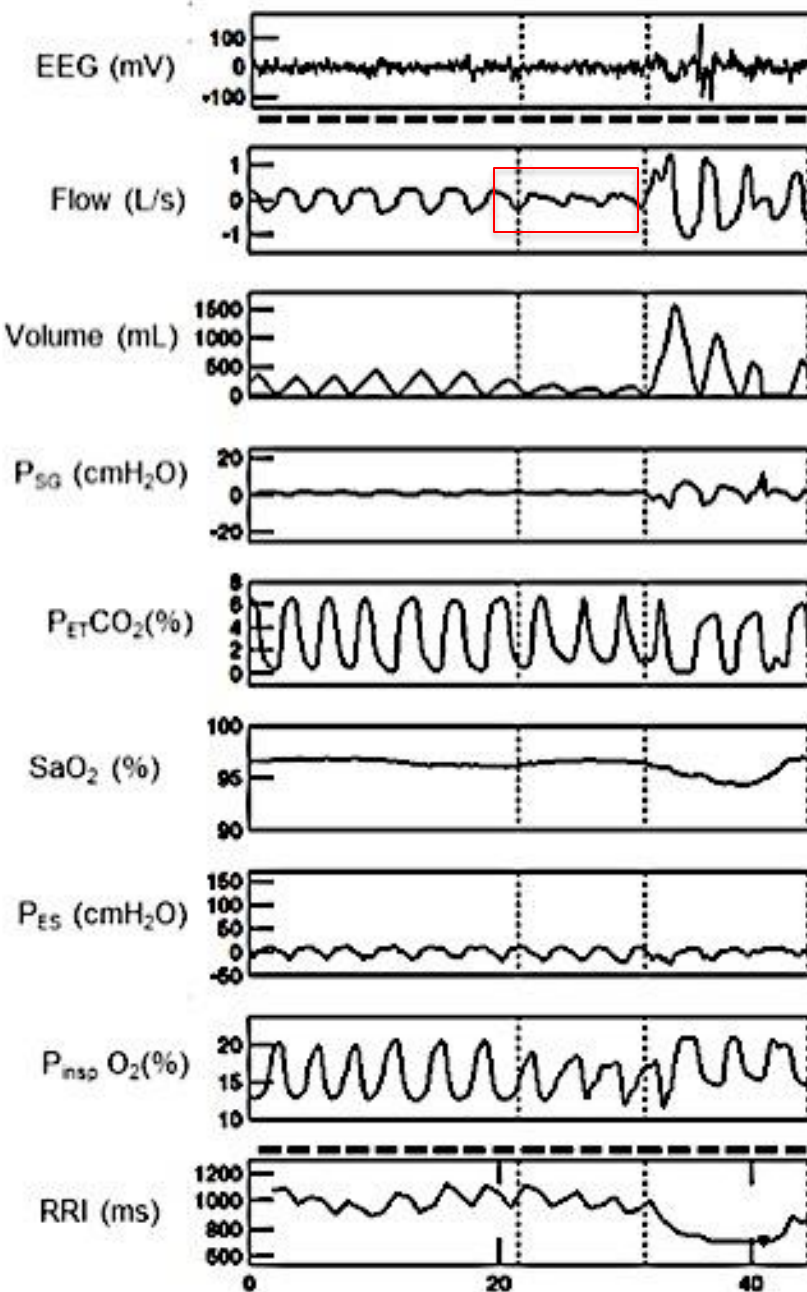


N=13

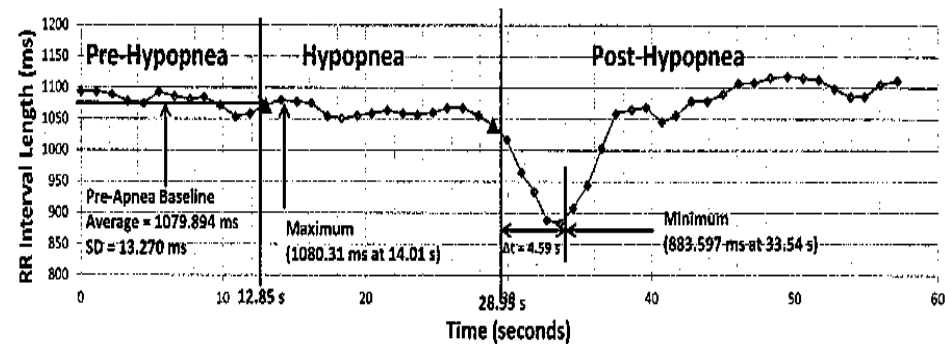
Hypopneas



Scott

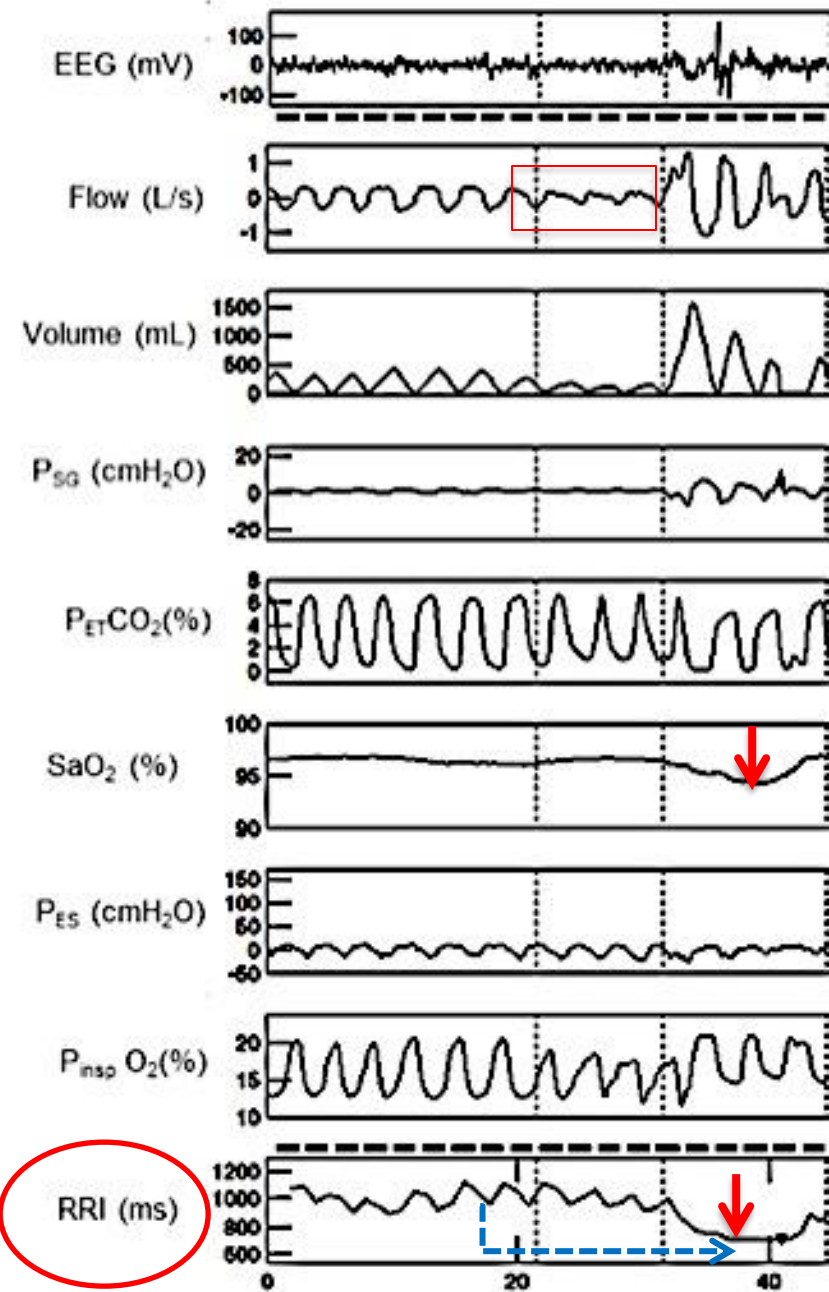


Intervals



N=13

Hypopneas



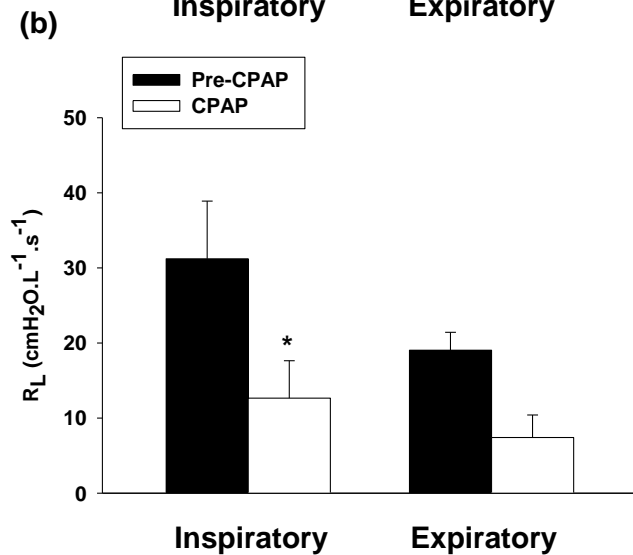
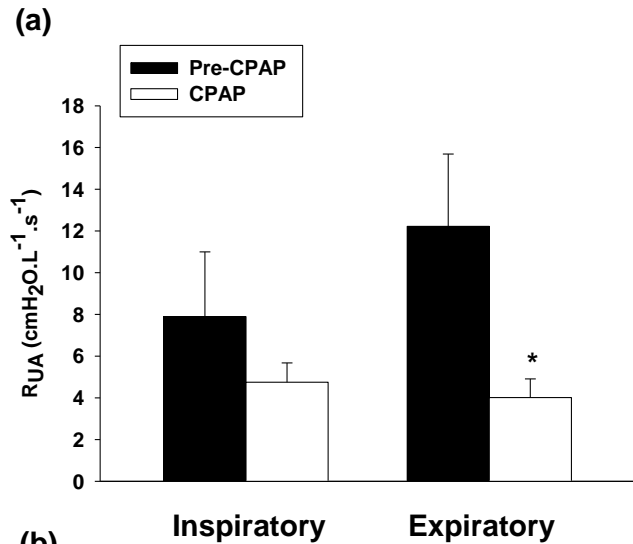
N=13

Hypopneas

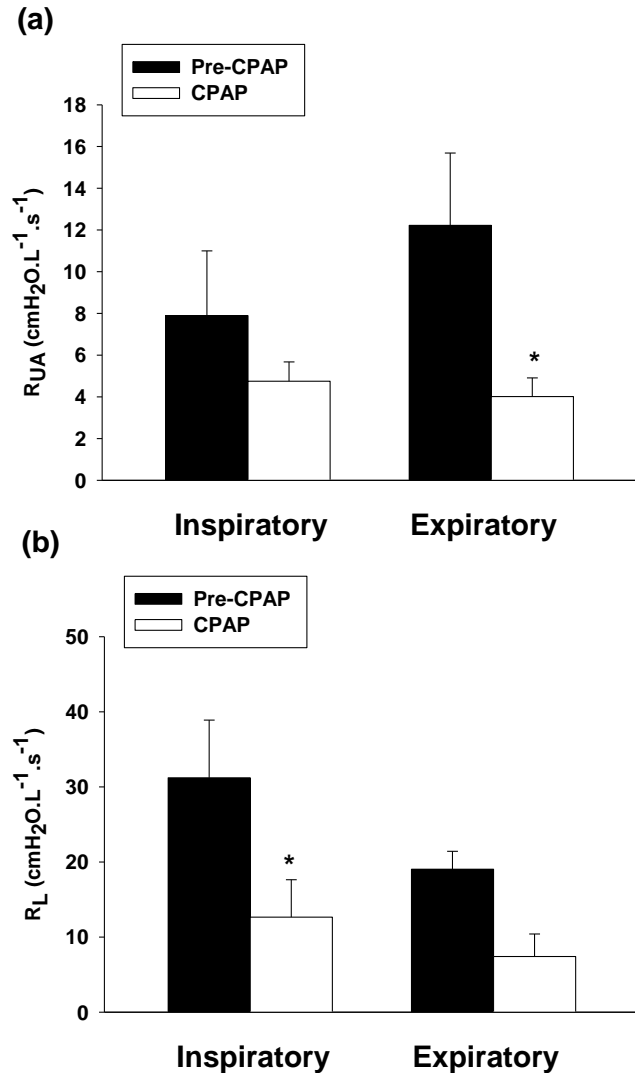
RE



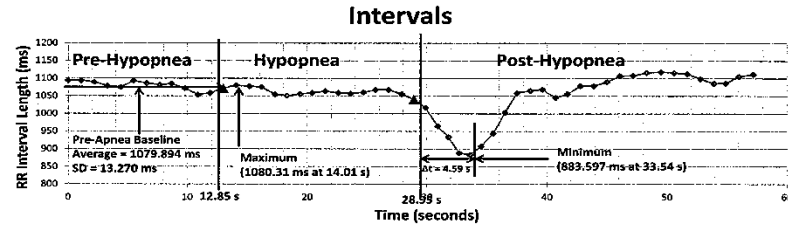
Effect of CPAP on upper airway and lung resistance



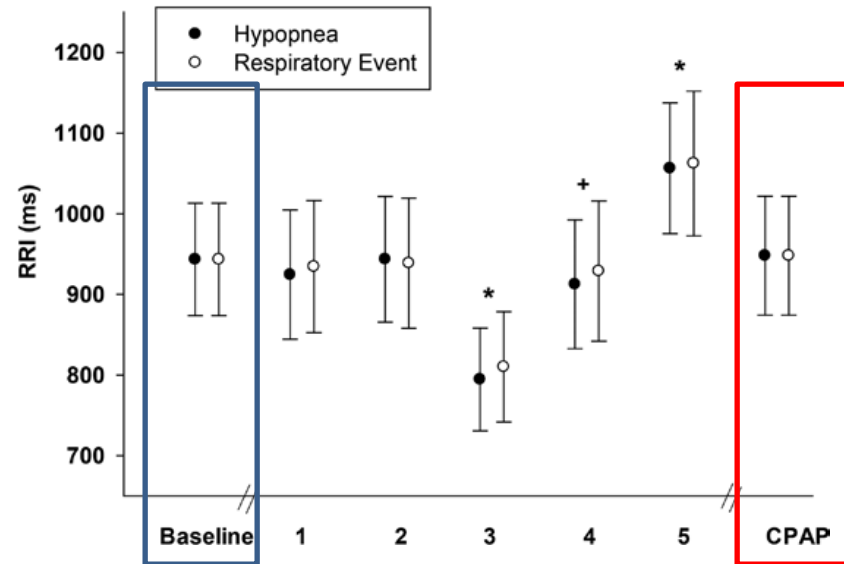
Effect of CPAP on upper airway and lung resistance



Effect of CPAP on heart rate (RRI)

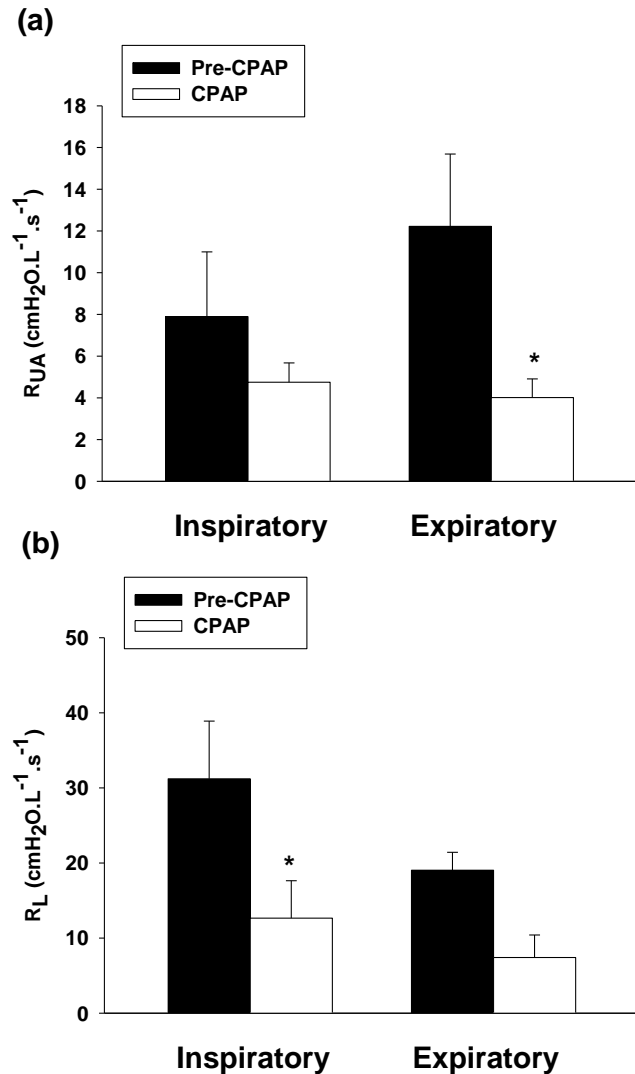


RRI (ms)

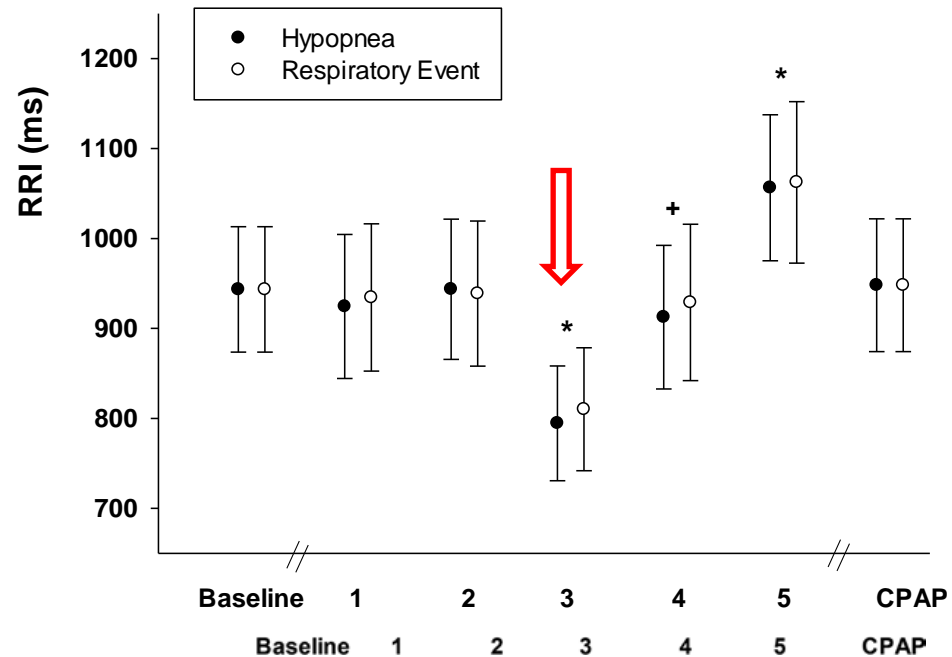


Mean \pm SE; n = 6 (ECG of two subjects were not included due to poor signal), *p < .05 vs. baseline, +p < .05 vs. (3) nadir RRI.

Effect of CPAP on upper airway and lung resistance



Effect of CPAP on heart rate (RRI)



Mean ± SE; n = 6 (ECG of two subjects were not included due to poor signal), *p < .05 vs. baseline, +p < .05 vs. (3) nadir RRI.

Can Heart Rate Responses during Sleep Predict Cardiovascular Disease?



Effect of nocturnal heart rate accelerations on long-term CV outcome

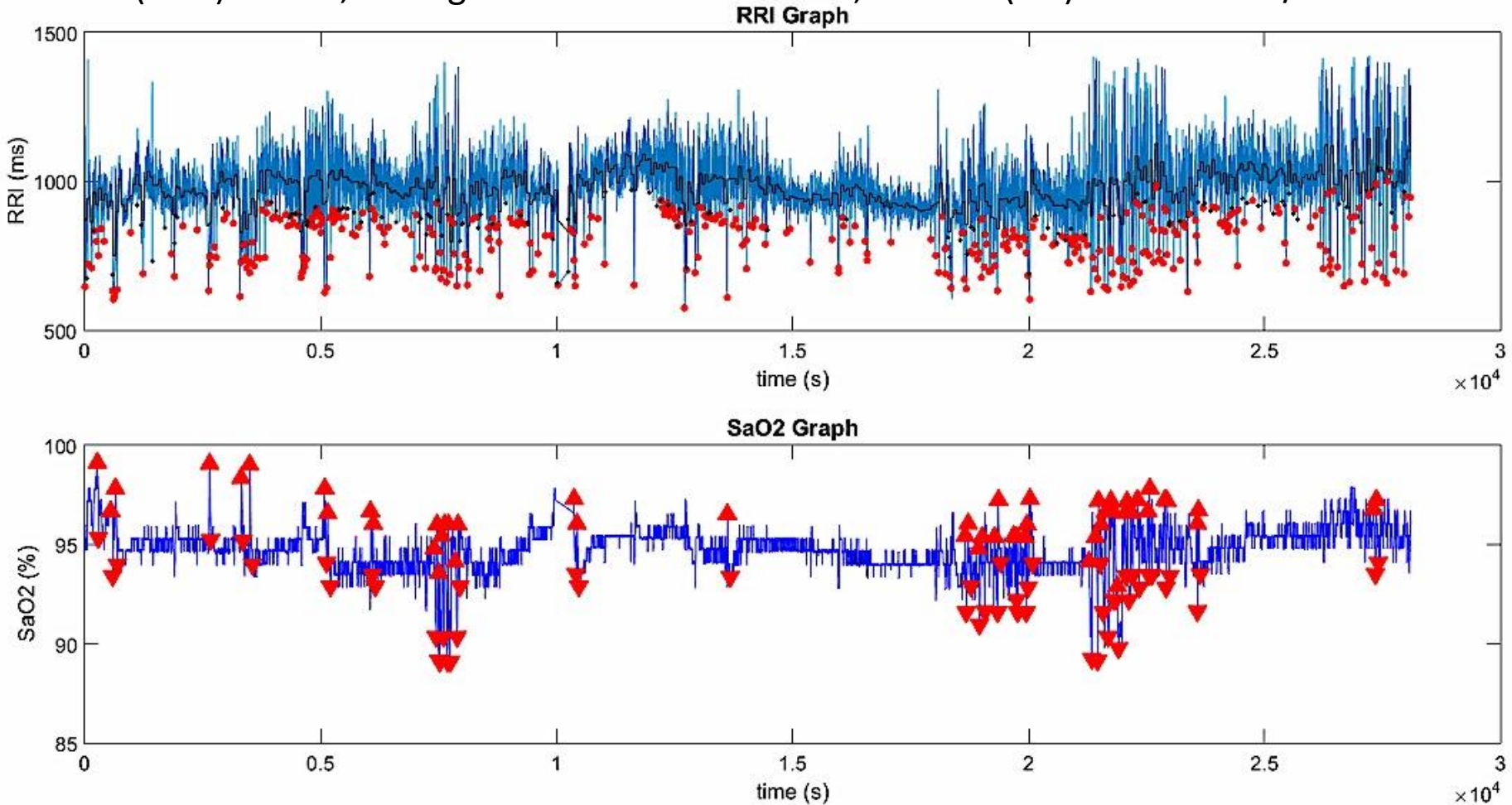
- Study population: WSCS
- WSCS: 1546 adult employees of state agencies aged 30 to 60 years in started in 1988.
- Digital PSG recordings between 8/2000 to 12/2016
- Inclusion:
 - most recent full PSG with adequate ECG recording,
 - not treated for SDB,
 - no prior CVD event,
 - No beta blockers used on the night of PSG or at any other point during follow-up.

Effect of nocturnal heart rate accelerations on long-term CV outcome

- Study protocol: The ECG and SaO₂ of every participant who meets the entry criteria will be examined to obtain beat-to-beat RRI dips and ODI.
- Primary outcome is an incident CVD event:
 - death related to CVD or
 - self-reported physician-diagnosed heart attack, heart failure, a CVD procedure -angioplasty, stent, pacemaker, bypass, or defibrillation.

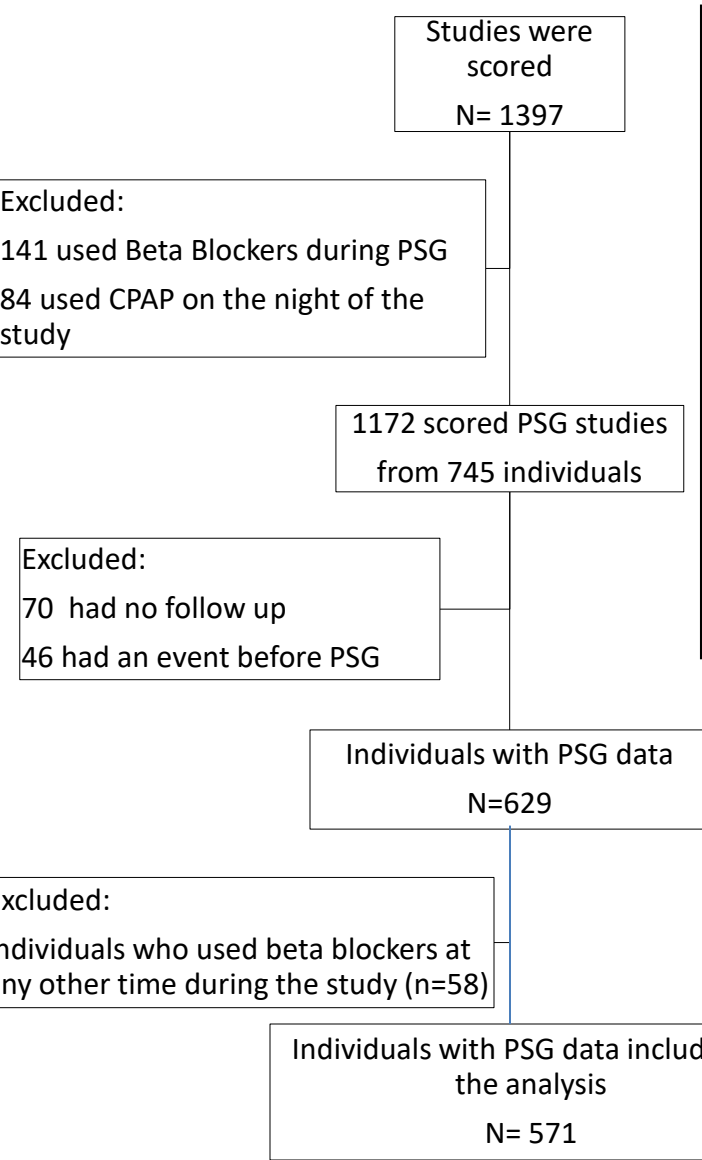
Heart Rate Responses during Sleep in a Participant from the Wisconsin Sleep Cohort (who was not on beta blocker)

RRDI(90%) is 54.5, average heart rate is 61.1 BPM, and ODI(4%) is 2.3 desats/hour



Matlab program developed internally at WSU for automated heart rate changes (R-R interval dips) [pending patent #62/395,634]. RRI dips @90, 80, 70 and 60%

Heart Rate Responses during Sleep Predicts Cardiovascular Disease in a Community-Based Cohort: Results from the Wisconsin Sleep Cohort

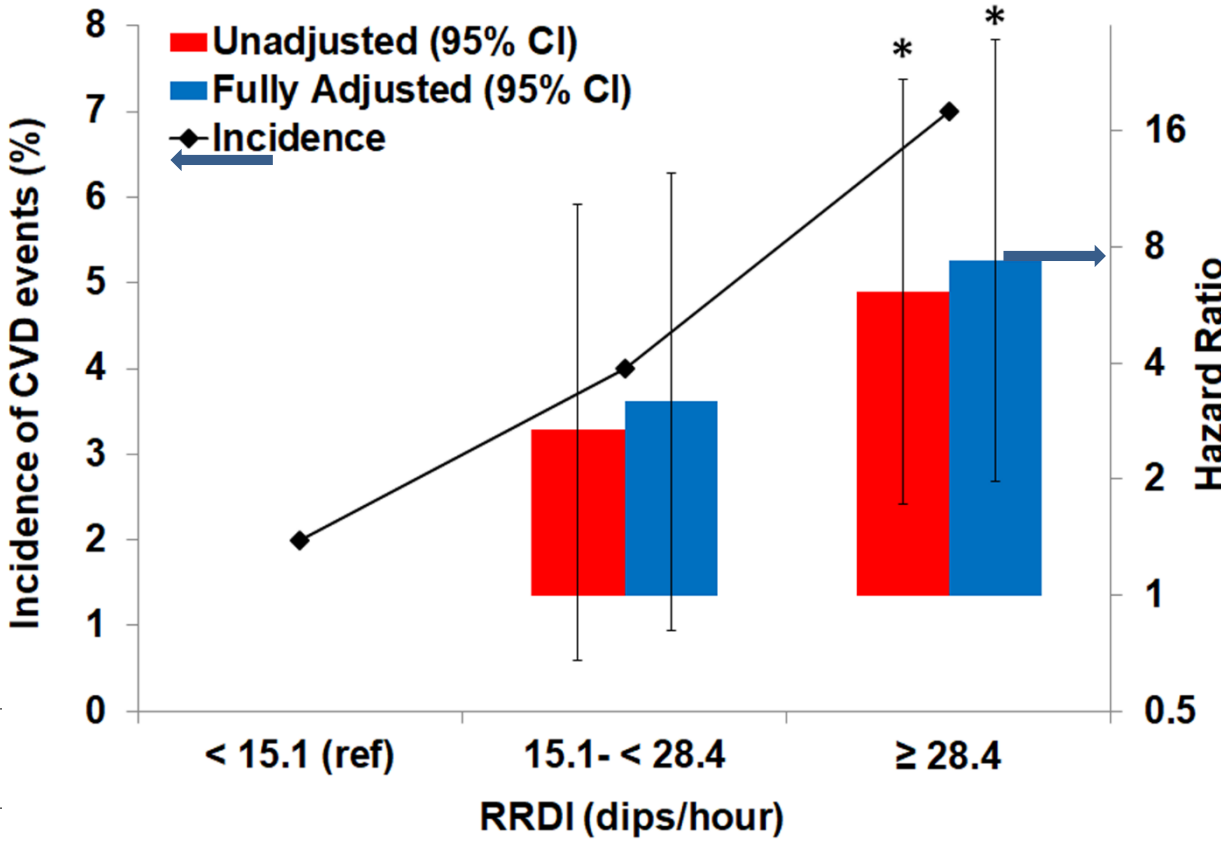
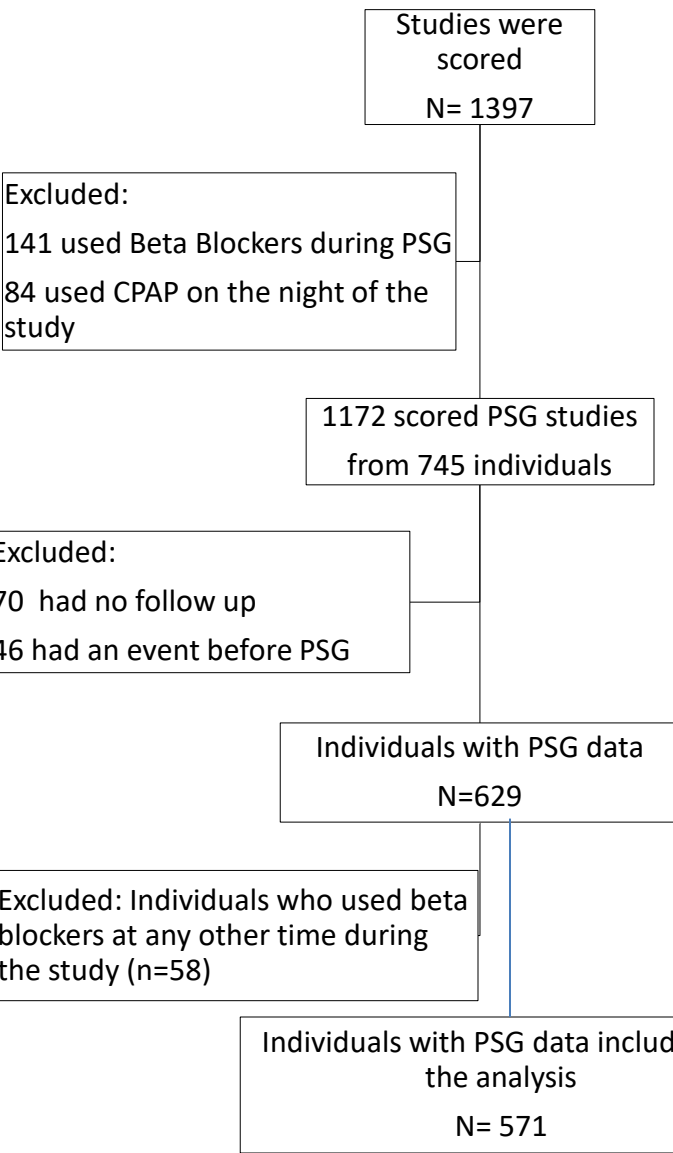


	CVD Events	Hazard Ratio (95% CI)			
		p-value			
	N (%)	Adjusted for age, BMI, and gender	Adjusted for age, BMI, gender and AHI categories (<5, 5-15 >15)	Adjusted for age, BMI, gender and AHI categories (<5, 5-15 >15), Diabetes, HTN, Stroke, and Smoking	Adjusted for age, BMI, gender and AHI categories (<5, 5-15 >15), Diabetes, HTN, Stroke, Smoking, Average HR, % TST It 90% SaO2
Continuous RRDI (10-unit increment)	26/571 (5)	1.17 (1.07, 1.28) 0.0003	1.19 (1.09, 1.29) 0.0001	1.20 (1.10, 1.31) <0.0001	1.21 (1.10, 1.32) <0.0001

CVD events: death related to CVD or self-reported physician-diagnosed heart attack, heart failure, a CVD procedure (angioplasty, stent, pacemaker, bypass, or defibrillation); RRDI: R-R interval dips index.

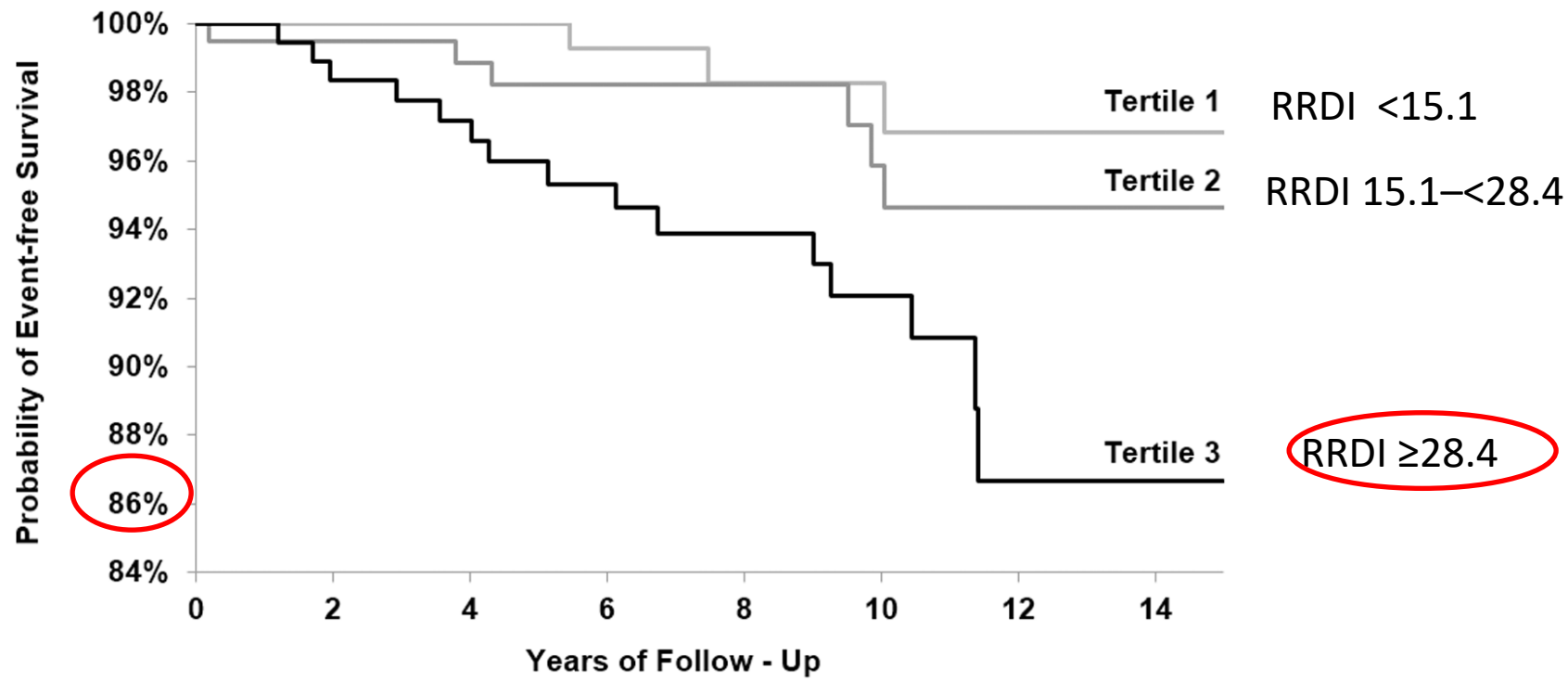
For every 10 HR changes/h CVD/events ↑ ~ 20%

Heart Rate Responses during Sleep Predicts Cardiovascular Disease in a Community-Based Cohort: Results from the Wisconsin Sleep Cohort



Heart Rate Responses during Sleep Predicts Cardiovascular Disease in a Community-Based Cohort: Results from the Wisconsin Sleep Cohort

↑ Risk of incident CVD event

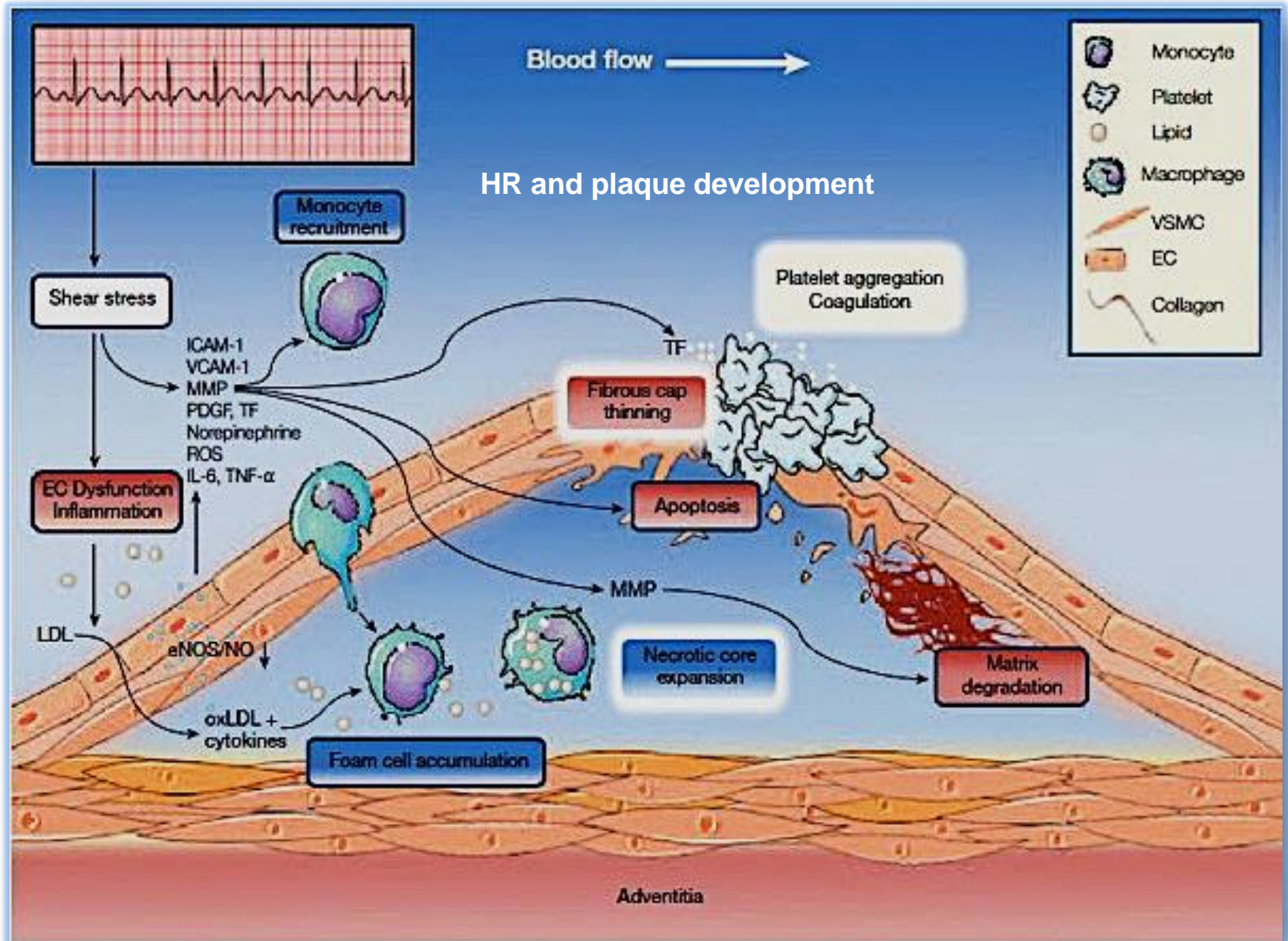


Log-Rank p=0.0139 for total RRDI

Not at Risk	0	2	4	6	8	10	12	14
Tertile 1	188	176	156	128	88	68	29	1
Tertile 2	193	182	160	134	106	79	35	2
Tertile 3	188	175	163	138	116	86	29	1

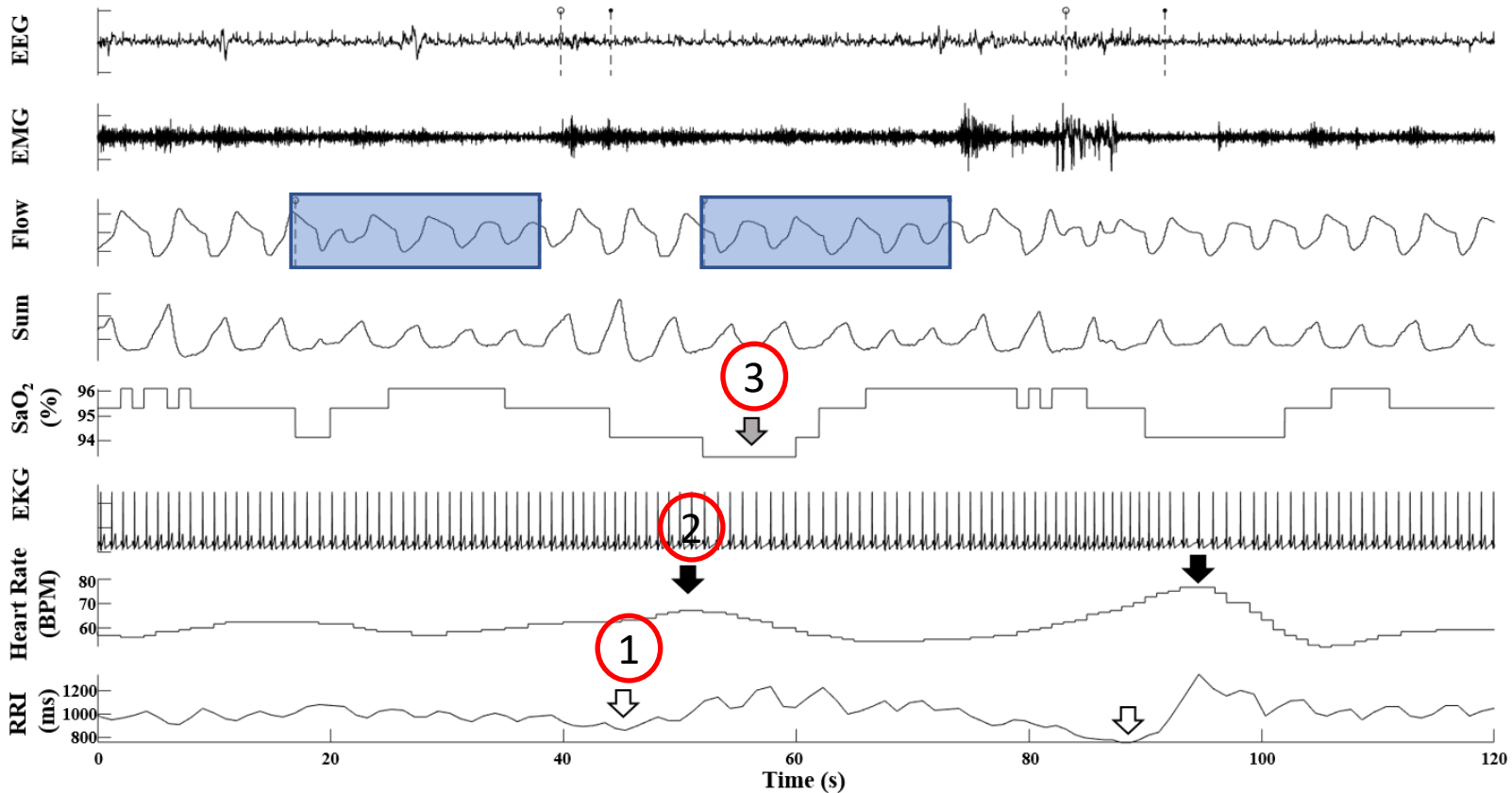
Kaplan-Meier likelihood of survival according to total RRDI severity

Mechanism-HR Shear Stress Theory

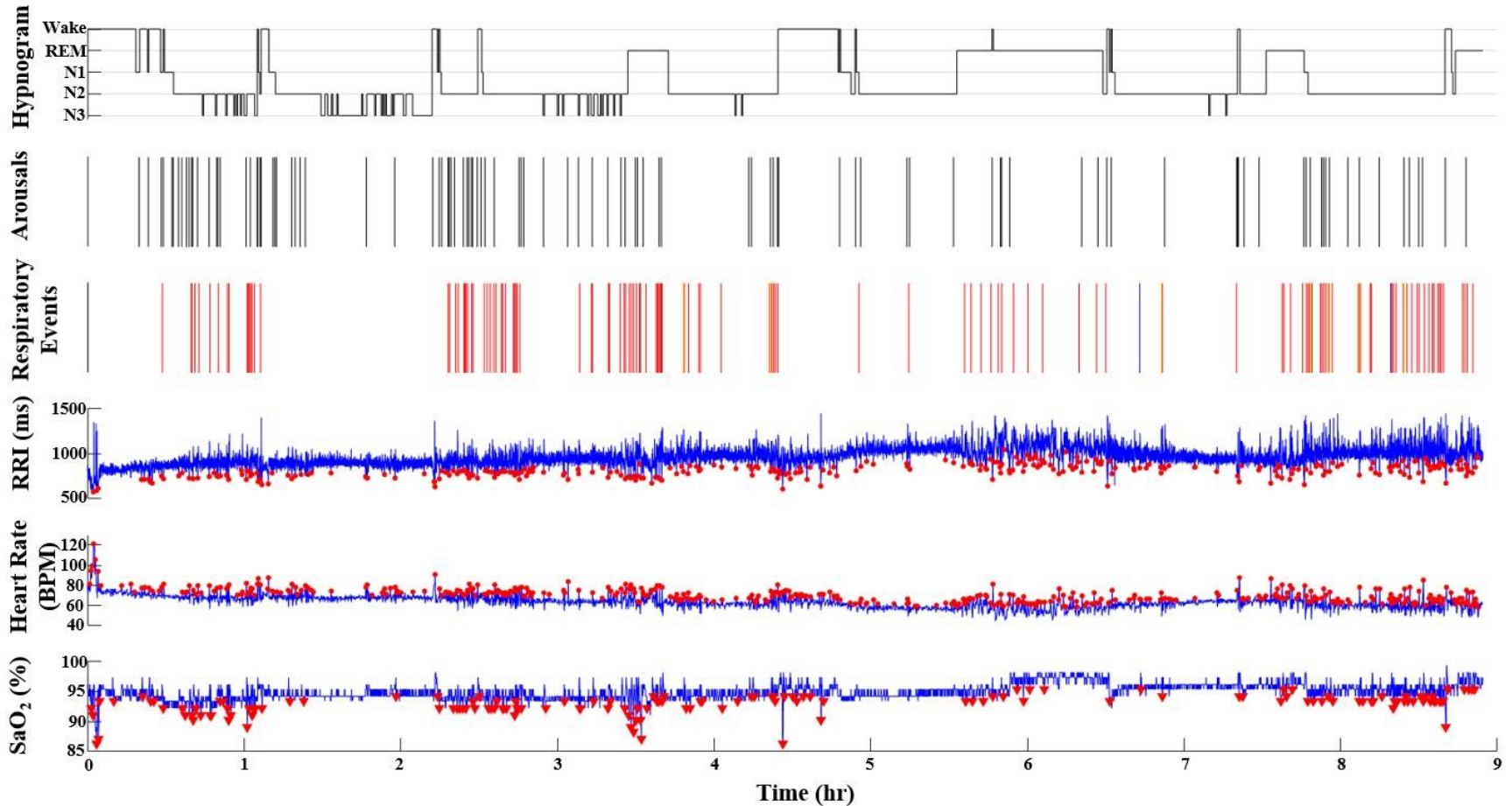


Can HR help in the diagnosis of SDB?

Can HR help in the diagnosis of SDB?



Representative Polygraph (SHHS)

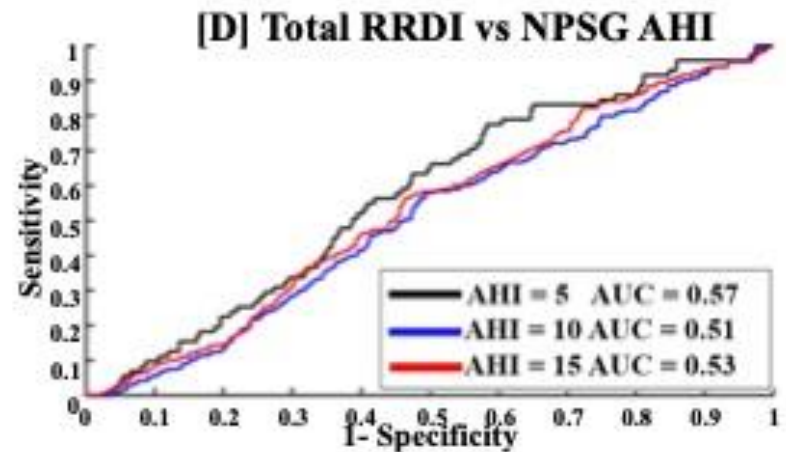
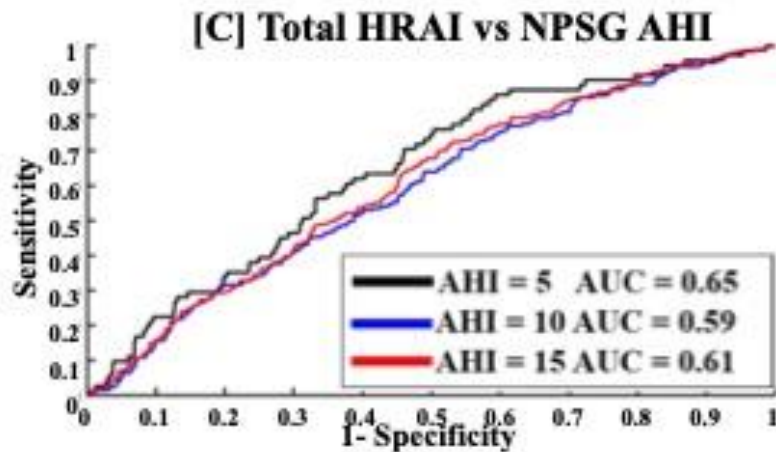
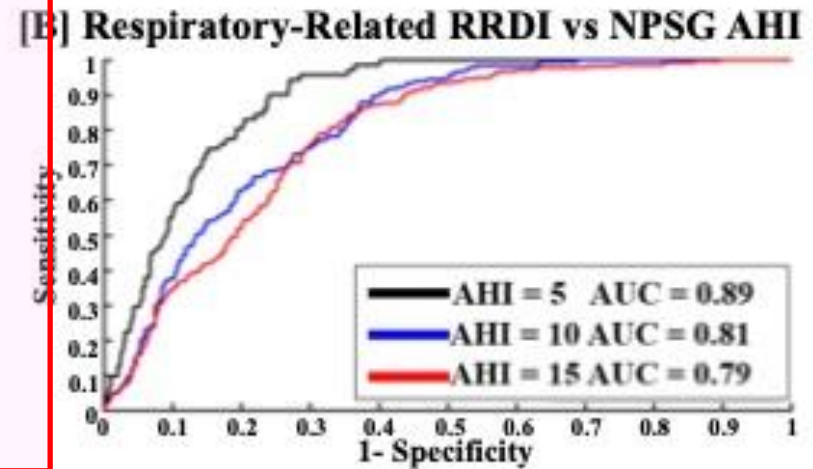
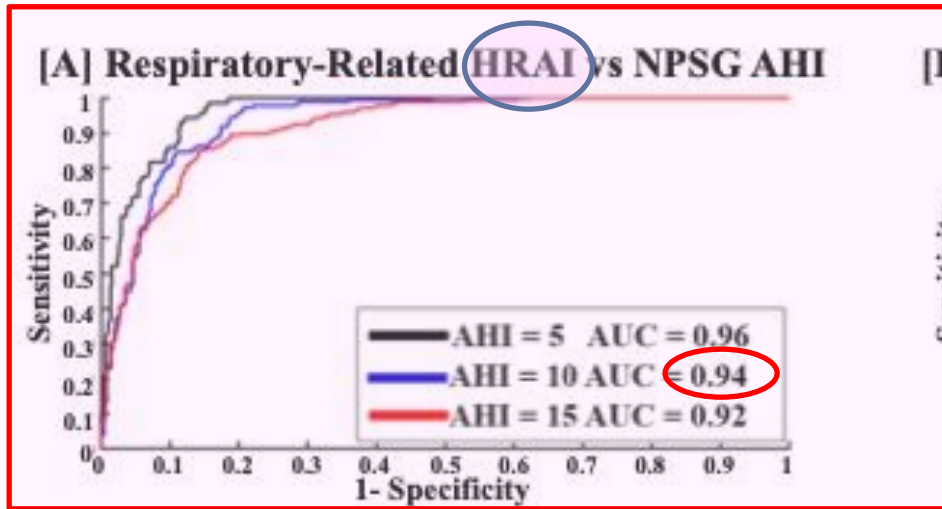


Diagnostic testing for RE RRD1 and HRAI.



	AHI cut off (RE RRD1 \geq 5)				AHI cut off (RE HRAI \geq 5)			
	AHI 5	AHI 10	AHI 15	AHI 30	AHI 5	AHI 10	AHI 15	AHI 30
Sensitivity, %	100%	93%	82%	36%	100%	94%	79%	36%
Specificity, %	21%	48%	65%	86%	33%	72%	86%	98%
PPV, %	54%	63%	69%	71%	75%	87%	92%	97%
NPV, %	100%	88%	79%	59%	100%	85%	67%	43%
Agreement, %	59%	70%	73%	62%	78%	87%	81%	56%
Kappa	0.21	0.40	0.46	0.22	0.40	0.68	0.61	0.25

AHI, apnea-hypopnea index; RE RRD1, respiratory RR interval dips index; RE HRAI, respiratory heart rate acceleration index; PPV, positive predictive value; NPV, negative predictive value.

Receiver operating characteristic curves for HRAI to AHI



When it comes to HR stories at bedtime **remember 10, 20, 28, 86, 94**

- For every **10** HR changes/h CVD events  **20%**
- For changes in HR **>28/h** 10-yr survival  **86%**
- The AHI-derived from HR is **94%** sensitive with an AUC of **.94**

Conclusion

- HR changes play important role during sleep in predicting CVD.
- HR changes indexes (HRAI) derived from ECG and pulse signals correlate strongly with SDB severity and may play an important role in the diagnosis of sleep apnea.
- Automated analysis of physiological data during sleep plays an important role in the diagnosis and prediction of outcomes.
- The use of these algorithms is applicable in the era of artificial intelligence and wearables in precision medicine

Acknowledgments



WAYNE STATE
UNIVERSITY
SCHOOL OF MEDICINE

Co-investigators:

Wayne State University

Safwan Badr, MD

University of Wisconsin

Paul Peppard, PhD

Erika Hagen, PhD

Laurel Finn, MS

Amanda Rasmuson

Funding

Department of Veterans Affairs

National Institute of Health

Department of Defense

DMC Foundation

Cardiovascular Research Institute

American Thoracic Society

Blue Cross Blue Shield Foundation



VA



U.S. Department of Veterans Affairs

Veterans Health Administration

Office of Research and Development

