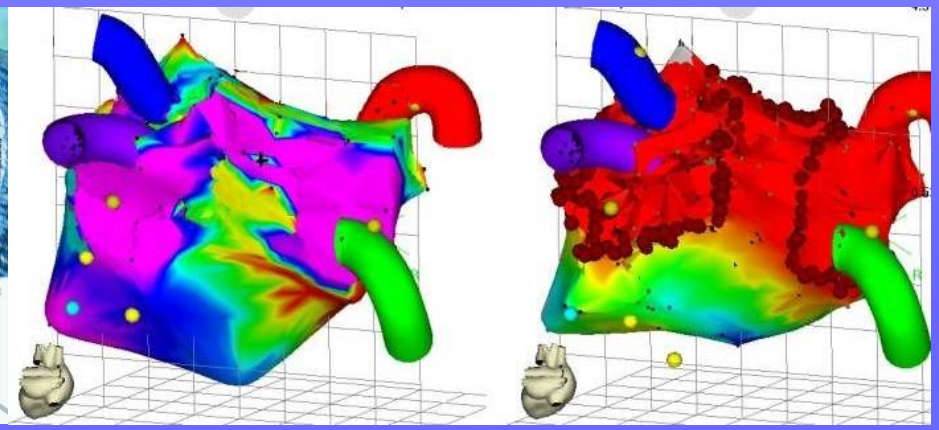
Sleep Apnea & Cardiovascular Disease



Adrian Baranchuk MD FACC FRCPC FCCS

Heart Rhythm Service

Professor of Medicine

Queen's University

February 2017

Winter Arrhythmia School

Arrhythmia Service KGH

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Conflict of interest

- Unrestricted grants from Medtronic, Bayer
- Local PI or co-PI for studies funded by Medtronic, St Jude, Boston Scientific
- Honorarium for lectures: Medtronic, Bayer, Boehringer Ingelheim, St Jude, Pfizer

Sleep Apnea & Cardiovascular Disease

1. Definitions
2. Brief epidemiology data
3. Brief physiopathology background. SA & HTN
4. SA and bradyarrhythmias & conduction disorders
5. SA & supraventricular/ventricular arrhythmias
6. SA & Stroke (brief)
7. SA & heart failure: role of CRT

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Sleep Apnea Definitions

1. SA: a history of excessive sleepiness, frequent episodes of obstructing breathing during sleep, snoring, morning headaches, “arousals” + polysomnography showing apneic episodes longer than 10 sec onds (at least 5 per hour)
2. Apnea: cessation of air flow, 0_2 saturation reduction ≥ 4%
   - ► Central: alteration at CNS level
   - ► Obstructive: alteration at the upper respiratory way
3. Hypopnea: air flow reduction ≥ 30%, 02 saturation reduction ≥ 4%
4. AHI (Apnea/hypopnea index): amount of apneas & hypopneas per hour

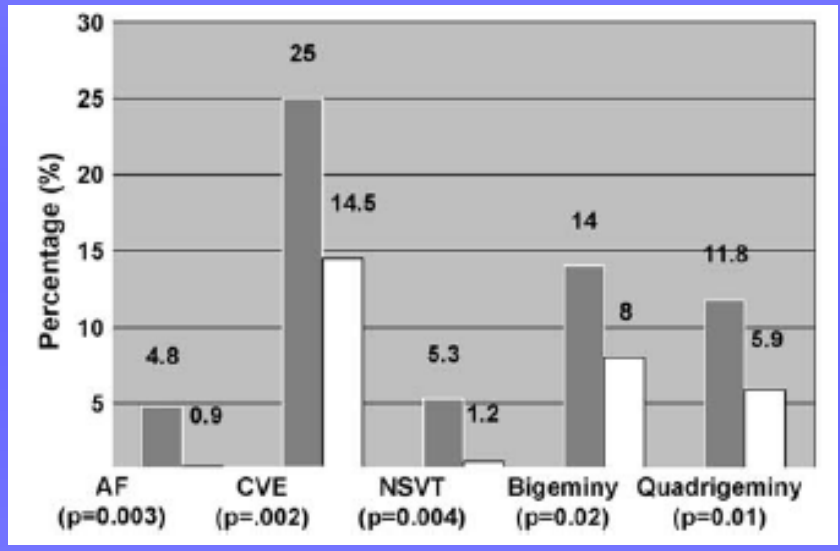
Sleep Apnea & Cardiac Arrhythmias: Epidemiology

Association of Nocturnal Arrhythmias with Sleep-disordered Breathing

The Sleep Heart Health Study

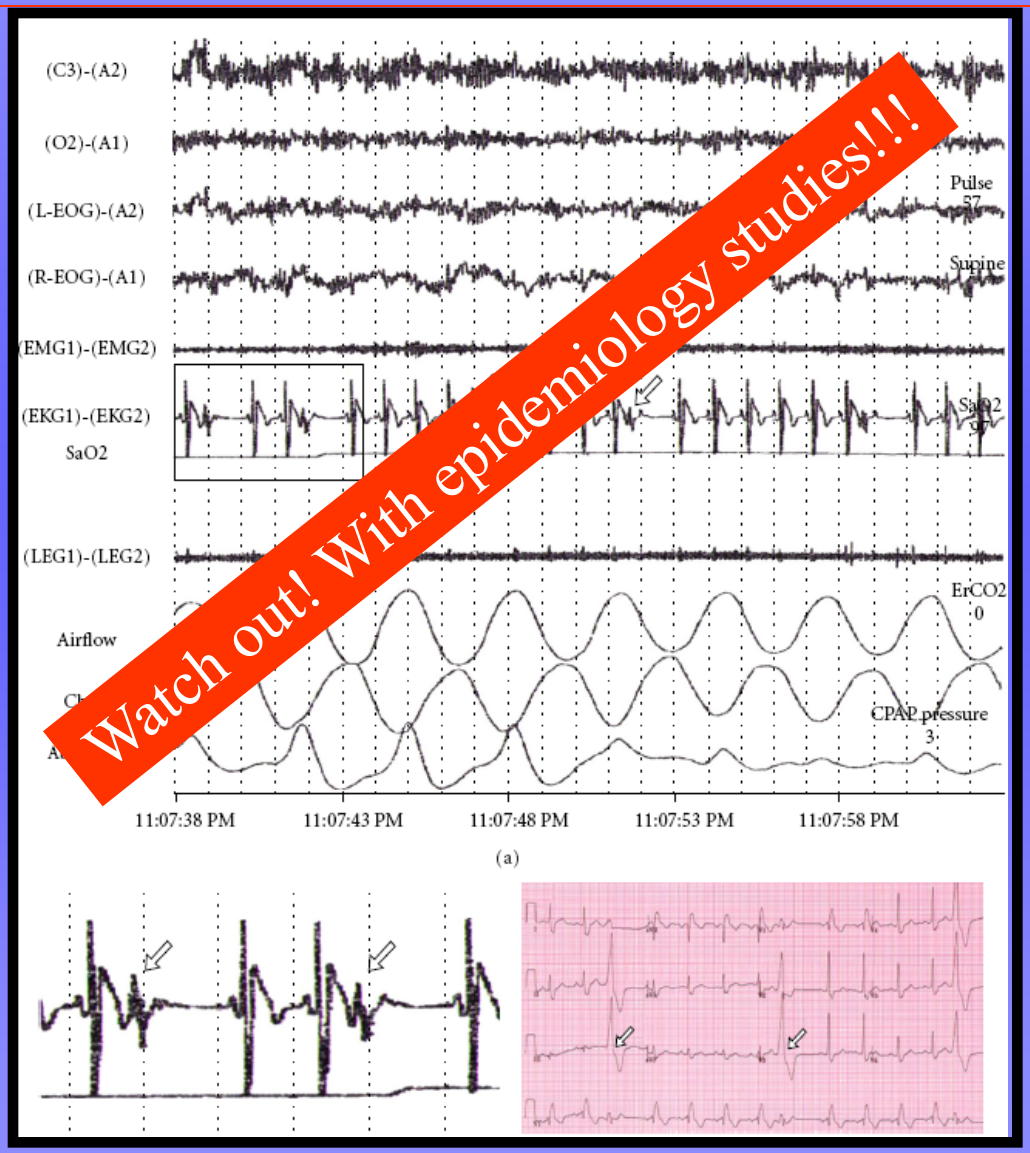
AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 173 2006

	SDB, % (*n* = 228)	No SDB, % (*n* = 338)	Pearson's χ^2 p Value
Ventricular Arrhythmias			
Premature Ventricular Contraction (≥ 5/h)	35.1	21.3	0.0003
Bigeminy	14.0	8.0	0.02
Trigeminy	9.2	5.6	0.10
Quadrigeminy	11.8	5.9	0.01
Nonsustained ventricular tachycardia	5.3	1.2	0.004
Complex ventricular ectopy*	25	14.5	0.002
Supraventricular Arrhythmias			
Premature atrial contraction (≥ 5/h)†	33.8	24.3	0.001
Atrial fibrillation	4.8	0.9	0.003
Supraventricular tachycardia	14.9	14.5	0.89
Conduction Delay Arrhythmias			
Sinus pause (≥ 3 s)	11.0	8.6	0.34
First-degree atrioventricular block	25.0	22.5	0.49
Second-degree atrioventricular block type 1	1.8	0.3	0.07
Second-degree atrioventricular block type 2	2.2	0.9	0.20
Intraventricular conduction delay	8.9	5.3	0.11



Association between SA & AF was statistically significant. SA was also associated with ventricular arrhythmia.

Truths and Lies from the Polysomnography ECG Recording: An Electrophysiologist Perspective



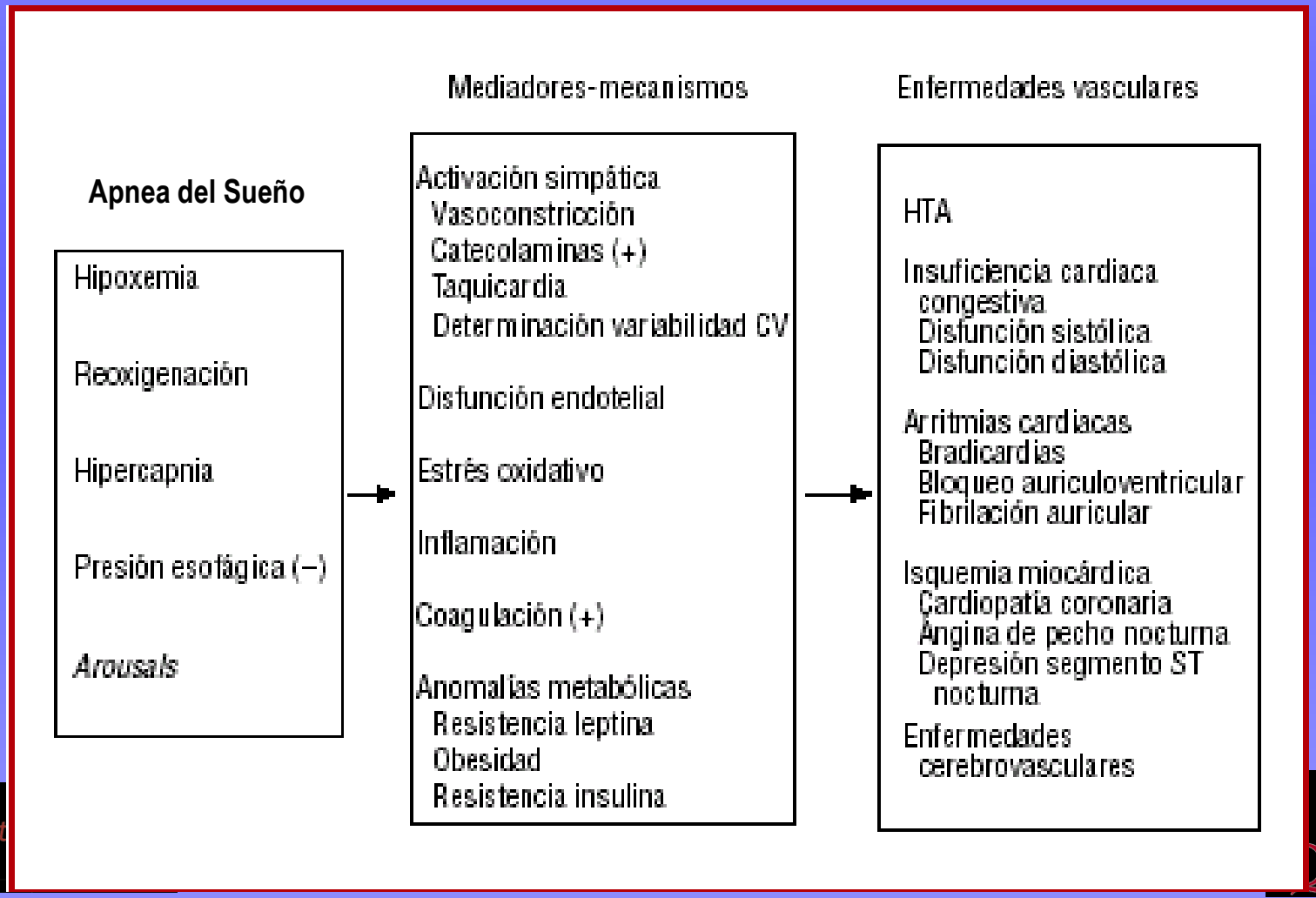
Baranchuk et al. Case Reports Med 2009

Physiopathology: Cardiovascular Morbidity

Síndrome de apneas-hipopneas durante el sueño y corazón

Joaquín Terán Santos[a], M. Luz Alonso Álvarez[a], José Cordero Guevara[b], José María Ayuela Azcárate[c] y José María Monserrat Canal[d]

Rev Esp Cardiol. 2006;59(7):718-24



In summary…

Cardiovascular Morbidity in Obstructive Sleep Apnea

J. Woodrow Weiss, Sandrine H. Launois, Amit Anand, and Erik Garpestad

Progress in Cardiovascular Diseases, Vol. 41, No. 5 (March/April), 1999: pp 367-376

SA

BP, HR & CO fluctuations + 0_2 Desaturation

Cardiovascular Morbidity

Acute changes

- Arrhythmias
- Myocardial infarction
- CVA

Chronic changes

- HF
- HTN
- PHT
- LVH

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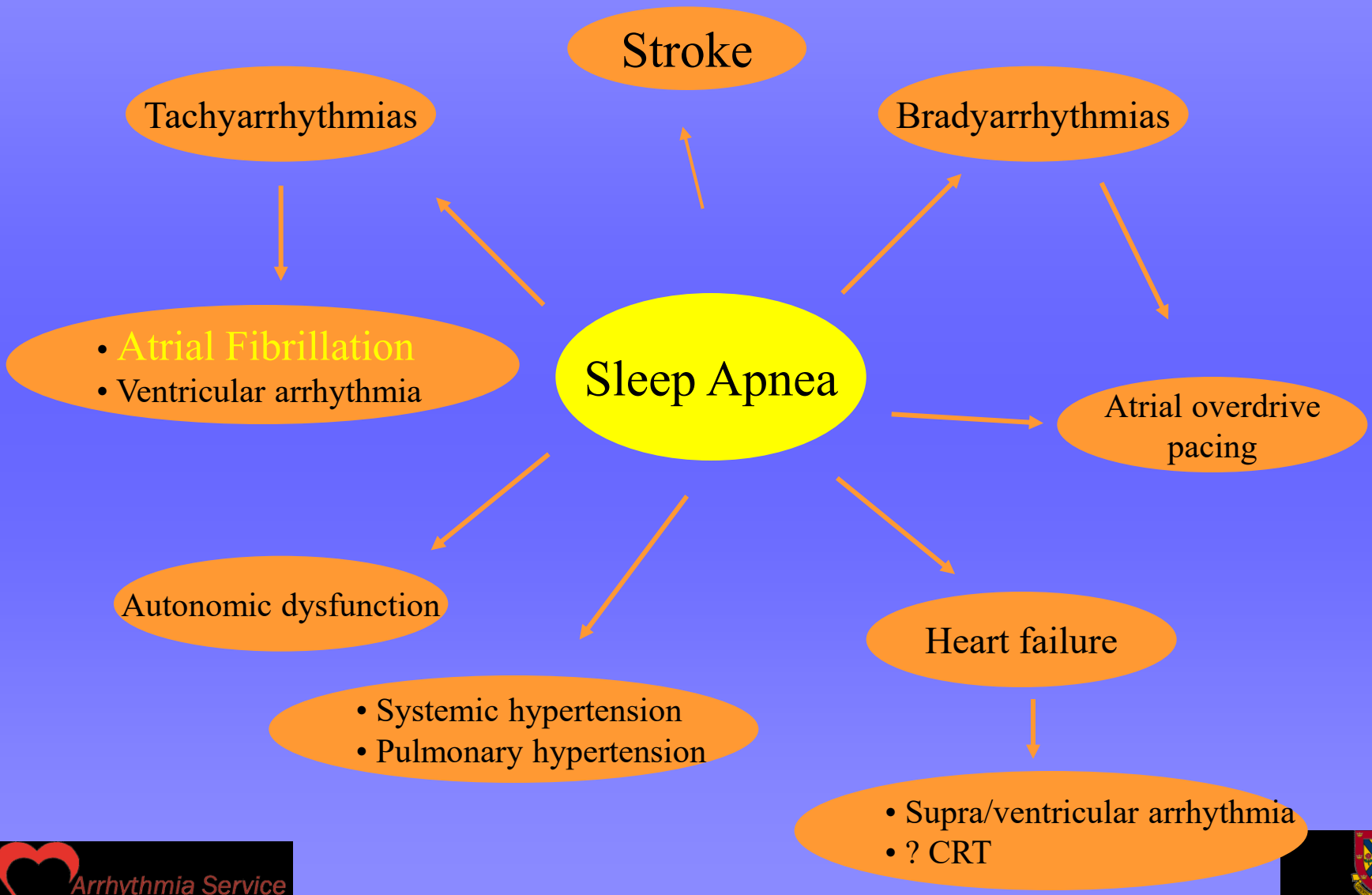
It's time to wake up!: sleep apnea and cardiac arrhythmias



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Baranchuk et al. Europace 2008; 10(6):666-667

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SA & Arrhythmias: Mechanisms

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It's time to wake up!: sleep apnea and cardiac arrhythmias

(i) Impaired autonomic nervous control has been demonstrated in patients with OSA, manifesting as increased sympathetic tone and/or decreased parasympathetic tone. Decreased baroreflex sensitivity, reduced vagal input, and impairment of the parasympathetic components of the heart rate variability have been demonstrated in patients with OSA.[22,23]

(ii) A persistent increase in sympathetic tone, as occurring in OSA, has been shown to generate abnormal electrical remodelling of the atrium, facilitating supraventricular arrhythmias, and AF in particular.[24] Specifically, electrical remodelling may create some degree of interatrial block, contributing to the genesis of atrial arrhythmias.[25]

(iii) A strong association between OSA and hypertension has been reported extensively.[6,26] As well, the association between hypertension and AF is well recognized.[27,28] Although purely speculative, the link

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Baranchuk et al. Europace 2008; 10(6):666-667

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Sleep Apnea:
SA & Hypertension: Is this the link to arrhythmias?

PROSPECTIVE STUDY OF THE ASSOCIATION BETWEEN SLEEP-DISORDERED BREATHING AND HYPERTENSION

PAUL E. PEPPARD, PH.D., TERRY YOUNG, PH.D., MARI PALTA, PH.D., AND JAMES SKATRUD, M.D.

NEJM 2000;342:1378-84

TABLE 3. ADJUSTED ODDS RATIOS FOR HYPERTENSION AT A FOLLOW-UP SLEEP STUDY, ACCORDING TO THE APNEA–HYPOPNEA INDEX AT BASE LINE.*

BASE-LINE APNEA–HYPOPNEA INDEX	ODDS RATIO, ADJUSTED FOR BASE-LINE HYPERTENSION STATUS	HTA: ODDS RATIO, ADJUSTED FOR BASE-LINE HYPERTENSION STATUS AND NONMODIFIABLE RISK FACTORS (AGE AND SEX)	HTA + BMI: ODDS RATIO, ADJUSTED FOR BASE-LINE HYPERTENSION STATUS, NONMODIFIABLE RISK FACTORS, AND HABITUS (BMI AND WAIST AND NECK CIRCUMFERENCE)	HTA + BMI + Alc/tabaco: ODDS RATIO, ADJUSTED FOR BASE-LINE HYPERTENSION STATUS, NONMODIFIABLE RISK FACTORS, HABITUS, AND WEEKLY ALCOHOL AND CIGARETTE USE
(n=709)	odds ratio (95% confidence interval)			
	1.0	1.0	1.0	1.0
	1.66 (1.35–2.03)	1.65 (1.33–2.04)	1.42 (1.14–1.78)	1.42 (1.13–1.78)
	2.74 (1.82–4.12)	2.71 (1.78–4.14)	2.03 (1.29–3.19)	2.03 (1.29–3.17)
	4.54 (2.46–8.36)	4.47 (2.37–8.43)	2.89 (1.47–5.69)	2.89 (1.46–5.64)
	<0.001	<0.001	<0.002	<0.002

SA & Hypertension Large trials

Wisconsin S dy[1]: (n=709), f/u 8 years
Sleep Hear tudy[2]: (n=6841), f/u 3 years

Wisconsin Sleep Study			Sleep Heart Health Study		
Punto de corte IAH	Prevalencia HTA (%)	OR* (IC del 95%)	Punto de corte IAH	Prevalencia HTA (%)	OR* (IC del 95%)
0	17	1	< 1,5	43	1
0,1-4,9	28	1,39 (1,04-1,84)	1,5-4,9	53	1,07 (0,91–1,26)
5-14,9	48	1,92 (1,09-3,39)	5-14,9	59	1,20 (1,01-1,42)
≥ 15	60	2,66 (1,13-6,25)	15-29,9	62	1,25 (1,00-1,56)
			≥ 30	67	1,37 (1,03-1,83)

Severe SA is significantly associated with HTN

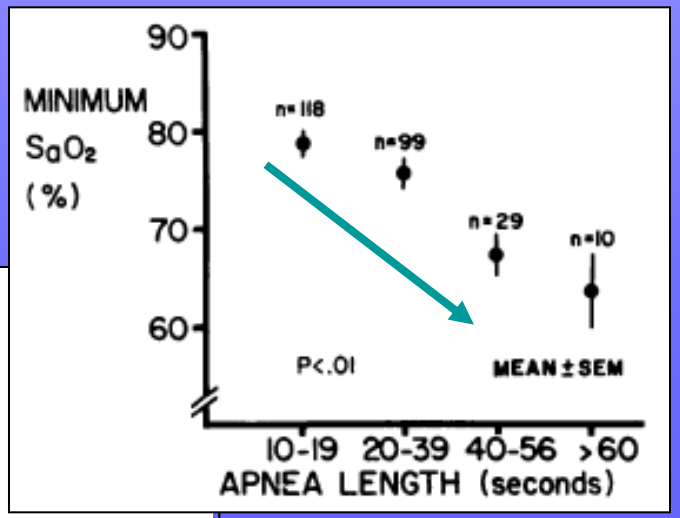
The question still is: is there a causative relationship?

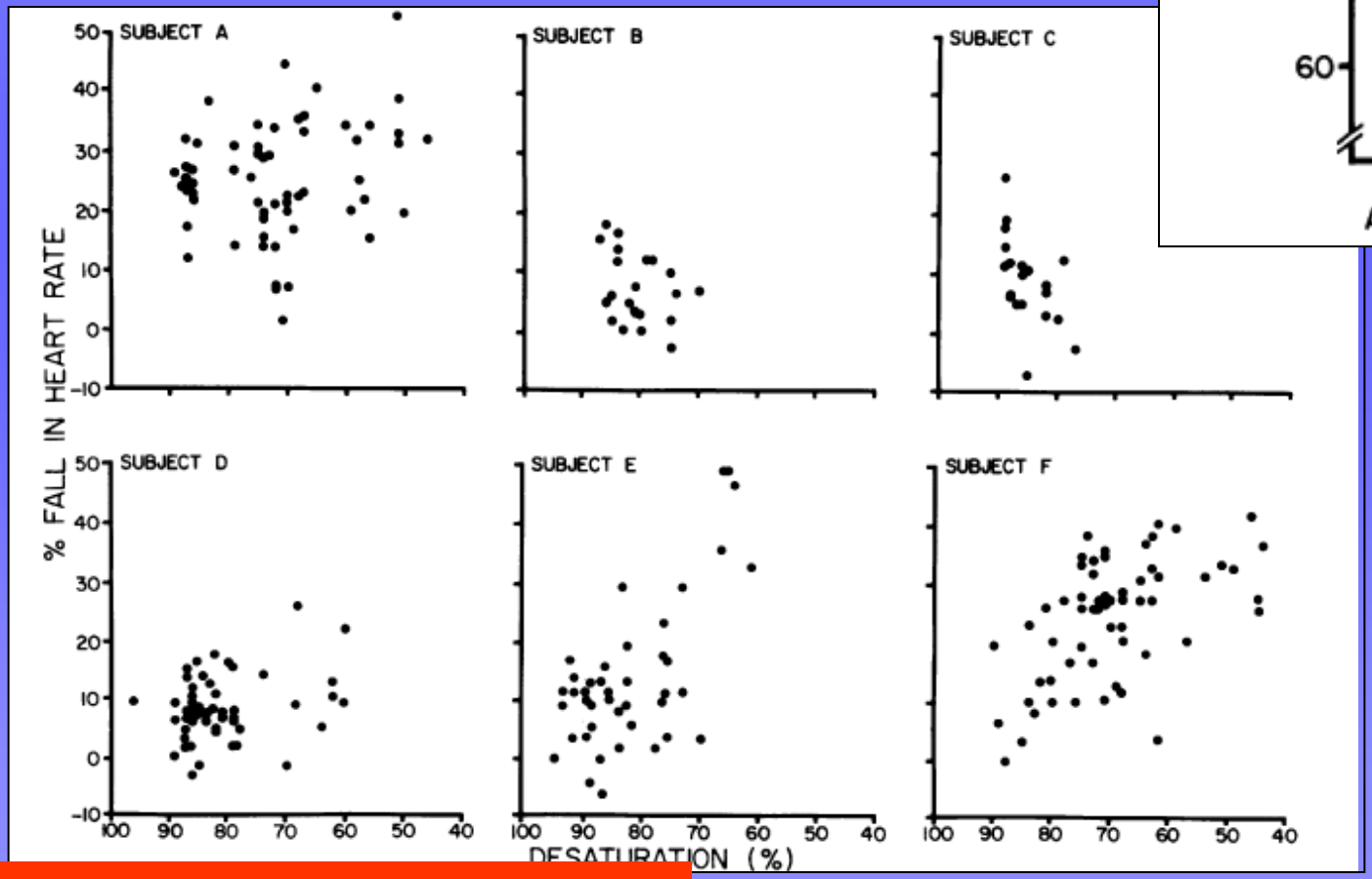
1. N Engl J Med 2000;342:1378-84
2. JAMA 2000;283:1829-36

1. SA & Bradyarrhythmias

Bradycardia during Sleep Apnea

CHARACTERISTICS AND MECHANISM





- Bradycardia during SA
- Longer the apnea, longer the bradycardia
- No bradycardia if no SA

Zwillich C. J Clin Invest 1982;69:1286-92

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SA & Bradyarrhythmias: the Role of Pacing

Physiologic Pacing in Patients With Obstructive Sleep Apnea

A Prospective, Randomized Crossover Trial

Andrew D. Krahn, MD,* Raymond Yee, MD,* Mark K. Erickson, BSc,† Toby Markowitz, BSEE,† Lorne J. Gula, MD,* George J. Klein, MD,* Allan C. Skanes, MD,* Charles F. P. George, MD,* Kathleen A. Ferguson, MD*

Parameter	Control	AAI Pacing	Difference (95% CI)	p Value
Heart rate (beats/min)	65 ± 7	77 ± 1	12 (8 to 16)	0.001
Time in bed (min)	437 ± 45	417 ± 108	−19 (−87 to 48)	0.55
Minimum SaO_2 (%)	77 ± 11	75 ± 10	−2 (−9 to 4)	0.38
% time SaO_2 <90%	3.5 ± 4.3	3.8 ± 6.0	0.3 (−1.4 to 2.1)	0.70
Apnea hypopnea duration (s)	28.4 ± 4.7	33.1 ± 11.2	4.7 (0.7 to 8.7)	0.11
Circulatory time (s)	25.5 ± 4.4	23.4 ± 3.2	−2.1 (−4.7 to 0.4)	0.09

AV sequential pacing did not show any benefits in patients with OSA

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JACC 2006;47:379-83

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Atrial overdrive pacing: 12 RCT since 2002…

Effects of physiological cardiac pacing on sleep-disordered breathing in patients with chronic bradydysrhythmias *Psychiatry and Clinical Neurosciences* (2001), 55, 257–258

Atrial Overdrive Pacing for the Obstructive Sleep Apnea–Hypopnea Syndrome
N Engl J Med 2005;353:2568-77.

Physiologic Pacing in Patients

- No clear benefit was demonstrated

Atrial overdrive pacing compared to CPAP in patients with obstructive sleep apnoea syndrome
European Heart Journal (2005) 26, 2568–2575

Overdrive atrial pacing does not improve obstructive sleep apnoea syndrome
Eur Respir J 2005; 25: 343–347

Effect of atrial overdrive pacing on obstructive sleep apnea in patients with systolic heart failure ☆
Sleep Medicine 8 (2007) 31–36

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Atrial overdrive pacing in sleep apnoea: a meta-analysis

Adrian Baranchuk[1]*, Jeff S. Healey[2], Christopher S. Simpson[1], Damian P. Redfearn[1], Carlos A. Morillo[2], Stuart J. Connolly[2], and Michael Fitzpatrick[1]

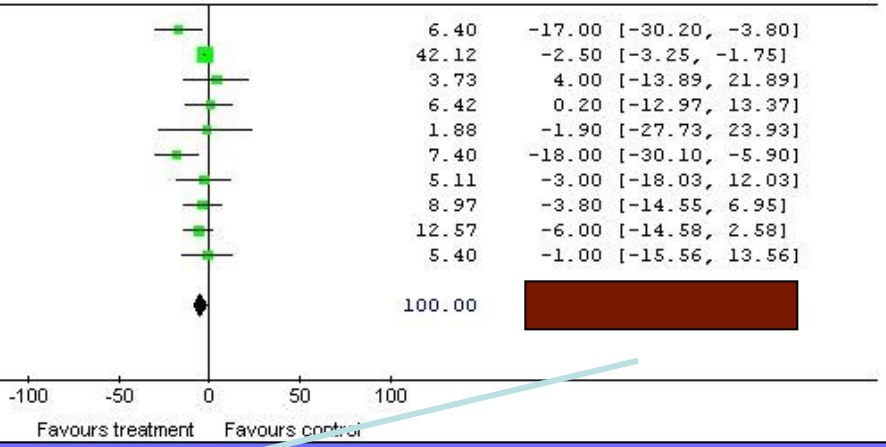
Séminaire Winter Arrhythmia School
Annual Cardiac Arrhythmia Meeting
Division of Cardiology, University of Toronto

Baranchuk et al. Europace 2009.

Review: OSA_AOP_Baranchuk
Comparison: 01 Apnea-Hypopnea Index
Outcome: 01 AHI

Study or sub-category	N	Treatment Mean (SD)	N	Control Mean (SD)	WMD (random) 95% CI	Weight %	WMD (random) 95% CI
Garrigue	15	11.00(14.00)	15	28.00(22.00)		6.40	-17.00 [-30.20, -3.80]
Luthje	20	10.90(1.00)	20	13.40(1.40)		42.12	-2.50 [-3.25, -1.75]
Pepin	17	50.00(24.00)	17	46.00(29.00)		3.73	4.00 [-13.89, 21.89]
Simantirakis	16	49.20(19.00)	16	49.00(19.00)		6.42	0.20 [-12.97, 13.37]
Unterberg	10	39.10(22.30)	10	41.00(35.20)		1.88	-1.90 [-27.73, 23.93]
Guo	16	10.00(13.00)	16	28.00(21.00)		7.40	-18.00 [-30.10, -5.90]
Krahn	15	39.00(21.00)	15	42.00(21.00)		5.11	-3.00 [-18.03, 12.03]
Melzer	19	23.00(16.70)	19	26.80(17.10)		8.97	-3.80 [-14.55, 6.95]
Sharafkeneh	33	18.00(16.60)	33	24.00(18.90)		12.57	-6.00 [-14.58, 2.58]
Shalaby	14	31.00(17.00)	14	32.00(22.00)		5.40	-1.00 [-15.56, 13.56]
Total (95% CI)	175		175			100.00	

Test for heterogeneity: Chi² = 12.26, df = 9 (P = 0.20), I² = 26.6%
Test for overall effect: Z = 2.52 (P = 0.01)



AHI reduction = 5 points:
Statistically significant (p=0.01) but…
No clinical relevance!!!

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2. SA & AF

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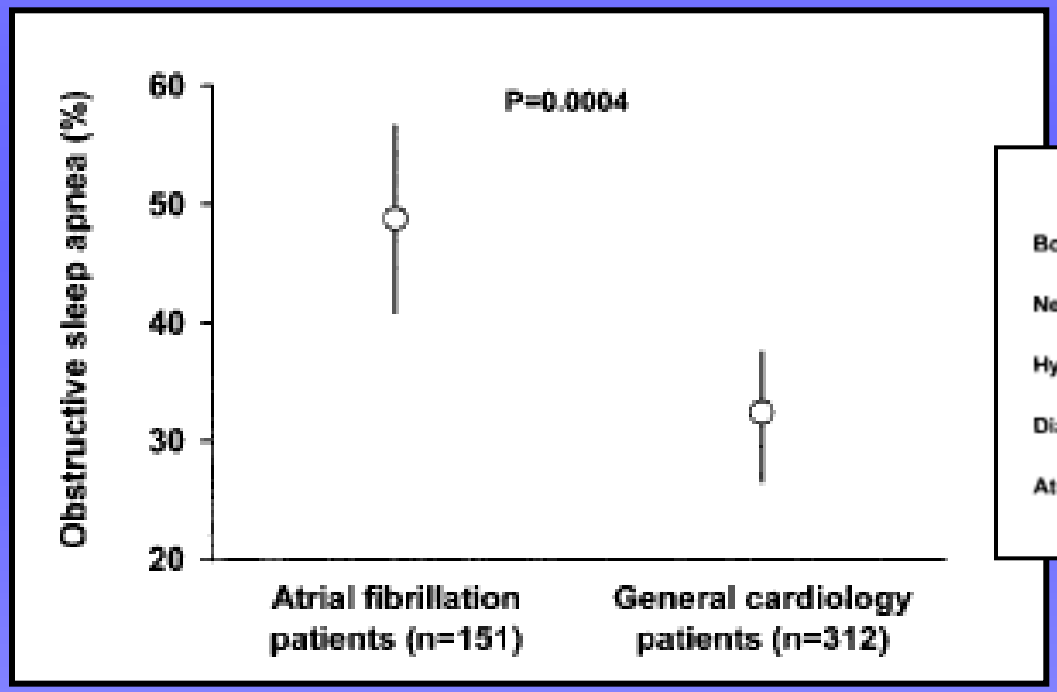
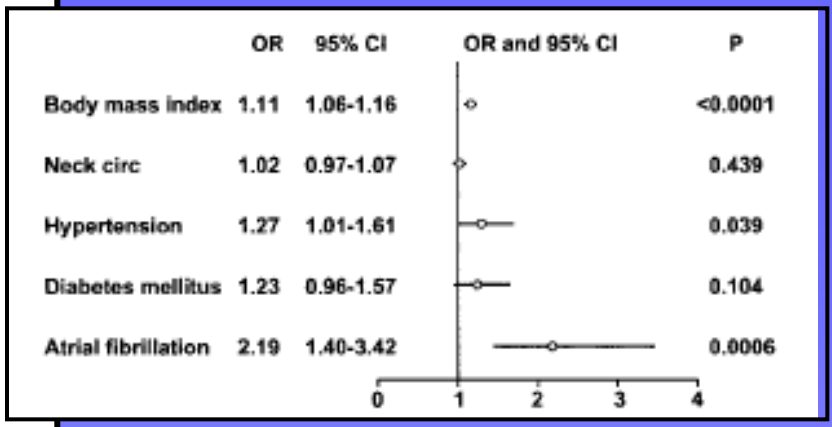
Association of Atrial Fibrillation and Obstructive Sleep Apnea

Apoor S. Gami, MD; Gregg Pressman, MD; Sean M. Caples, MD; Ravi Kanagala, MD; Joseph J. Gard, BS; Diane E. Davison, RN, MA; Joseph F. Malouf, MD; Naser M. Ammash, MD; Paul A. Friedman, MD; Virend K. Somers, MD, PhD





But…why?

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EDITORIAL COMMENTARY

Understanding the association between sleep apnea & cardiac arrhythmias

Adrian Baranchuk MD FACC[1], Christopher S. Simpson MD FACC FRCPC[1], Damian P. Redfearn MB ChB MRCPI[1], Kevin Michael MD[1], Mike Fitzpatrick MD FRCPI, FRCPC, D.ABSM[2]

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Annual Cardiac Arrhythmia Meeting
Division of Cardiology, University of Toronto

? CAD

? Interatrial block

Hypertension

SA & AF

Autonomic Imbalance

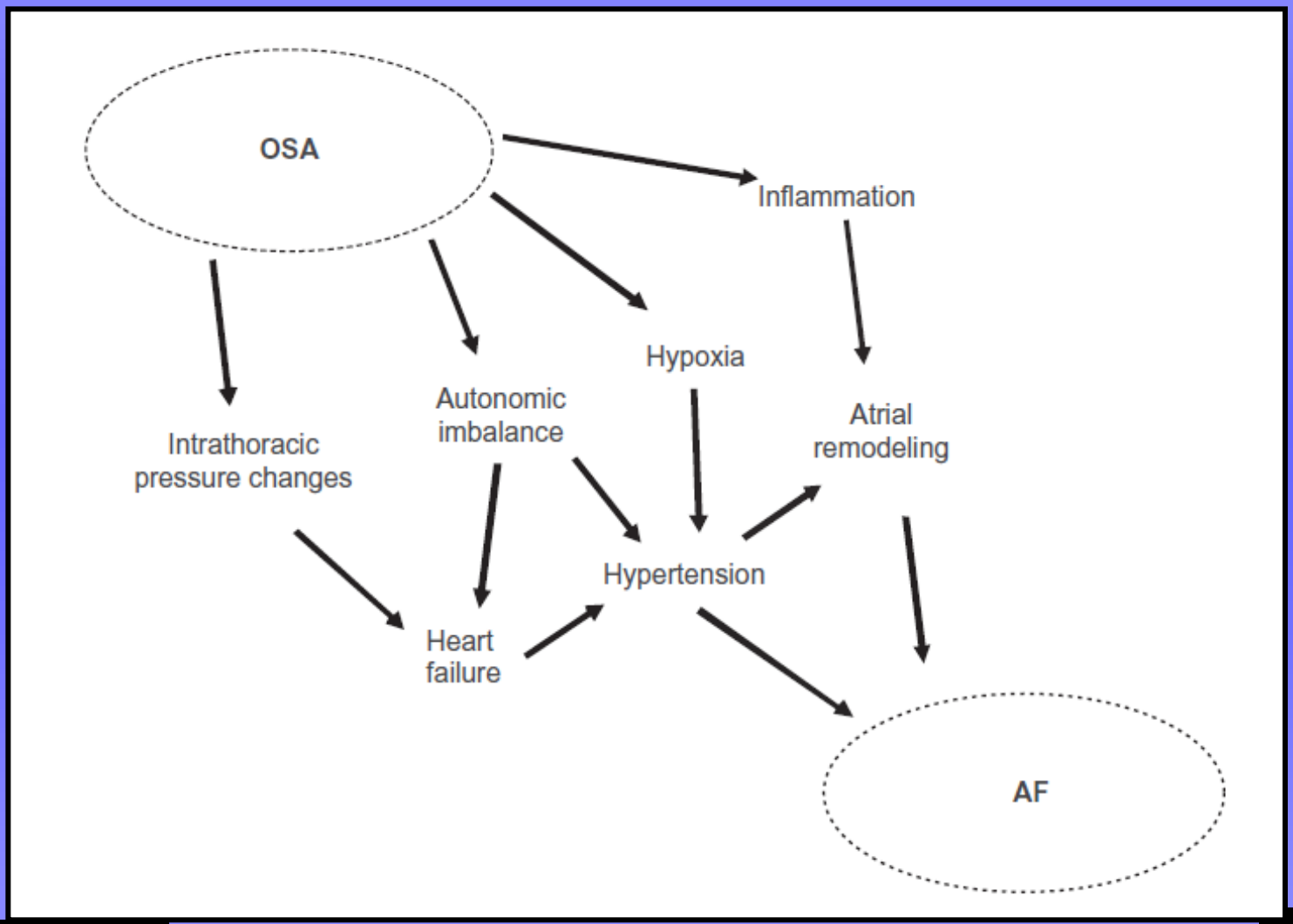
Heart failure

Bi-atrial enlargement

Baranchuk A et al. REA 2008;1:5-6

Obstructive sleep apnea and atrial fibrillation: a review of the literature

Nature and Science of Sleep 2010:2 1–7



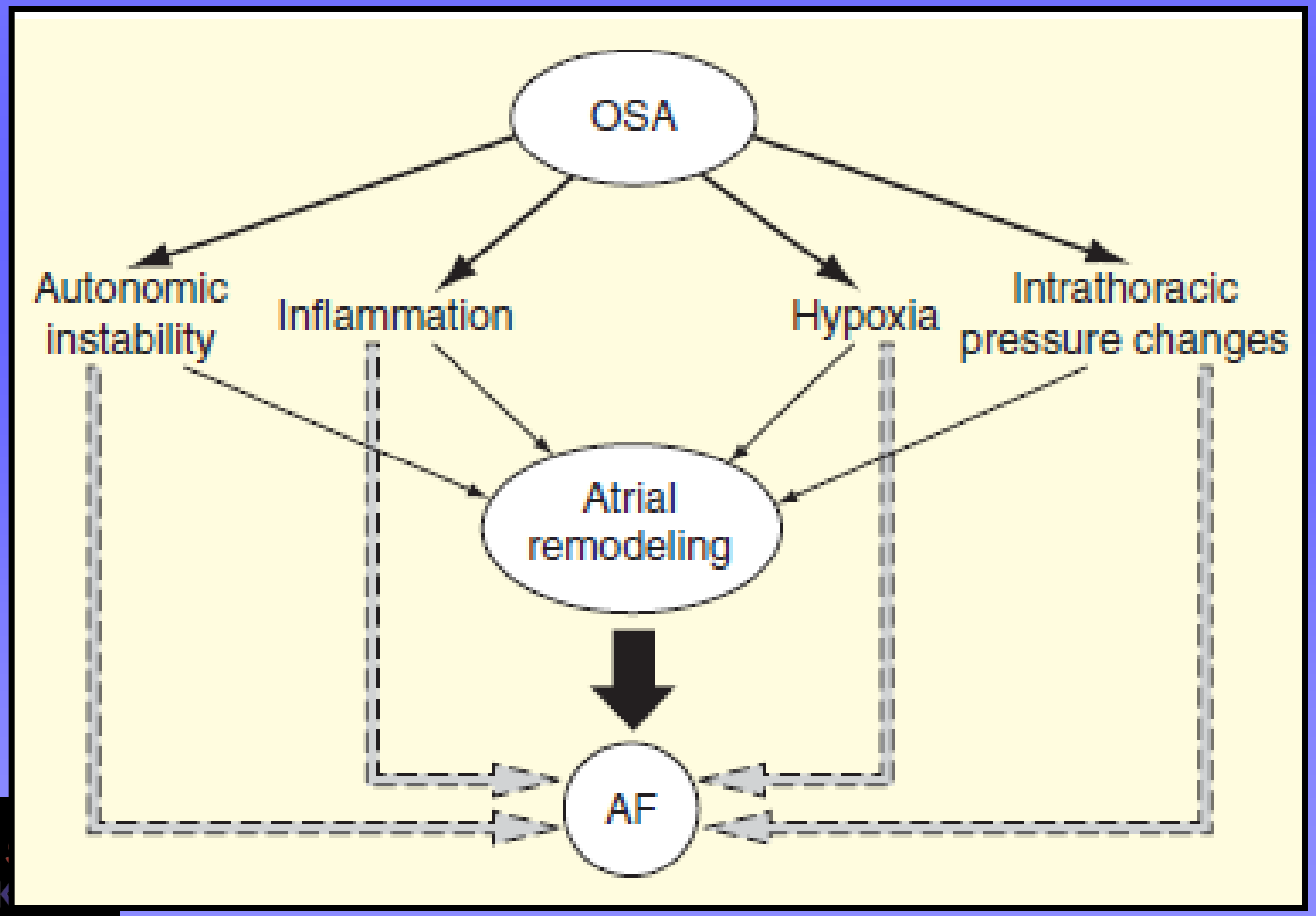
Todd & Baranchuk, Nat Science Sleep 2010

EXPERT REVIEWS

The relationship between obstructive sleep apnea and atrial fibrillation in special patient populations

Doran Drew,
Amro Qaddoura and
Adrian Baranchuk*

Expert Rev. Cardiovasc. Ther. Early online, 1–12 (2014)



Prevalence of risk factors for atrial fibrillation and stroke among 1210 patients with sleep disordered breathing ☆,☆☆

Marie Carmen Valenza [a,*], Adrian Baranchuk [b], Gerald Valenza-Demet [a], Tomás Muñoz-Casaubon [c], Jose Antonio Martin-Navajas [d], Jeff Healey [e]

Int J Cardiol 2014

Variables	AHI < 5 (n = 107)	AHI 5–30 (n = 306)	AHI > 30 (n = 797)	p-Value
Age (years) Mean ± SD	47.3 ± 11.4	49.3 ± 12.3	52.74 ± 12.4	0.001[b]
Sex (females) n (%)	97 (59.5)	77 (33.3)	170 (21)	<0.001[b,c]
BMI (Kg/m^2) Mean ± SD	30.7 ± 7.3	30.8 ± 4.7	33.83 ± 10.1	<0.001[b,c]
Smoking history:				
Never	77 (43.9)	113 (48.9)	262 (32.5)	
Current	51 (36.4)	61 (26.9)	289 (35.7)	<0.001
Ex-smoker	35 (19.6)	56 (24.3)	258 (32.0)	
Alcohol (daily consumers) n (%)	46 (43.0)	154 (50.3)	430 (54.0)	0.081
Percent SaO_2 < 90% Mean ± SD	3.7 ± 11.3	7.7 ± 12.8	23.2 ± 25.1	<0.001[b,c]
HTN n (%)	19 (17.8)	83 (27.1)	308 (38.6)	<0.001
COPD n (%)	3 (2.8)	11 (3.6)	38 (4.8)	0.502
Diabetes n (%)	4 (3.7)	24 (7.8)	78 (9.8)	0.093
Prior stroke or TIA n (%)	3 (2.8)	7 (2.3)	18 (2.3)	0.939
Heart failure n (%)	1 (0.9)	6 (2)	18 (3.4)	0.206
$CHADS_2$ score Mean ± SD	0.28 ± 0.64	0.43 ± 0.8	0.59 ± 0.8	<0.001[b]
$CHADS_2$ score 0 n (%)	82 (79.6)	207 (70.2)	423 (56.3)	
$CHADS_2$ score 1 n (%)	16 (15.5)	64 (21.7)	248 (33)	<0.001
$CHADS_2$ Score ≥ 2 n (%)	5 (4.9)	24 (8.1)	81 (10.8)	
Medications				
Digoxin, %	1.7	1.9	2.5	0.918
ACE inhibitors, %	16.9	12.3	10.9	0.517
Diuretics, %	10.2	5.7	14.3	0.103
B-blockers, %	10.2	6.6	10.9	0.509
Amiodarone, %	0.5	5.7	3.4	0.166
ASA, %	8.5	5.7	5	0.651
Anticoagulant, %	13.6	12.3	11.8	0.943
Benzodiazepines, %	1.7	6.6	9.2	0.165

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Interatrial block in patients with obstructive sleep apnea

(n=180)

	Moderate-severe obstructive sleep apnea (AHI > 25)	Control group	P
Age (years)	56.7 ± 12.6	56.4 ± 12.4	0.90
Gender (male, %)	69.4	47.2	0.01
Hypertension (%)	51.4	27.8	< 0.01
Obesity (%)	78.5	39.4	< 0.001
Heart failure (%)	17.6	5.6	0.12
Coronary artery disease (%)	30.1	16.7	0.11
Diabetes mellitus (%)	30.8	22.2	0.31
Left atrium dimension [mm]	40.8 ± 7	34.6 ± 4.8	0.038
Apnea/hypopnea index (AHI)	56.2 ± 27.9	5.6 ± 3.6	< 0.001
Maximum desaturation (%)	79.8	88.4	< 0.001

	Moderate-severe OSA (AHI > 25)	Control group	P
Interatrial block (%)	34.7	0	< 0.001
P-wave dispersion [ms]	14.6 ± 7.5	8.9 ± 3.1	< 0.001

Baranchuk et al. Cardiol J 2011; 18(2): 171-175

Reverse atrial electrical remodelling induced by continuous positive airway pressure in patients with severe obstructive sleep apnoea

Adrian Baranchuk · Helen Pang · Geoffrey E. J. Seaborn · Payam Yazdan-Ashoori · Damian P. Redfearn · Christopher S. Simpson · Kevin A. Michael · Michael Fitzpatrick

JICE 2013

	Severe OSA	Controls	*p*
n	19	10	
Age	51.1 ± 12.3	39.2 ± 20.9	*NS*
Male (%)	68	40	*NS*
BMI (kg/m^2)	34.3 ± 5.4	26.6 ± 4.6	< 0.001
Hypertensive (%)	37	10	*NS*
Smoker (%)	16	10	*NS*
Diabetes (%)	5	0	*NS*
AHI	41.4 ± 10.1	2.8 ± 1.2	< 0.001
Nadir O_2 Saturation (%)	80.5 ± 6.5	91.4 ± 2.1	< 0.001

Severe OSA + Controls

↓

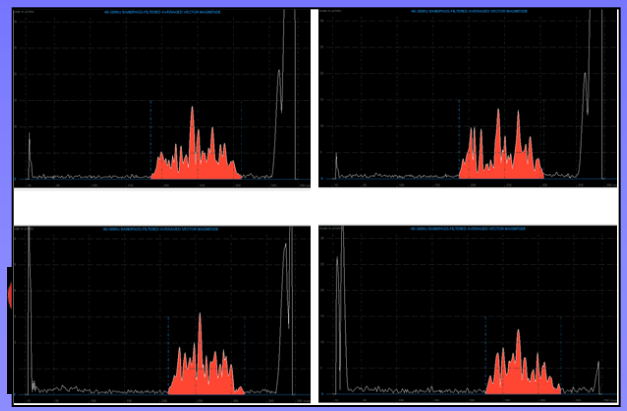
SAPW

↓

CPAP 4-6 weeks

↓

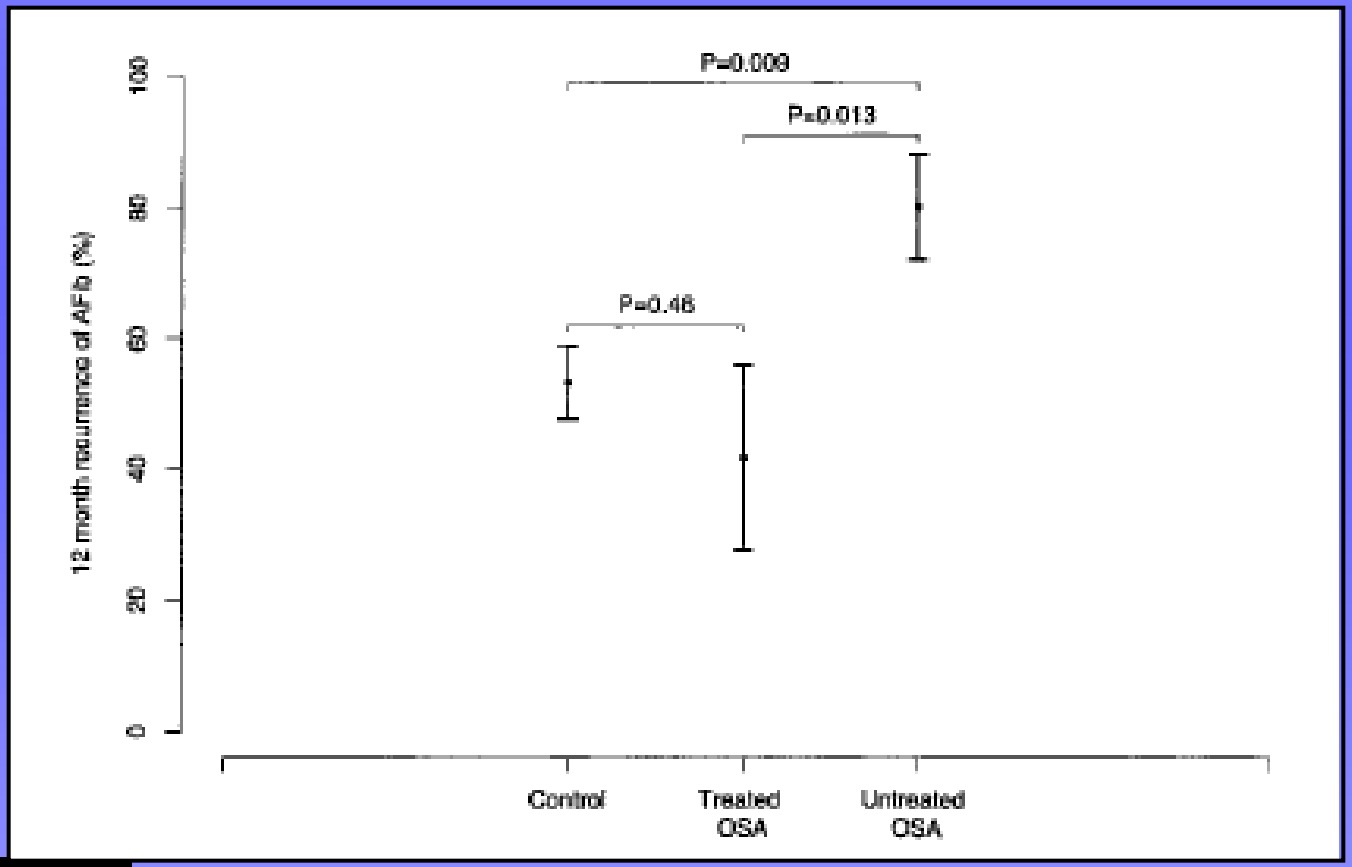
SAPW



SAPW (ms)	Severe OSA	Control	
Baseline	131.9±10.4	122.8±10.5	p=0.04
4–6 weeks[a]	126.2±8.8	122.6±10.9	NS
	p<0.001	NS	

OSA & AF:
Post-cardioversion recurrence

Obstructive Sleep Apnea and the Recurrence of Atrial Fibrillation



Circulation 2003,107

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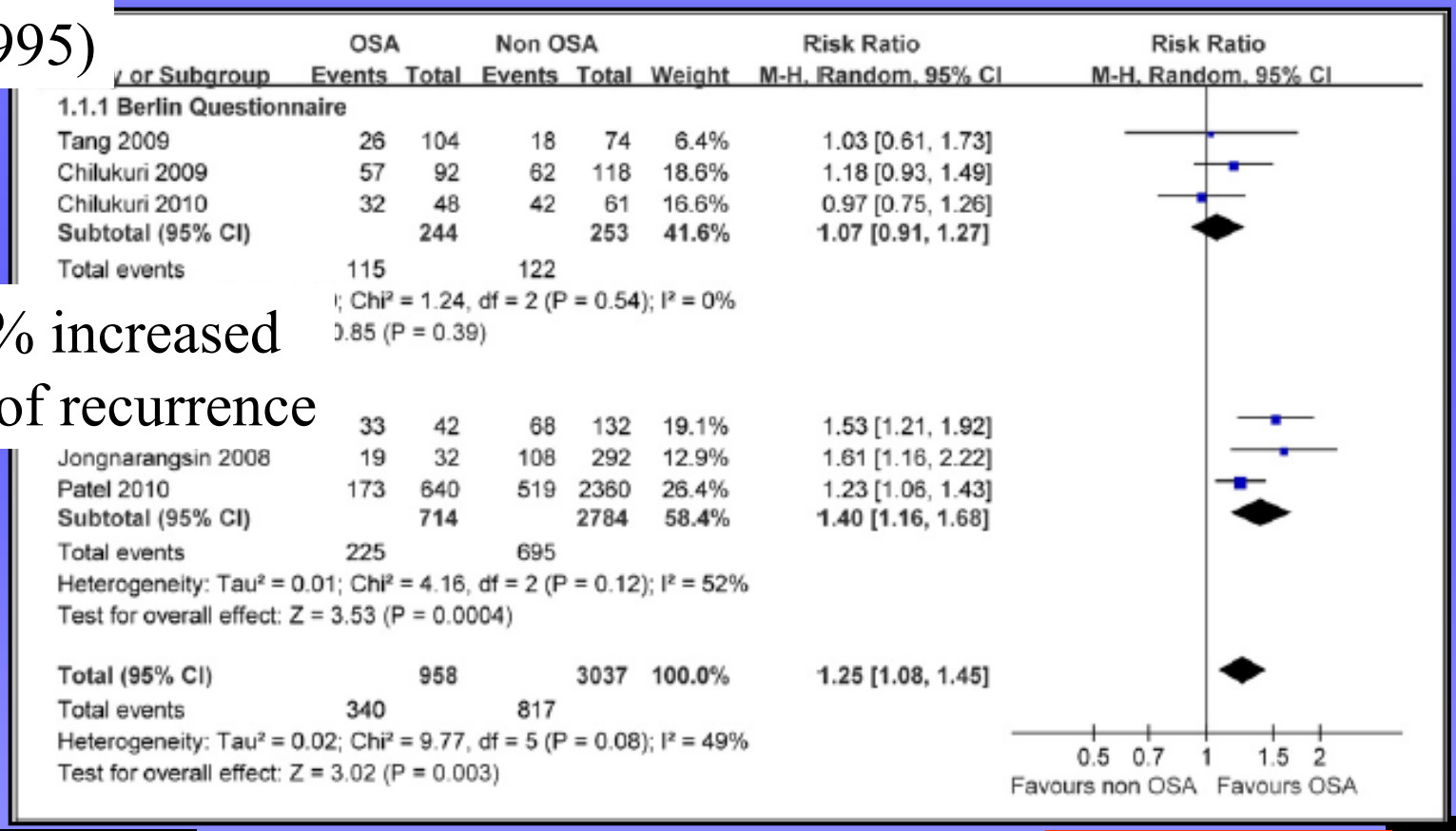
OSA & AF:
Post-Catheter ablation recurrence

Meta-Analysis of Obstructive Sleep Apnea as Predictor of Atrial Fibrillation Recurrence After Catheter Ablation

(N=3995)

25% increased risk of recurrence



Am J Cardiol 2011

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Sleep Apnea: Stroke

Séminaire Winter Arrhythmia School
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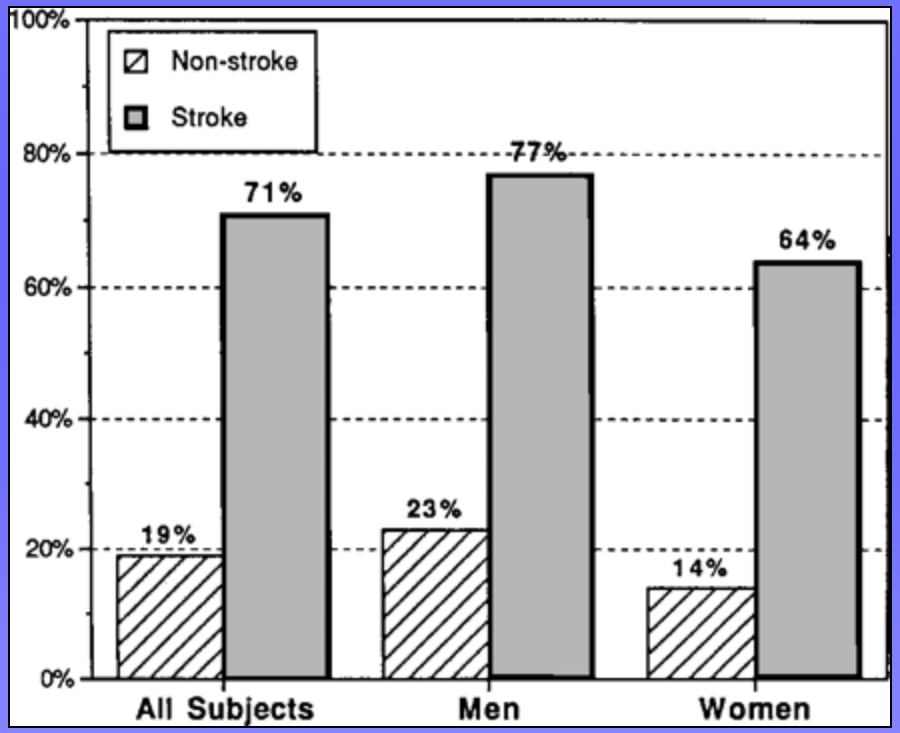
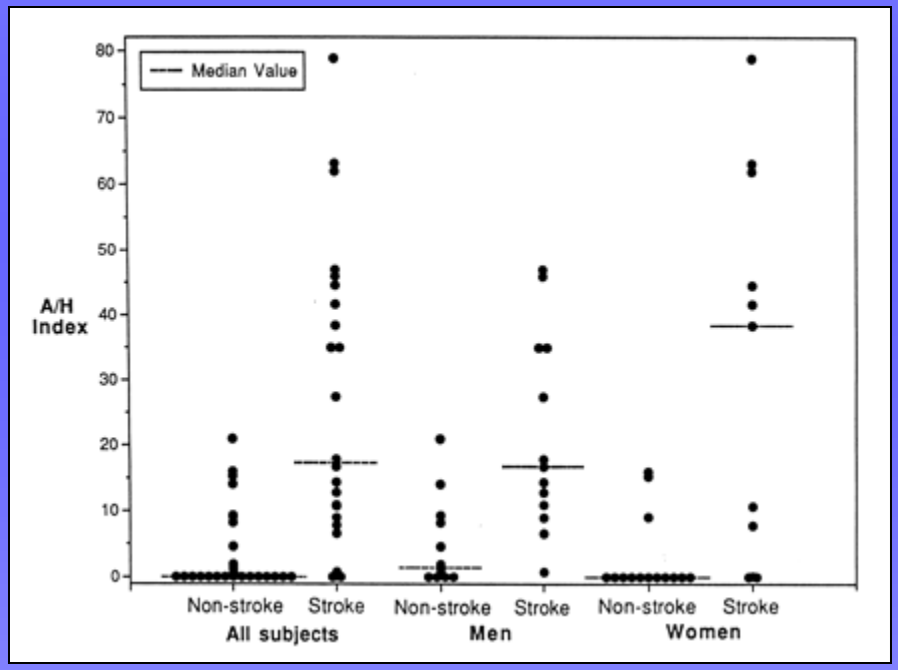
Division of Cardiology, University of Toronto

Investigating the Relationship Between Stroke and Obstructive Sleep Apnea

Dyken ME. Stroke 1996;27:401-407





Should we reformulate the CHADS2 score?

SA ⇒ CVA

?

CVA ⇒ SA

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Queen's University

OSA & AF: Risk of Stroke

Séminaire Winter Arrhythmia School
Annual Cardiac Arrhythmia Meeting
Division of Cardiology, University of Toronto

Obstructive sleep apnea may increase the risk of stroke in AF patients: Refining the $CHADS_2$ score

Payam Yazdan-Ashoori, Adrian Baranchuk *

International Journal of Cardiology 146 (2011) 131–133

Prospective cohort studies showing OSA as an independent predictor of stroke.

Author (year)	N	AHI for the OSA group	AHI for the control group	Mean follow-up (years)	Outcome	Risk of outcome (95% CI)	p-value	% AF in the OSA group (N)
Marin et al. (2005)[9]	235	≥30	<5	10.1	Fatal MI or stroke	OR=2.87* (1.17–7.51)	0.025	2.9 (7)
Arzt et al. (2005)[10]	1189	≥20	<5	4.0, 8.0 and 12.0	Stroke	OR=4.48+ (1.31–15.33)	0.020	N.R.
Yaggi et al. (2005)[11]	842	≥5	<5	3.4	Stroke, TIA or death	HR=1.97‡ (1.12–3.48)	0.010	7 (48)
Munoz et al. (2006)[12]	394	≥30	<30	4.5	Stroke	HR=2.52§ (1.04–6.01)	0.040	38 (36)
Valham et al. (2008)[13]	392	≥5	<5	10.0	Stroke, MI, or death	HR=2.89† (1.37–6.09)	0.005	2 (4)

Significant multivariate relative risks for stroke in non-anticoagulated patients with AF combined from seven studies.

Variable	Relative risk* (95% CI)
Prior stroke/TIA	2.5 (1.8–3.5)
Increasing age+	1.5 (1.3–1.7)
History of hypertension	2.0 (1.6–2.5)
Diabetes mellitus	1.7 (1.4–2.0)

CHADSS2 score?

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Effect of Preoperative Obstructive Sleep Apnea on the Frequency of Atrial Fibrillation After Coronary Artery Bypass Grafting

Erik M. van Oosten, MD, MSc[a], Andrew Hamilton, MD[a,b], Dimitri Petsikas, MD[a,b], Darrin Payne, MD[a,b], Damian P. Redfearn, MBChB[a,c], Shetuan Zhang, PhD[d], Wilma M. Hopman, MA[c], and Adrian Baranchuk, MD[a,c,*]

Am J Cardiol 2014

Demographics and clinical characteristics of patients with and without obstructive sleep apnea (OSA)

Variable	Total	OSA High Risk + Confirmed	OSA Low Risk	p Value	OSA Confirmed	OSA High Risk	OSA Low Risk	p Value
Characteristics								
Age (yrs)	65.1 ± 10.3	63.7 ± 10.7	66.4 ± 9.9	0.031	63.2 ± 10.3	63.9 ± 10.9	66.4 ± 9.9	0.093
Men	78.0	80.3	75.9	0.373	80.0	80.4	75.9	0.672
Body mass index (kg/m^2)	28.9 ± 5.3	31.0 ± 6.0	26.9 ± 3.6	<0.001	33.1 ± 7.1	30.3 ± 5.4	26.9 ± 3.6	<0.001
Smokers	35.4	31.1	39.3	0.152	25.7	33.0	39.3	0.265
Hypertension	71.1	78.0	64.8	0.015	80.0	77.3	64.8	0.051
Diabetes mellitus	36.5	45.5	28.3	0.003	60.0	40.2	28.3	0.001
Chronic obstructive pulmonary disease	14.4	12.1	16.6	0.295	8.6	13.4	16.6	0.453
Asthma	9.0	9.8	8.3	0.648	14.3	8.2	8.3	0.509
History of paroxysmal AF	4.7	5.3	4.1	0.647	2.9	6.2	4.1	0.655
History of persistent AF	3.2	1.5	4.8	0.120	2.9	1.0	4.8	0.261
β-Blocker use	66.8	63.6	69.7	0.288	62.9	63.9	69.7	0.565
Continuous positive airway pressure use	7.9	16.7	0.0	<0.001	62.9	0.0	0.0	<0.001
Left ventricular ejection fraction (%)	53.3 ± 10.5	52.7 ± 11.1	53.9 ± 10.0	0.452	56.7 ± 9.7	51.4 ± 11.3	53.9 ± 10.0	0.077
Left atrial diameter (mm)	40.4 ± 6.0	41.1 ± 6.2	39.8 ± 5.7	0.116	40.5 ± 6.3	41.3 ± 6.2	39.8 ± 5.7	0.242
Intraoperative variables								
Revascularization of RCA	35.0	45.4	54.6	0.575	40.0	30.9	36.6	0.537
Use of intraoperative inotropes	13.7	12.1	15.2	0.461	11.4	12.4	15.2	0.755
Antegrade cardioplegia	99.6	100.0	99.3	0.339	100.0	100.0	99.3	0.633
Clamp time (minutes)	55.1 ± 18.6	57.3 ± 19.3	53.2 ± 17.9	0.065	56.3 ± 20.0	57.6 ± 16.1	53.2 ± 17.9	0.172
Intraoperative cardiac pacing	36.8	40.2	33.8	0.273	45.7	38.1	33.8	0.400
Postoperative variables								
Postoperative body temperature (°C)	36.9 ± 0.5	36.9 ± 0.4	36.9 ± 0.6	0.225	36.9 ± 0.3	37.0 ± 0.4	36.9 ± 0.6	0.294
Use of postoperative inotropes	16.2	15.2	17.2	0.638	20.0	13.4	17.2	0.593
Use of temporary pacing wire	6.5	6.1	6.9	0.778	5.7	6.2	6.9	0.957
β Blockers on discharge	91.7	92.4	91.0	0.675	100.0	89.7	91.0	0.152
Reintubation	3.6	4.5	2.8	0.426	2.9	5.2	2.8	0.599
β-Blocker prophylaxis	86.3	86.4	86.2	0.970	82.9	87.6	86.2	0.780
Postoperative atrial flutter	3.2	3.8	2.8	0.629	5.7	3.1	2.8	0.672
Postoperative other arrhythmia	4.0	4.5	3.4	0.640	2.9	5.2	3.4	0.750
Outcomes								
Presence of PCAF	37.2	45.5	29.7	0.007	51.4	43.3	29.7	0.017
Time after surgery (days)	2.3 ± 1.8	2.1 ± 1.1	2.6 ± 2.4	0.182	2.1 ± 0.6	2.1 ± 1.3	2.6 ± 2.4	0.410
LOS (days)	5.7 ± 3.8	5.6 ± 3.1	5.8 ± 4.3	0.220	5.7 ± 2.3	5.6 ± 3.3	5.8 ± 4.3	0.194

Effect of Preoperative Obstructive Sleep Apnea on the Frequency of Atrial Fibrillation After Coronary Artery Bypass Grafting

Erik M. van Oosten, MD, MSc[a], Andrew Hamilton, MD[a,b], Dimitri Petsikas, MD[a,b], Darrin Payne, MD[a,b], Damian P. Redfearn, MBChB[a,c], Shetuan Zhang, PhD[d], Wilma M. Hopman, MA[c], and Adrian Baranchuk, MD[a,c,*]

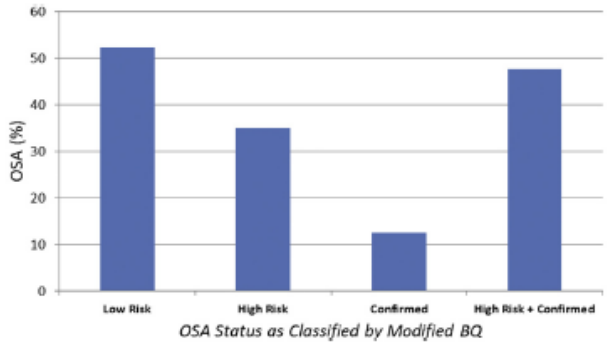

Figure 1. Prevalence of OSA in patients undergoing CABG as classified by the modified BQ.

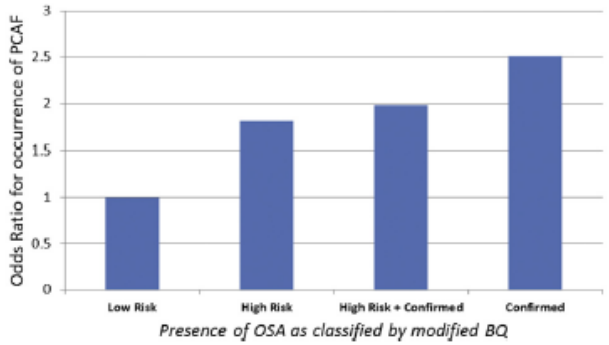

Figure 2. OSA as a predictor of PCAF.

Logistic regression models for presence of high-risk obstructive sleep apnea (OSA) and post–coronary artery bypass grafting atrial fibrillation (PCAF)

Covariates	Odds Ratio	95% Confidence Interval	p Value
Model for OSA high/confirmed			
BMI (5-point increase)	2.61	1.89–3.62	<0.001
Clamp time (10-minute increase)	1.14	1.13–3.35	0.074
Model for PCAF			
Smoking history	0.57	0.33–1.00	0.048
Use of temporary wire	2.55	0.94–6.89	0.065

Am J Cardiol 2014

Take a look to the 2 sub-studies of this series…

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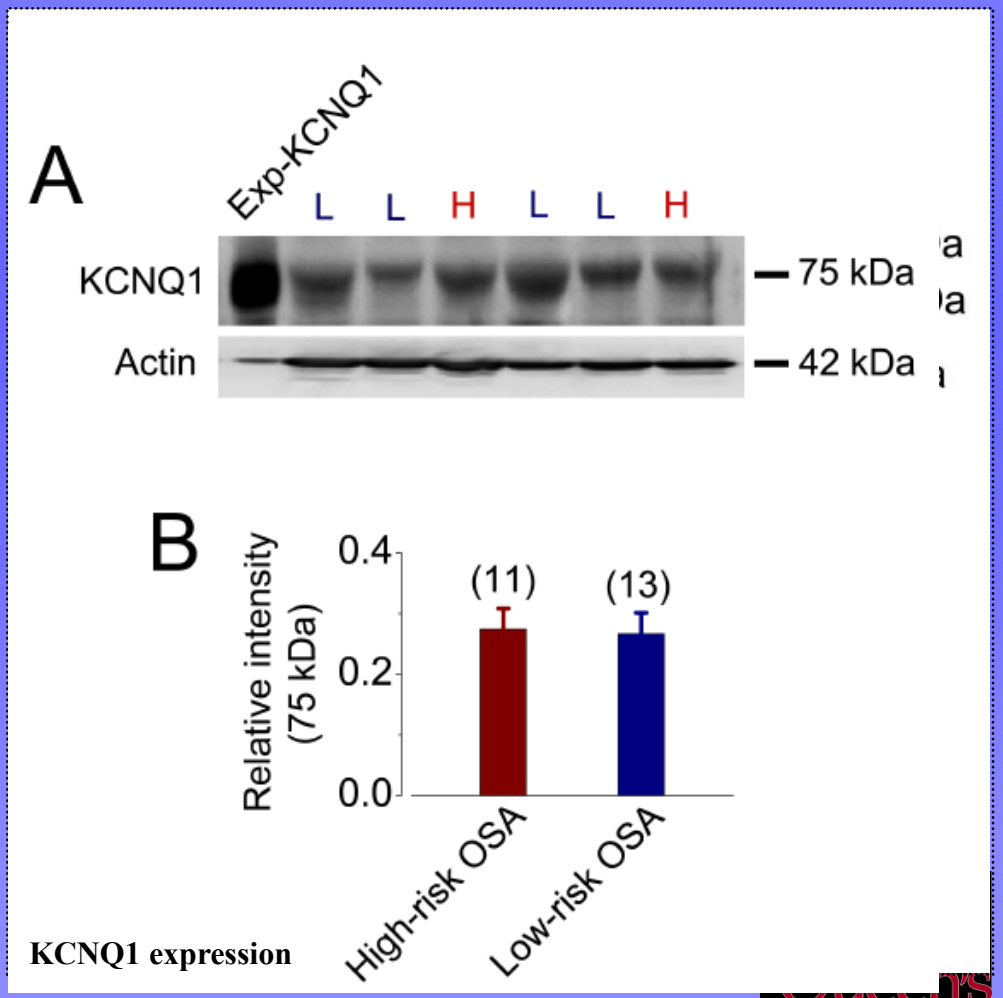
Alterations in hERG Potassium Channel Expression in Patients with Obstructive Sleep Apnea

Original Research

WonJu Song BSc[1], Erik M. van Oosten MD[2], Tingzhong Wang PhD[1], Shawn Lamothe MSc[1], Andrew Hamilton MD[2,3], Dimitri Petsikas MD[2,3], Darrin Payne MD[2,3], Damian P. Redfearn MB ChB[2,4], Shetuan Zhang PhD[1], Adrian Baranchuk MD FACC FRCPC[2,4]

	TOTAL (n=24)	OSA High Risk (n=11)	OSA Low Risk (n=13)	*P*
Age (years)	63.8 ± 9.1	63.3 ± 11.3	64.2 ± 7.2	*0.819*
Gender (male, %)	70.8	76.9	63.8	*0.659*
BMI (kg/m^2)	29.1 ± 6.1	31.7 ± 7.6	26.9 ± 3.4	*0.051*
Smoking History (%)	45.8	36.4	53.8	*0.444*
Hypertension (%)	54.2	81.8	30.8	*0.019*
Diabetes (%)	37.5	54.5	23.1	*0.206*
COPD (%)	12.5	27.3	0	*0.082*
Asthma (%)	4.2	0	7.7	*1.000*
History of Paroxysmal AF (%)	12.5	9.1	15.4	*1.000*
History of Persistent AF (%)	0	0	0	*n/a*
Beta-Blocker Use (%)	50.0	45.5	53.8	*1.000*
LVEF (%)	52.8 ± 11.9	53.4 ± 10.2	52.4 ± 13.6	*0.846*
LAD (mm)	40.0 ± 6.0	41.2 ±7.4	39.0 ± 4.6	*0.385*

Exp Clin Cardiol 2014



KCNQ1 expression

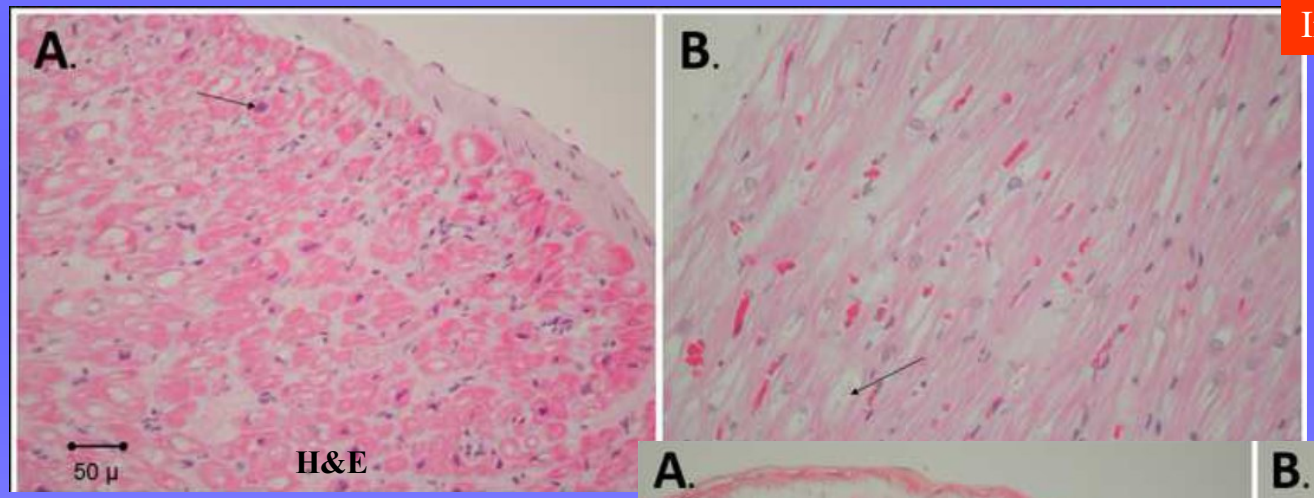
The Histology of Human Right Atrial Tissue in Patients with High-Risk Obstructive Sleep Apnea and Underlying Cardiovascular Disease: A Pilot Study

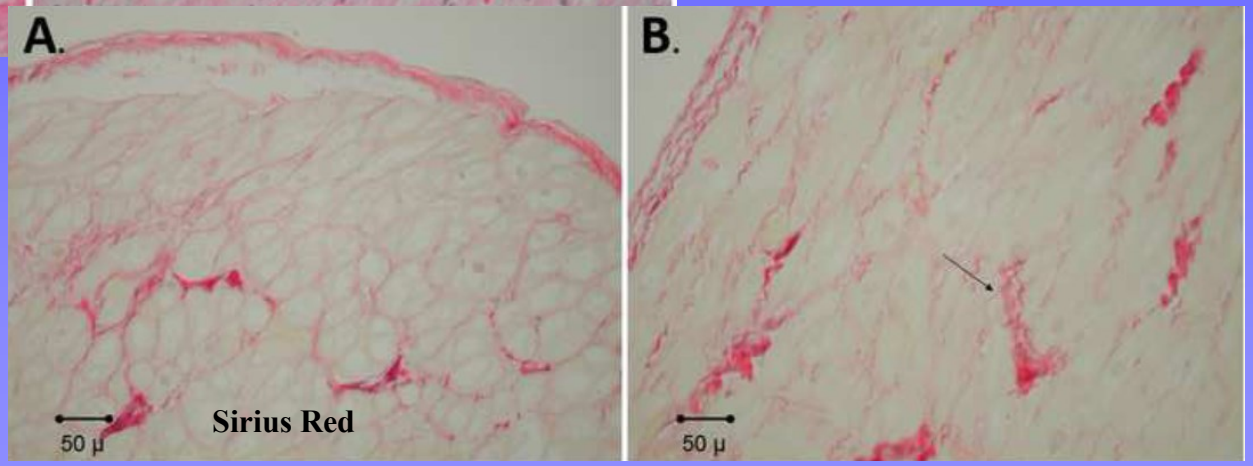
Original Research

Erik M. van Oosten MD[1], Alexander H. Boag MD[2], Kris Cunningham MD[2], John Veinot MD[3], Andrew Hamilton MD[1,4], Dimitri Petsikas MD[1,4], Darrin Payne MD[1,4], Wilma M. Hopman MA[5], Damian P. Redfearn MB ChB[1,5], WonJu Song BSc[6], Shawn Lamothe MSc[6], Shetuan Zhang PhD[6], Adrian Baranchuk MD FACC FRCPC[1,5]

Kingston General Hospital
Queen's University

Int J Cardiol H&V 2015





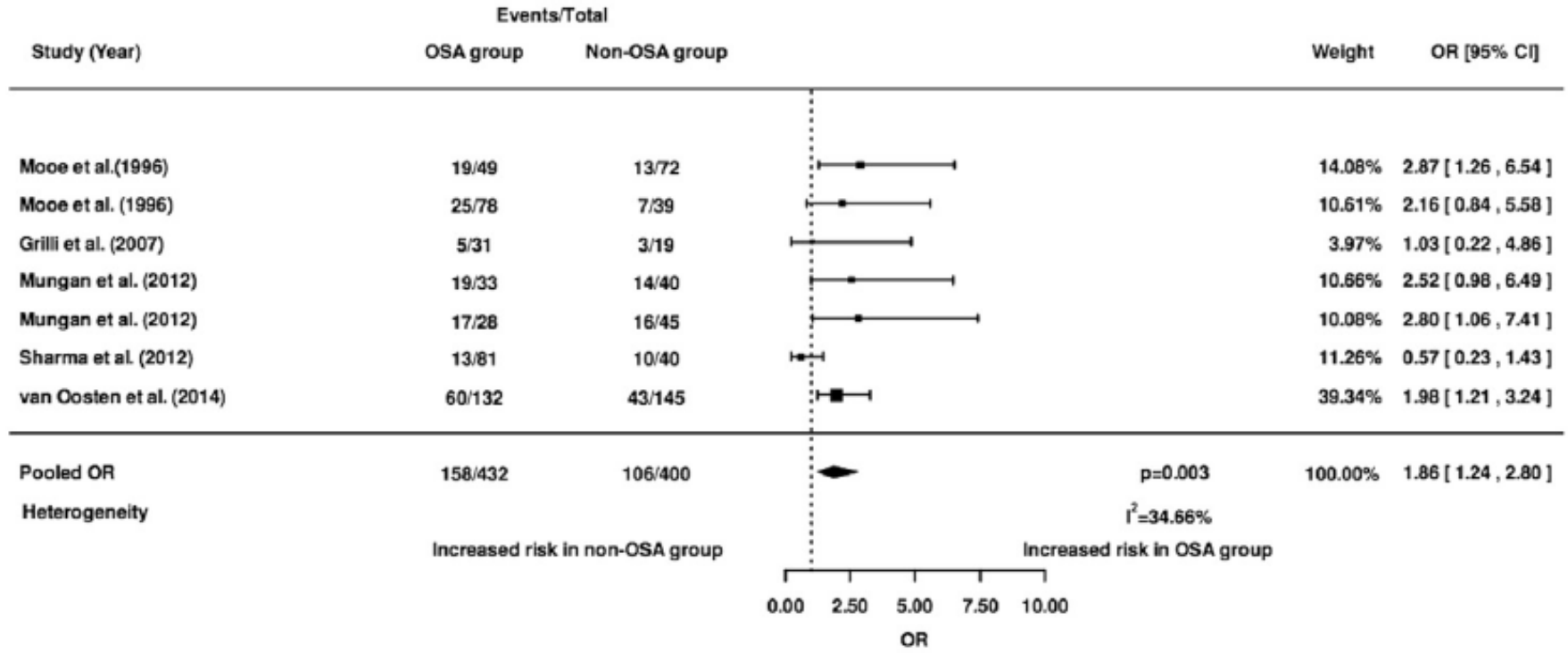
Arrhythmia Service KGH

Canadian Journal of Cardiology 30 (2014) 1516–1522

Systematic Review/Meta-analysis

Obstructive Sleep Apnea as a Predictor of Atrial Fibrillation After Coronary Artery Bypass Grafting: A Systematic Review and Meta-analysis

Amro Qaddoura, BHSc,[a] Conrad Kabali, PhD,[b] Doran Drew, BScH,[a]
Erik M. van Oosten, MD, MSc,[c] Kevin A. Michael, MBChB, MPhil,[a,d]
Damian P. Redfearn, MBChB,[a,d] Christopher S. Simpson, MD,[a,d] and Adrian Baranchuk, MD[a,d]

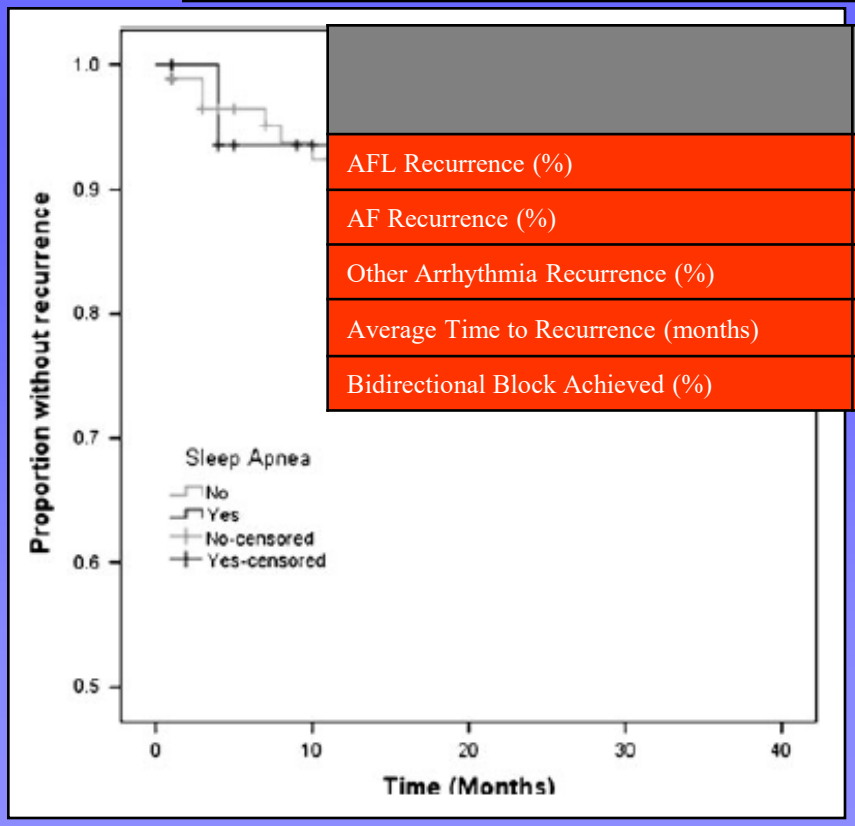


3. SA & AFL

Séminaire Winter Arrhythmia School
Annual Cardiac Arrhythmia Meeting
Division of Cardiology, University of Toronto

Sleep apnea does not predict atrial flutter recurrence after atrial flutter ablation

Erik M. van Oosten • Muhammed Ali Furqan • Damian P. Redfearn • Christopher S. Simpson • Michael Fitzpatrick • Kevin A. Michael • Wilma M. Hopman • Adrian Baranchuk



	TOTAL (n=122)	SA (n=33)	No SA (n=89)	*P*
AFL Recurrence (%)	9.8	6.1	11.2	0.394
AF Recurrence (%)	22.1	27.3	20.2	0.405
Other Arrhythmia Recurrence (%)	4.9	3.0	5.6	0.557
Average Time to Recurrence (months)	8.6 ± 8.6	9.3 ± 9.4	8.4 ± 8.4	0.742
Bidirectional Block Achieved (%)	94.3	97.0	93.3	0.434

		Hazard ratio and 95% confidence interval
		1.29 (0.64, 2.63)
		0.96 (0.11, 8.65)
		0.17 (0.04, 0.66)
		0.25 (0.07, 0.93)
		0.54 (0.10, 2.80)
Age by 10-year increments		0.74 (0.44, 1.26)
Sex (0=F, 1=M)	0.22	0.50 (0.17, 1.52)
LVEF by 10-point increments	0.073	1.39 (0.97, 1.98)
Bidirectional block (0=unsuccessful, 1=successful)	0.004	0.17 (0.05, 0.58)
Postablation antiarrhythmia meds (0=N, 1=Y)	0.033	5.14 (1.14, 23.2)
Prior history of atrial fibrillation (0=N, 1=Y)	0.008	3.52 (1.39, 8.91)
Sleep apnea (0=N, 1=Y)	0.54	1.37 (0.51, 3.66)

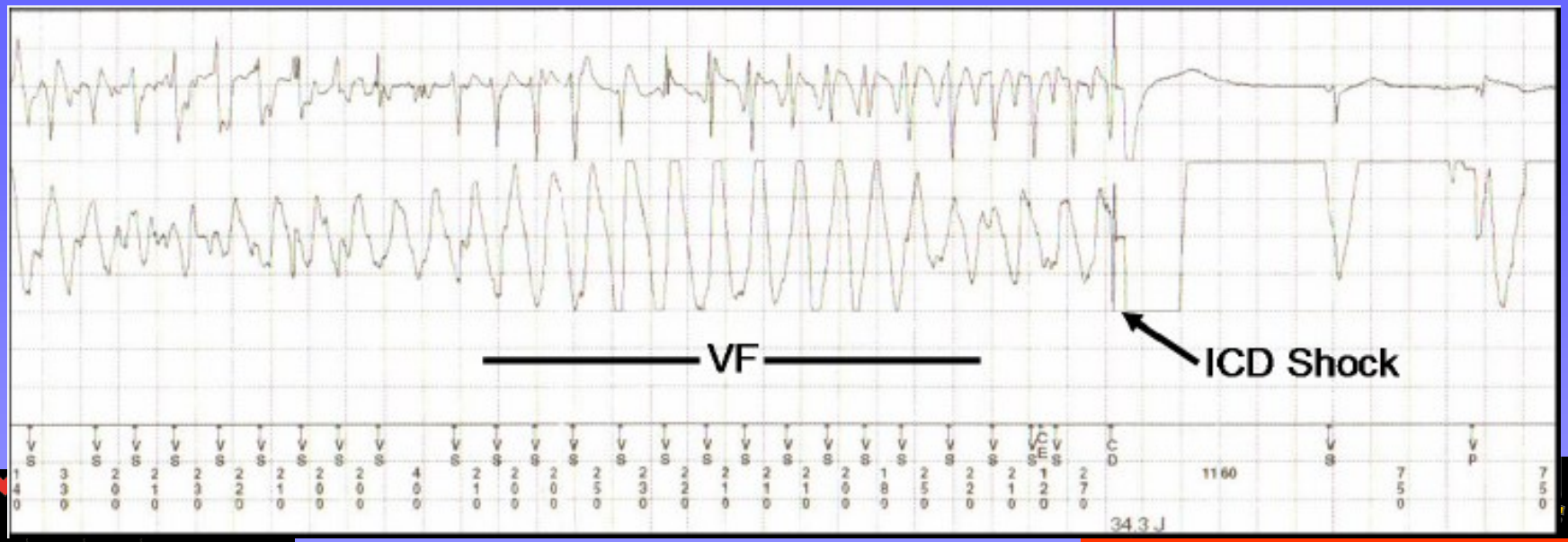
J Interv Card Electrophysiol (2012) 34:73–78

Queen's University

Sleep Disordered Breathing And Ventricular Arrhythmias: Mechanisms and Implications

4. SA & Ventricular arrhythmias

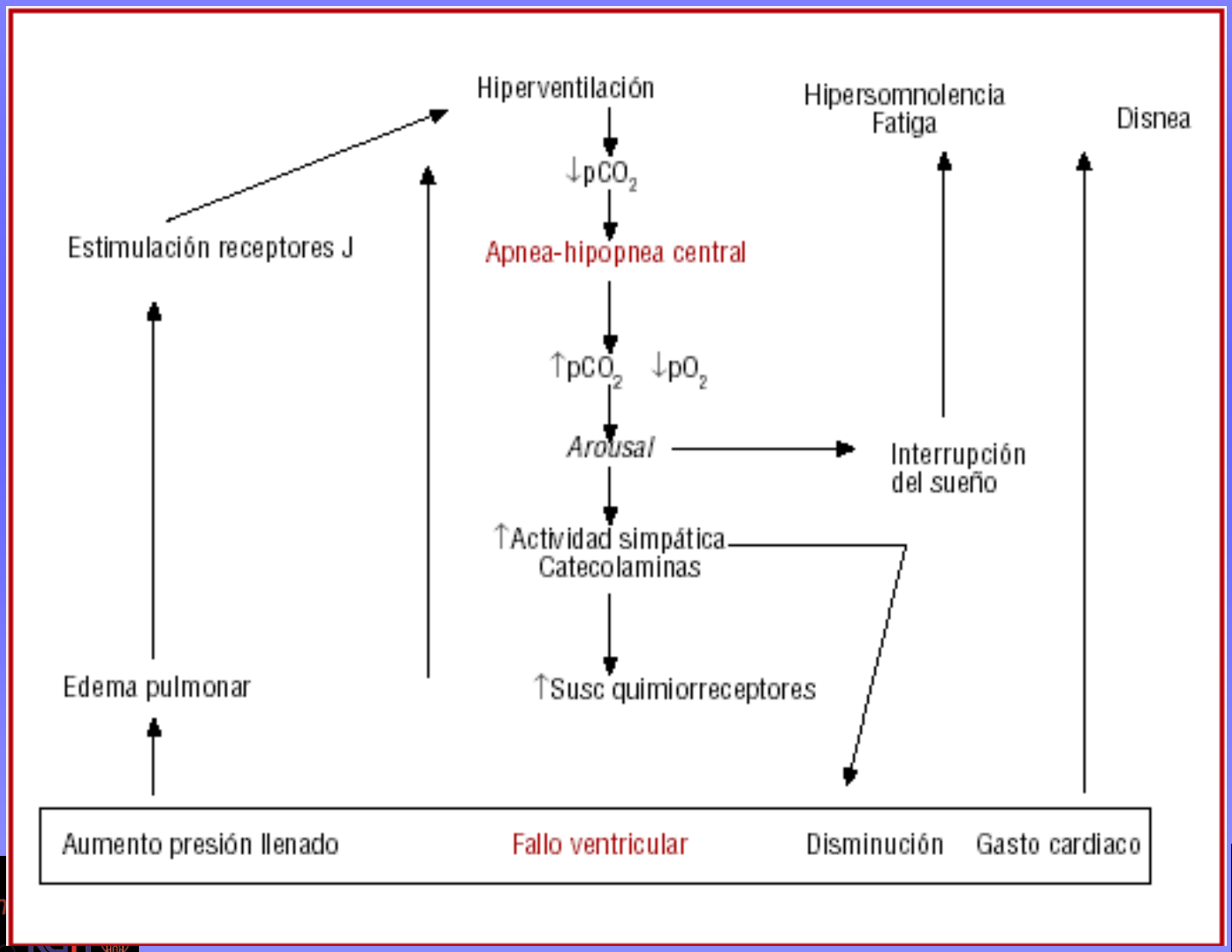
	SA (N=26)	NO SA (N=106)	p
Incidence of Therapies			
Appropriate (%)	31	17	0.09
Inappropriate (%)	3.8	9.4	NS
Time to First Appropriate Therapy (months ± SD)	8.0 ± 5.2	11.89 ± 5.9	0.12
Incidence of Arrhythmias			
NSVT (%)	34.6	50.0	NS
SVT (%)	26.9	30.1	NS



Baranchuk et al. ICRJ 2008;2(1):10-13

5. SA & Heart Failure Interaction

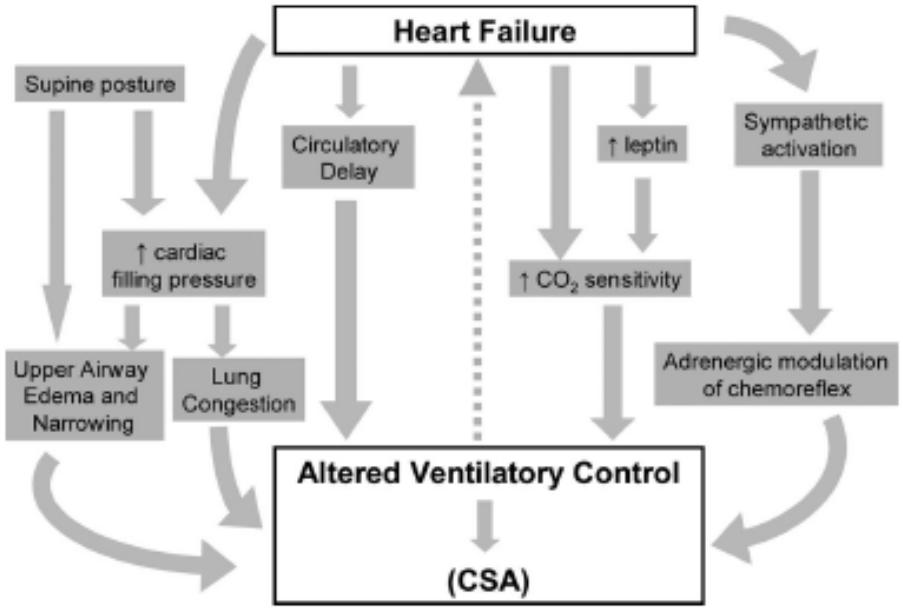
Rev Esp Cardiol. 2006;59(7):718-24

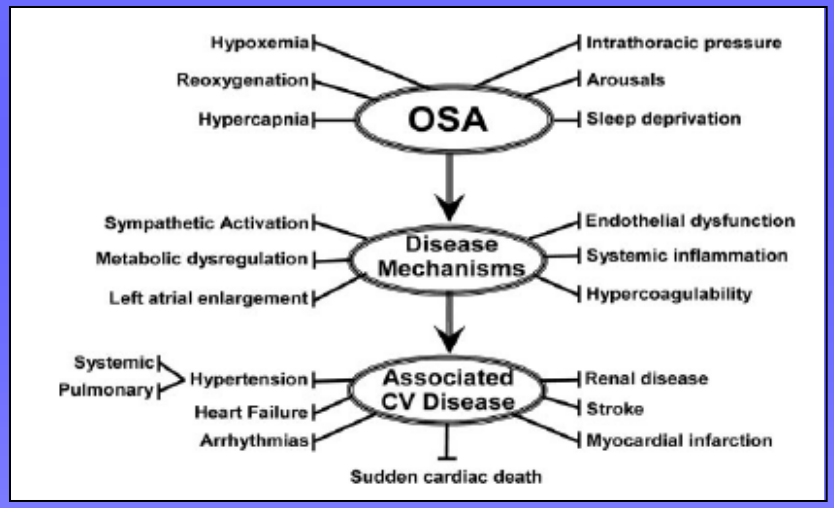


Sleep Apnea and Cardiovascular Disease

An American Heart Association/American College of Cardiology Foundation Scientific Statement From the American Heart Association Council for High Blood Pressure Research Professional Education Committee, Council on Clinical Cardiology, Stroke Council, and Council on Cardiovascular Nursing Council

In Collaboration With the National Heart, Lung, and Blood Institute National Center on Sleep Disorders Research (National Institutes of Health)





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AUGUST 2008 (On-LINE)

DOI: 10.1161/CIRCULATIONAHA.107.189420

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SA & Heart Failure
Different clinical scenarios

1. Left ventricular dysfunction

(n=47)
EF < 40%
AHI > 15

Results

1. SA: 55%
2. More frequent in CAD

Central Sleep Apnea in Left Ventricular Dysfunction
Prevalence and Implications for Arrhythmic Risk

Paola A. Lanfranchi, MD; Virend K. Somers, MD, PhD; Alberto Braghiroli, MD; Ugo Corra, MD; Ermanno Eleuteri, MD; Pantaleo Giannuzzi, MD

Background—The prevalence and characteristics of sleep-disordered breathing in patients with asymptomatic left ventricular (LV) dysfunction are unknown. Therefore, we evaluated the prevalence of sleep-disordered breathing in patients with LV dysfunction without overt heart failure and tested the hypothesis that sleep-disordered breathing is linked to greater hemodynamic and autonomic impairment.

Methods and Results—We studied 47 patients with LV ejection fractions ≤40% without any history of heart failure. Central sleep apnea (CSA), as defined by an apnea-hypopnea index ≥15/h, was present in 26 patients (55%), 17 (36%) of whom had severe CSA (apnea-hypopnea index ≥30/h). Obstructive sleep apnea was evident in 5 patients (11%). The prevalence and severity of CSA were higher in patients with ischemic cardiomyopathy than in patients with nonischemic cardiomyopathy ($P<0.05$). Exercise tolerance and echocardiographic indices of systolic and diastolic function were similar in patients without CSA, with mild CSA, and with severe CSA. Heart rate variability was markedly depressed in patients with CSA ($P<0.05$). Patients with severe CSA also had a higher incidence of nonsustained ventricular tachycardia ($P=0.05$).

Conclusions—CSA is highly prevalent in patients with asymptomatic LV dysfunction. The severity of CSA may not be related to the severity of hemodynamic impairment. Severe CSA is associated with impaired cardiac autonomic control and with increased cardiac arrhythmias. (*Circulation*. 2003;107:727-732.)

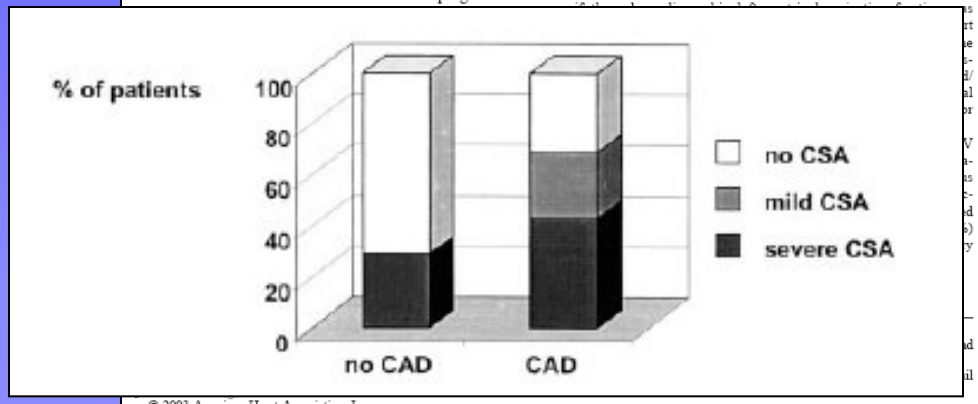
Key Words: sleep

Circulation 2003,197:727-732

In patients with overt heart failure, there is a high prevalence of nocturnal periodic breathing with central apneas (central sleep apnea: CSA).[1–4] CSA is associated with increased arrhythmic risk[3] and may indicate increased mortality in heart failure.[4] Autonomic responses to CSA may contribute to the adverse prognosis in these patients.[2,5] Patients with left ventricular (LV) dysfunction without heart failure also have neurohumoral activation and are at risk for progression to

Methods

We prospectively studied consecutive patients referred to the Cardiology Department of the Medical Center of Rehabilitation, Veruno, Italy, between January 1999 and December 2000 who were found to have LV systolic dysfunction due to either ischemic or nonischemic cardiomyopathy. Patients were referred for one of the following: (1) functional evaluation of asymptomatic LV dysfunction, (2) evaluation of chest pain, or (3) rehabilitation after myocardial infarction or cardiac surgery. They were eligible



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SA & Heart Failure
Different clinical scenarios

2. Congestive heart failure

(n=450)
EF 27.3±15%
NYHA II: 62%, NYHA III: 34%
AF: 15%
AHI > 20

Results

1. SA (AHI>20): 53%
2. More freq. in AF (p<0.01)

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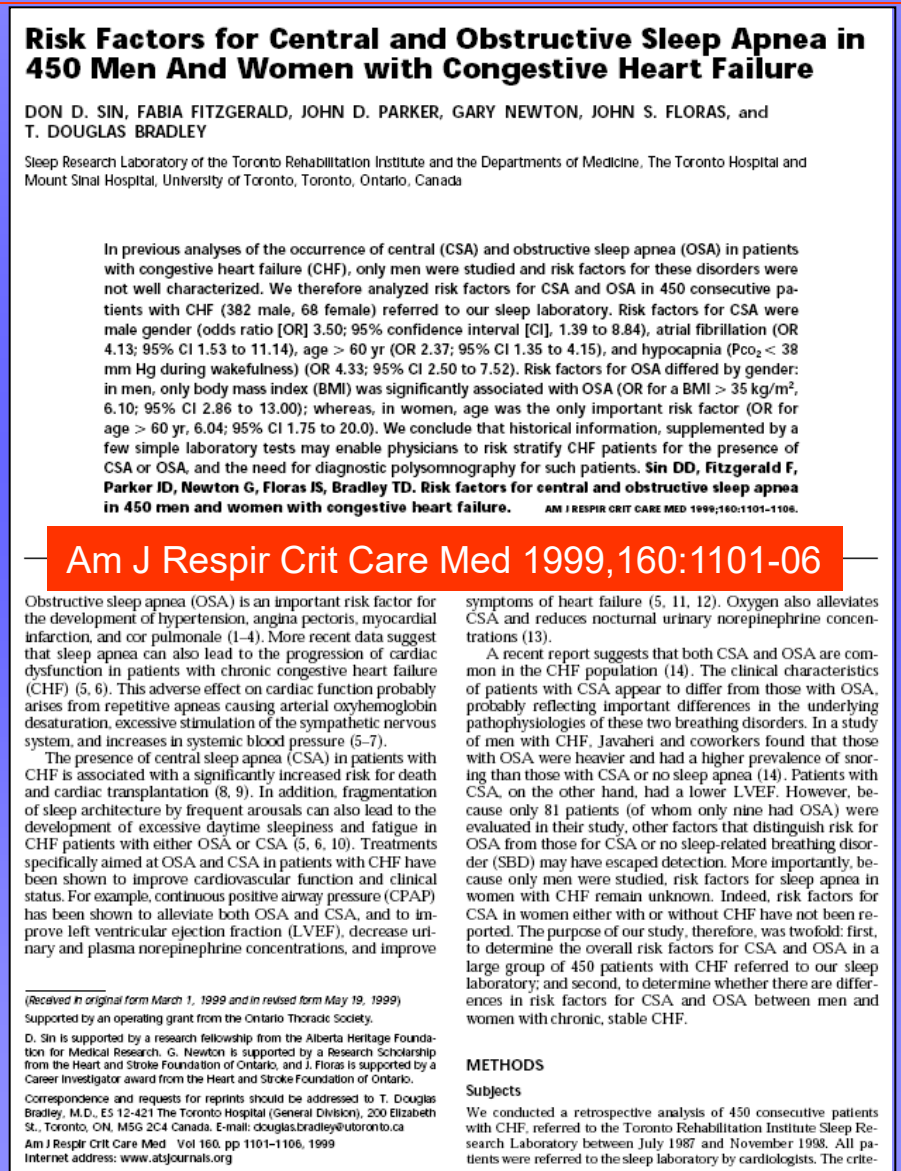

Risk Factors for Central and Obstructive Sleep Apnea in 450 Men And Women with Congestive Heart Failure

DON D. SIN, FABIA FITZGERALD, JOHN D. PARKER, GARY NEWTON, JOHN S. FLORAS, and T. DOUGLAS BRADLEY

Sleep Research Laboratory of the Toronto Rehabilitation Institute and the Departments of Medicine, The Toronto Hospital and Mount Sinai Hospital, University of Toronto, Toronto, Ontario, Canada

In previous analyses of the occurrence of central (CSA) and obstructive sleep apnea (OSA) in patients with congestive heart failure (CHF), only men were studied and risk factors for these disorders were not well characterized. We therefore analyzed risk factors for CSA and OSA in 450 consecutive patients with CHF (382 male, 68 female) referred to our sleep laboratory. Risk factors for CSA were male gender (odds ratio [OR] 3.50; 95% confidence interval [CI], 1.39 to 8.84), atrial fibrillation (OR 4.13; 95% CI 1.53 to 11.14), age > 60 yr (OR 2.37; 95% CI 1.35 to 4.15), and hypocapnia (Pco_2 < 38 mm Hg during wakefulness) (OR 4.33; 95% CI 2.50 to 7.52). Risk factors for OSA differed by gender: in men, only body mass index (BMI) was significantly associated with OSA (OR for a BMI > 35 kg/m², 6.10; 95% CI 2.86 to 13.00); whereas, in women, age was the only important risk factor (OR for age > 60 yr, 6.04; 95% CI 1.75 to 20.0). We conclude that historical information, supplemented by a few simple laboratory tests may enable physicians to risk stratify CHF patients for the presence of CSA or OSA, and the need for diagnostic polysomnography for such patients. **Sin DD, Fitzgerald F, Parker JD, Newton G, Floras JS, Bradley TD. Risk factors for central and obstructive sleep apnea in 450 men and women with congestive heart failure.** AM J RESPIR CRIT CARE MED 1999;160:1101–1106.

Am J Respir Crit Care Med 1999,160:1101-06

Obstructive sleep apnea (OSA) is an important risk factor for the development of hypertension, angina pectoris, myocardial infarction, and cor pulmonale (1–4). More recent data suggest that sleep apnea can also lead to the progression of cardiac dysfunction in patients with chronic congestive heart failure (CHF) (5, 6). This adverse effect on cardiac function probably arises from repetitive apneas causing arterial oxyhemoglobin desaturation, excessive stimulation of the sympathetic nervous system, and increases in systemic blood pressure (5–7).

The presence of central sleep apnea (CSA) in patients with CHF is associated with a significantly increased risk for death and cardiac transplantation (8, 9). In addition, fragmentation of sleep architecture by frequent arousals can also lead to the development of excessive daytime sleepiness and fatigue in CHF patients with either OSA or CSA (5, 6, 10). Treatments specifically aimed at OSA and CSA in patients with CHF have been shown to improve cardiovascular function and clinical status. For example, continuous positive airway pressure (CPAP) has been shown to alleviate both OSA and CSA, and to improve left ventricular ejection fraction (LVEF), decrease urinary and plasma norepinephrine concentrations, and improve symptoms of heart failure (5, 11, 12). Oxygen also alleviates CSA and reduces nocturnal urinary norepinephrine concentrations (13).

A recent report suggests that both CSA and OSA are common in the CHF population (14). The clinical characteristics of patients with CSA appear to differ from those with OSA, probably reflecting important differences in the underlying pathophysiologies of these two breathing disorders. In a study of men with CHF, Javaheri and coworkers found that those with OSA were heavier and had a higher prevalence of snoring than those with CSA or no sleep apnea (14). Patients with CSA, on the other hand, had a lower LVEF. However, because only 81 patients (of whom only nine had OSA) were evaluated in their study, other factors that distinguish risk for OSA from those for CSA or no sleep-related breathing disorder (SBD) may have escaped detection. More importantly, because only men were studied, risk factors for sleep apnea in women with CHF remain unknown. Indeed, risk factors for CSA in women either with or without CHF have not been reported. The purpose of our study, therefore, was twofold: first, to determine the overall risk factors for CSA and OSA in a large group of 450 patients with CHF referred to our sleep laboratory; and second, to determine whether there are differences in risk factors for CSA and OSA between men and women with chronic, stable CHF.

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Am J Respir Crit Care Med Vol 160, pp 1101–1106, 1999
Internet address: www.atsjournals.org

METHODS

Subjects

We conducted a retrospective analysis of 450 consecutive patients with CHF, referred to the Toronto Rehabilitation Institute Sleep Research Laboratory between July 1987 and November 1998. All patients were referred to the sleep laboratory by cardiologists. The crite-

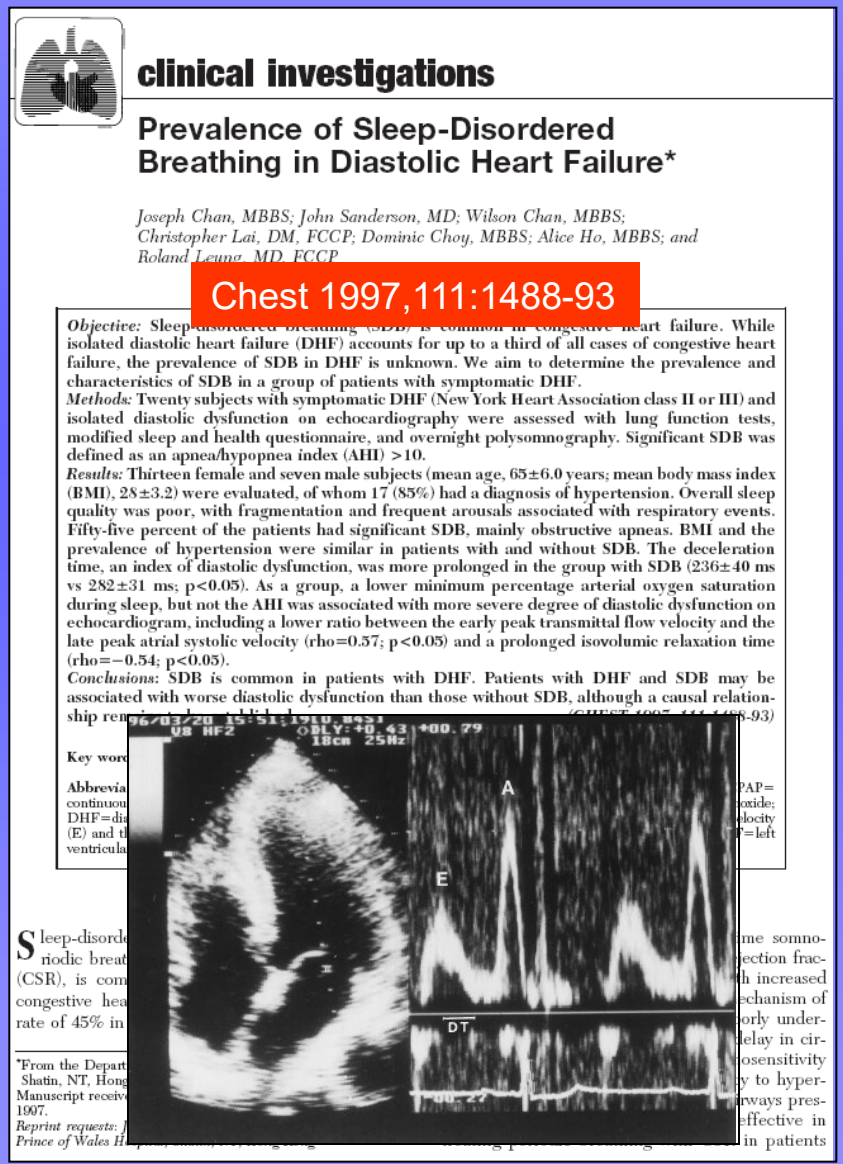
SA & Heart Failure
Different clinical scenarios

3. Diastolic dysfunction

(n=20)
NYHA II-III
AHI > 10

Results

1. SA (AHI>10): 55%
2. Deceleration time (p<0.05)



clinical investigations

Prevalence of Sleep-Disordered Breathing in Diastolic Heart Failure*

Joseph Chan, MBBS; John Sanderson, MD; Wilson Chan, MBBS; Christopher Lai, DM, FCCP; Dominic Choy, MBBS; Alice Ho, MBBS; and Roland Leung, MD, FCCP

Chest 1997,111:1488-93

Objective: Sleep-disordered breathing (SDB) is common in congestive heart failure. While isolated diastolic heart failure (DHF) accounts for up to a third of all cases of congestive heart failure, the prevalence of SDB in DHF is unknown. We aim to determine the prevalence and characteristics of SDB in a group of patients with symptomatic DHF.
Methods: Twenty subjects with symptomatic DHF (New York Heart Association class II or III) and isolated diastolic dysfunction on echocardiography were assessed with lung function tests, modified sleep and health questionnaire, and overnight polysomnography. Significant SDB was defined as an apnea/hypopnea index (AHI) >10.
Results: Thirteen female and seven male subjects (mean age, 65±6.0 years; mean body mass index (BMI), 28±3.2) were evaluated, of whom 17 (85%) had a diagnosis of hypertension. Overall sleep quality was poor, with fragmentation and frequent arousals associated with respiratory events. Fifty-five percent of the patients had significant SDB, mainly obstructive apneas. BMI and the prevalence of hypertension were similar in patients with and without SDB. The deceleration time, an index of diastolic dysfunction, was more prolonged in the group with SDB (236±40 ms vs 282±31 ms; p<0.05). As a group, a lower minimum percentage arterial oxygen saturation during sleep, but not the AHI was associated with more severe degree of diastolic dysfunction on echocardiogram, including a lower ratio between the early peak transmittal flow velocity and the late peak atrial systolic velocity (rho=0.57; p<0.05) and a prolonged isovolumic relaxation time (rho=−0.54; p<0.05).
Conclusions: SDB is common in patients with DHF. Patients with DHF and SDB may be associated with worse diastolic dysfunction than those without SDB, although a causal relationship ren

Arrhythmia Service KGH

SA & Resinchronization Therapy

Cardiac Resynchronization Therapy Improves Central Sleep Apnea and Cheyne-Stokes Respiration in Patients With Chronic Heart Failure

Anil-Martin Sinha, MD, DPHIL,* Erik C. Skobel, MD,* Ole-Alexander Breithardt, MD,* Christine Norra, MD,† Kai U. Markus, MD,* Christian Breuer, MD,* Peter Hanrath, MD, FESC, FACC,* Christoph Stellbrink, MD, FESC*

Aachen, Germany

(n=24)

Non-randomized study

Ambulatory polygraph

		All Patients (n = 24)	CSA (n = 14)	No CSA (n = 10)	p Value (CSA vs. No CSA)
Cardiorespiratory polygraph					
Duration of recording (h)	Pre	8 ± 2	8 ± 2	8 ± 3	NS
	CRT	8 ± 3	8 ± 3	8 ± 2	NS
AHI (per h)	Pre	11.9 ± 11.7 (1–42)	19.2 ± 10.3 (9–42)	1.7 ± 0.7 (1–3)	0.00001
	CRT	3.3 ± 3.8* (0–12)	4.6 ± 4.4* (0–12)	1.5 ± 1.6 (0–4)	NS
SaO_2min (%)	Pre	88 ± 5 (70–92)	84 ± 5 (70–90)	90 ± 2 (88–92)	<0.05
	CRT	90 ± 2* (85–93)	89 ± 2* (85–90)	91 ± 1 (90–93)	NS
PSQI	Pre	7.5 ± 4.2 (2–14)	10.4 ± 1.6 (8–14)	2.4 ± 0.5 (2–4)	<0.05
	CRT	3.5 ± 2.2* (2–10)	3.9 ± 2.4* (2–10)	2.6 ± 0.9 (2–4)	NS

1. Significant reduction of AHI (pre CRT vs post CRT)
2. Significant increment of SaO_2
3. Significant reduction of PSQI (Pittsburgh Sleep Quality Index)

JACC 2004,44:68-71

CRT & SA

Séminaire Winter Arrhythmia School
Annual Cardiac Arrhythmia Meeting
Division of Cardiology, University of Toronto

Improvement in Cheyne-Stokes respiration following cardiac resynchronisation therapy

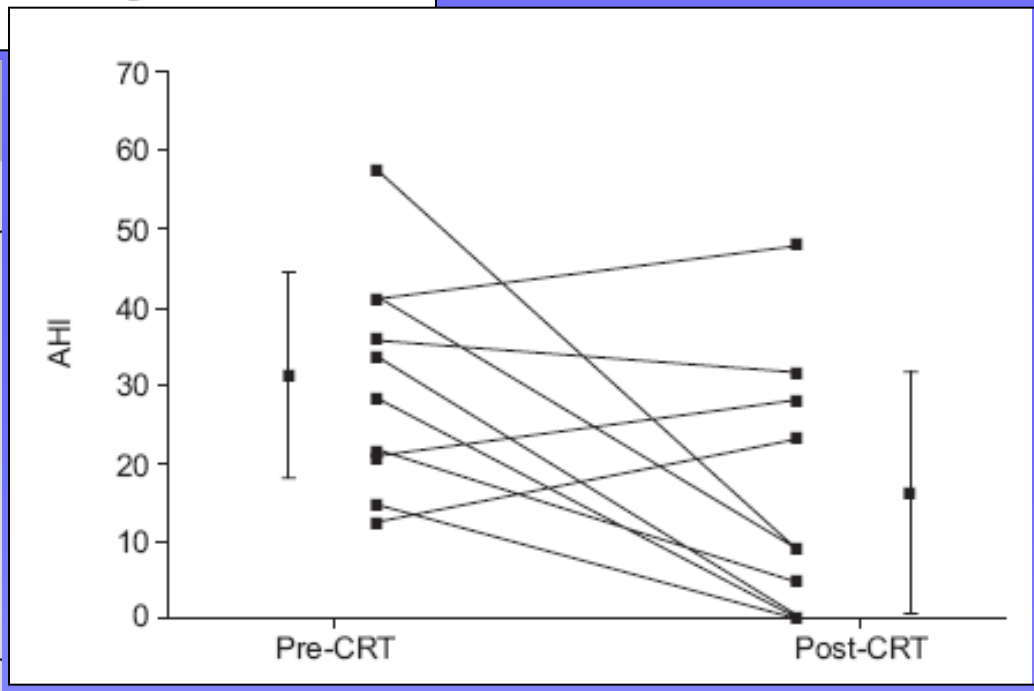
J.Y. Gabor, D.A. Newman, V. Barnard-Roberts, V. Korley, I. Mangat, P. Dorian and P.J. Hanly

- uncontrolled
- observational
- small sample

TABLE 3 Sleep apnoea following 6 months of cardiac resynchronisation therapy (CRT)

	Pre-CRT	Post-CRT
Subjects n	10	10
Total AHI[¶] ·h^{-1}	42.7±9.1	30.8±18.7
CSR events ·h^{-1}*	30.6±14.0	15.3±16.5
Obstructive AHI ·h^{-1}	9.7±12.3	11.8±10.2
Mean Sa,O_2,awake %	93.6±1.0	93.9±0.7
Mean Sa,O_2,sleep %	93.3±1.1	93.3±1.1
Mean PCO_2,tc,awake mmHg	42.1±4.1	43.6±4.9
Mean PCO_2,tc,sleep mmHg	42.2±3.9	44.9±4.4
PB cycle length s	63.6±16.2	59.1±9.6
LFCT s	43.0±12.4	35.6±6.8[#]

Data are presented as mean±SD, unless otherwise stated. AHI: apnoea–hypopnoea index; CSR: Cheyne-Stokes respiration; Sa,O_2: arterial oxygen saturation; PCO_2,tc: transcutaneous partial pressure of carbon dioxide; PB: periodic breathing; LFCT: lung-to-finger circulation time. [¶]: includes mixed apnoeas in addition to CSR and obstructive apnoeas. *: $p<0.05$ *versus* pre-CRT; [#]: $p=0.09$.



6/10 have significantly reduced AHI
Two thirds have reduced CSR

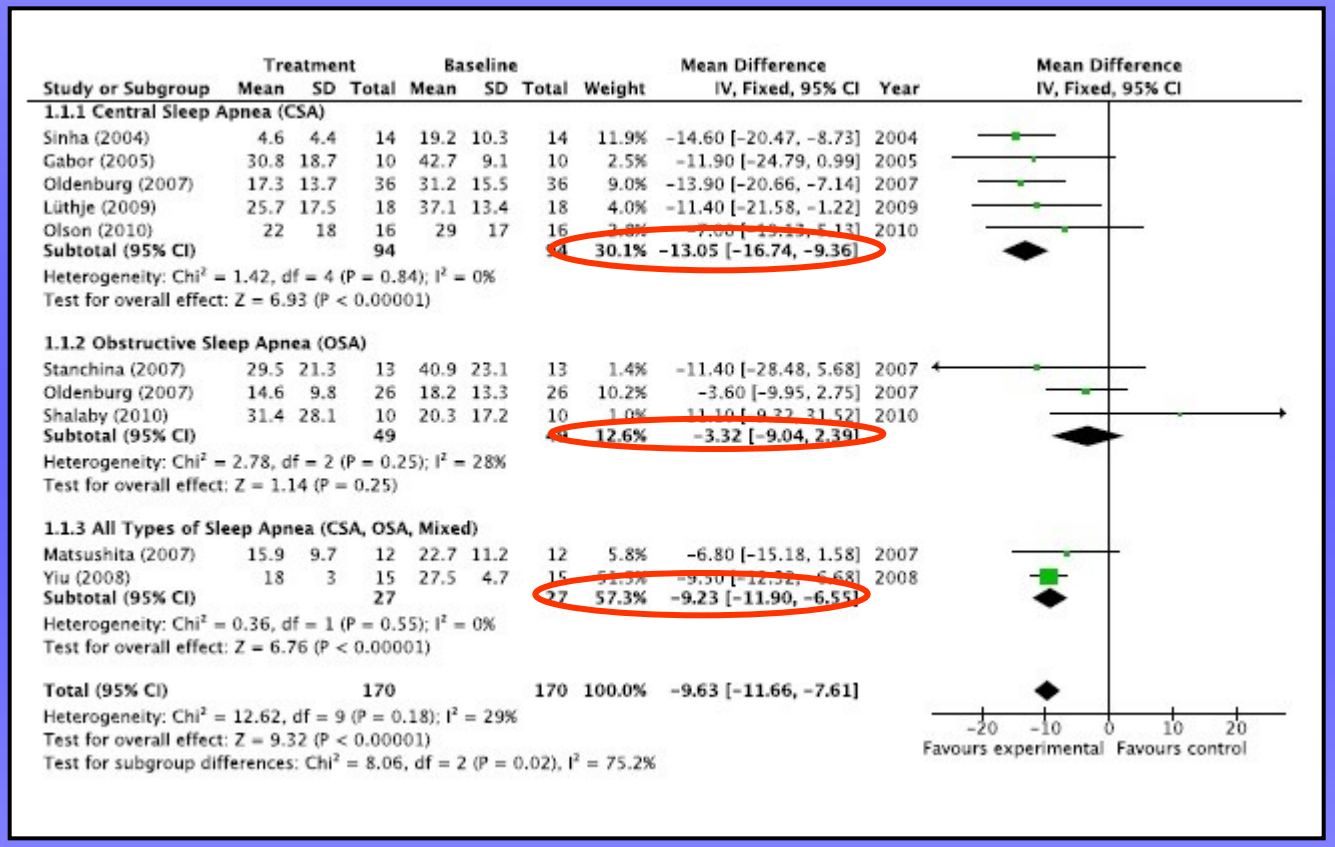
Eur Respir J 2006,26:95-100

Queen's University

Cardiac resynchronization therapy for the treatment of sleep apnoea: a meta-analysis

Jasmine Lamba[1], Christopher S. Simpson[1,2], Damian P. Redfearn[1,2], Kevin A. Michael[1,2], Michael Fitzpatrick[1,2], and Adrian Baranchuk[1,2]*

Séminaire Winter Arrhythmia School
Annual Cardiac Arrhythmia Meeting
Division of Cardiology, University of Toronto



Study or Subgroup	Treatment Mean	SD	Total	Baseline Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI	Year
1.1.1 Central Sleep Apnea (CSA)									
Sinha (2004)	4.6	4.4	14	19.2	10.3	14	11.9%	-14.60 [-20.47, -8.73]	2004
Gabor (2005)	30.8	18.7	10	42.7	9.1	10	2.5%	-11.90 [-24.79, 0.99]	2005
Oldenburg (2007)	17.3	13.7	36	31.2	15.5	36	9.0%	-13.90 [-20.66, -7.14]	2007
Lüthje (2009)	25.7	17.5	18	37.1	13.4	18	4.0%	-11.40 [-21.58, -1.22]	2009
Olson (2010)	22	18	16	29	17	16	[illegible]	[illegible]	2010
Subtotal (95% CI)			94			[illegible]	30.1%	-13.05 [-16.74, -9.36]	
Heterogeneity: Chi² = 1.42, df = 4 (P = 0.84); I² = 0%									
Test for overall effect: Z = 6.93 (P < 0.00001)									
1.1.2 Obstructive Sleep Apnea (OSA)									
Stanchina (2007)	29.5	21.3	13	40.9	23.1	13	1.4%	-11.40 [-28.48, 5.68]	2007
Oldenburg (2007)	14.6	9.8	26	18.2	13.3	26	10.2%	-3.60 [-9.95, 2.75]	2007
Shalaby (2010)	31.4	28.1	10	20.3	17.2	10	1.0%	11.10 [-9.32, 31.52]	2010
Subtotal (95% CI)			49			[illegible]	12.6%	-3.32 [-9.04, 2.39]	
Heterogeneity: Chi² = 2.78, df = 2 (P = 0.25); I² = 28%									
Test for overall effect: Z = 1.14 (P = 0.25)									
1.1.3 All Types of Sleep Apnea (CSA, OSA, Mixed)									
Matsushita (2007)	15.9	9.7	12	22.7	11.2	12	5.8%	-6.80 [-15.18, 1.58]	2007
Yiu (2008)	18	3	15	27.5	4.7	15	[illegible]	[illegible]	2008
Subtotal (95% CI)			27			27	57.3%	-9.23 [-11.90, -6.55]	
Heterogeneity: Chi² = 0.36, df = 1 (P = 0.55); I² = 0%									
Test for overall effect: Z = 6.76 (P < 0.00001)									
Total (95% CI)			170			170	100.0%	-9.63 [-11.66, -7.61]	
Heterogeneity: Chi² = 12.62, df = 9 (P = 0.18); I² = 29%									
Test for overall effect: Z = 9.32 (P < 0.00001)									
Test for subgroup differences: Chi² = 8.06, df = 2 (P = 0.02), I² = 75.2%									

Mean Difference IV, Fixed, 95% CI

-20 -10 0 10 20

Favours experimental Favours control

Is there any association between SA & ANS imbalance?

Arrhythmia Service KGH

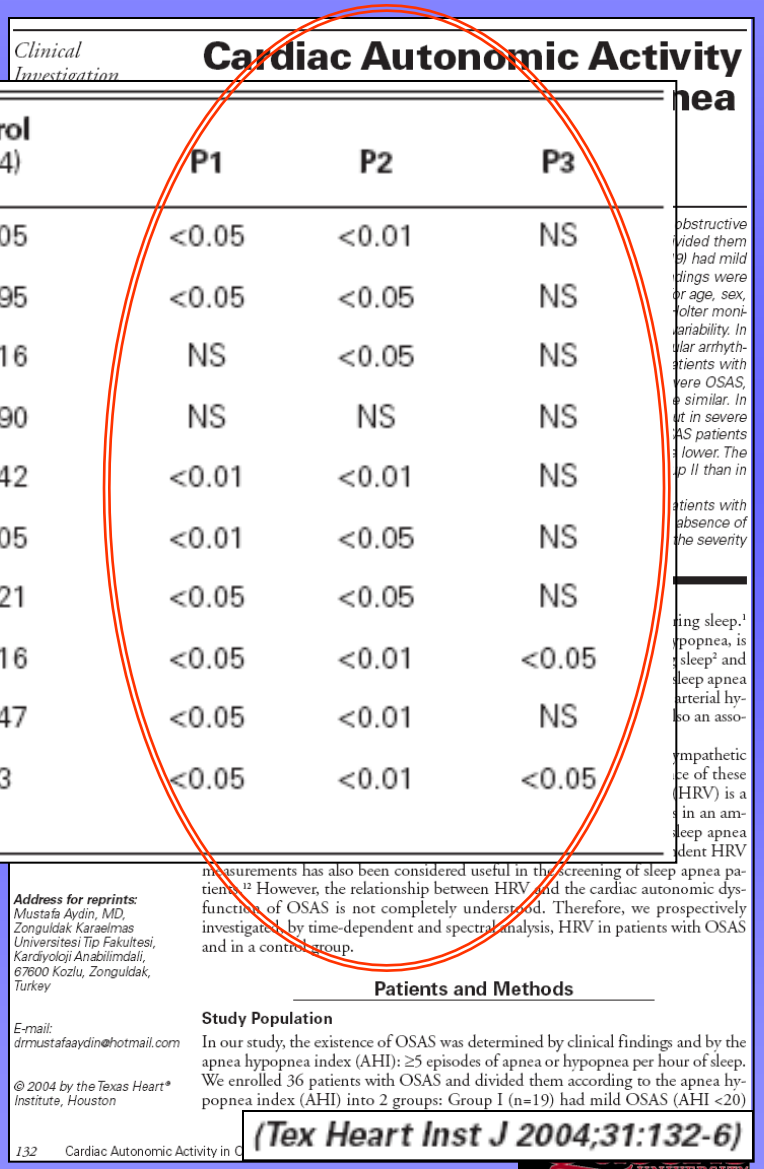
Lamba, Baranchuk et al. Europace 2011

Queen's University

6. Sleep Apnea & Autonomic Nervous System

- (n=60)
- 3
- S
- 2
- -
- -
- A

HRV Data	Mild OSAS (n=19)	Severe OSAS (n=17)	Control (n=24)	P1	P2	P3
SDNN (ms)	124.94	120.38	131.05	<0.05	<0.01	NS
SDANN (ms)	112.29	108.63	126.95	<0.05	<0.05	NS
RMSSD (ms)	35.11	31.54	44.16	NS	<0.05	NS
Triangular index*	33.88	32.33	36.90	NS	NS	NS
Total power (ms²)	1,405.35	1,695.63	1,290.42	<0.01	<0.01	NS
Ultra low frequency (ms²)	165.24	137.54	119.05	<0.01	<0.05	NS
Very low frequency (ms²)	582.77	633.71	510.21	<0.05	<0.05	NS
Low frequency (ms²)	432.12	476.58	411.16	<0.05	<0.01	<0.05
High frequency (ms²)	341.12	332.50	351.47	<0.05	<0.01	NS
Low-frequency/high-frequency ratio	1:4	1:4	1:3	<0.05	<0.01	<0.05



Clinical Investigation

Cardiac Autonomic Activity

Address for reprints: Mustafa Aydin, MD, Zonguldak Karaelmas Universitesi Tip Fakultesi, Kardiyoloji Anabilimdali, 67600 Kozlu, Zonguldak, Turkey

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measurements has also been considered useful in the screening of sleep apnea patients.[12] However, the relationship between HRV and the cardiac autonomic dysfunction of OSAS is not completely understood. Therefore, we prospectively investigated by time-dependent and spectral analysis, HRV in patients with OSAS and in a control group.

Patients and Methods

Study Population

In our study, the existence of OSAS was determined by clinical findings and by the apnea hypopnea index (AHI): ≥5 episodes of apnea or hypopnea per hour of sleep. We enrolled 36 patients with OSAS and divided them according to the apnea hypopnea index (AHI) into 2 groups: Group I (n=19) had mild OSAS (AHI <20)

132 Cardiac Autonomic Activity in C

(Tex Heart Inst J 2004;31:132-6)

- ↓ parasympathetic tone
- ↑ sympathetic tone

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Sleep Apnea & Impact on the ANS

Séminaire Winter Arrhythmia School
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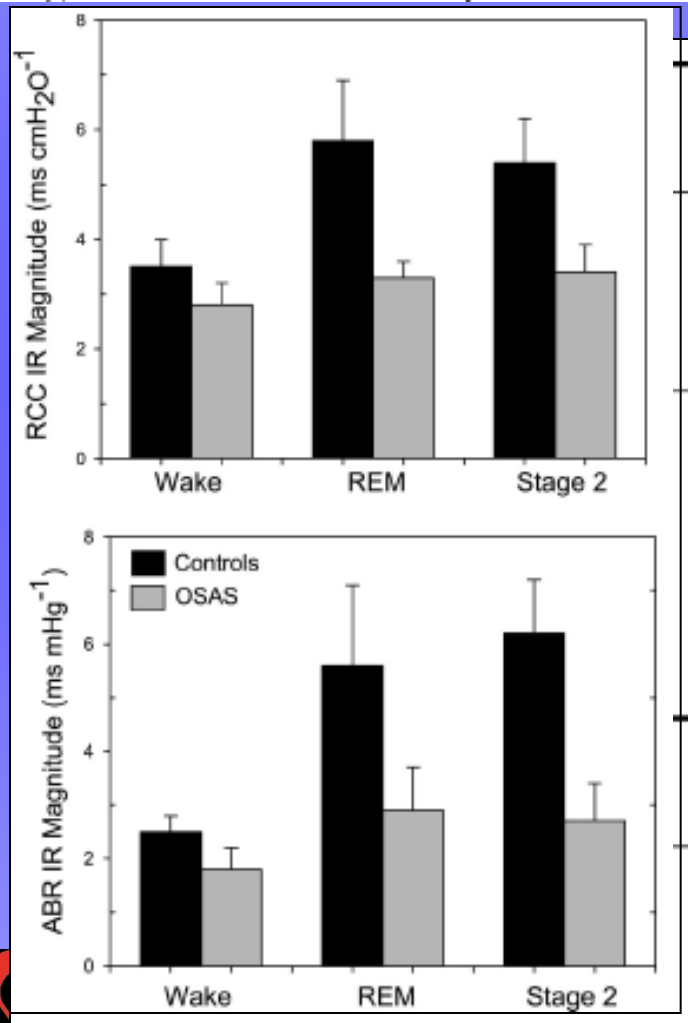
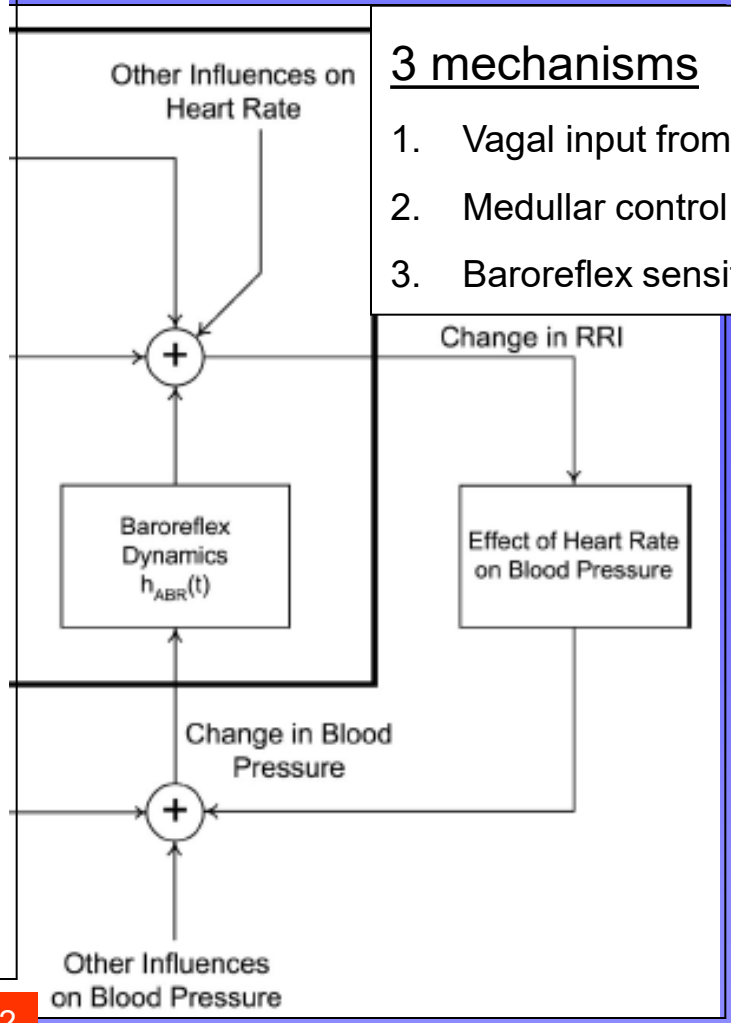
Division of Cardiology, University of Toronto

Determinants of heart rate variability in obstructive sleep apnea syndrome during wakefulness and sleep





3 mechanisms

1. Vagal input from pulmonary receptors
2. Medullar control over respiration
3. Baroreflex sensitivity

↓ vagal input (P<0.04)

↓ BRS (P<0.03)

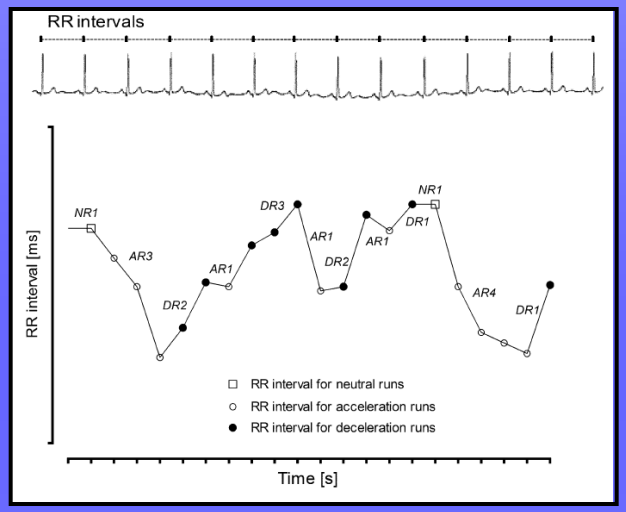
Am J PhysiolHeart Circ Physiol 2005;288:1103-12

Queen's University

Obstructive sleep apnea and heart rate asymmetry microstructure during sleep

Przemyslaw Guzik · Jaroslaw Piskorski · Kokab Awan · Tomasz Krauze · Michael Fitzpatrick · Adrian Baranchuk

Clin Auton Res (2013) 23:91–100



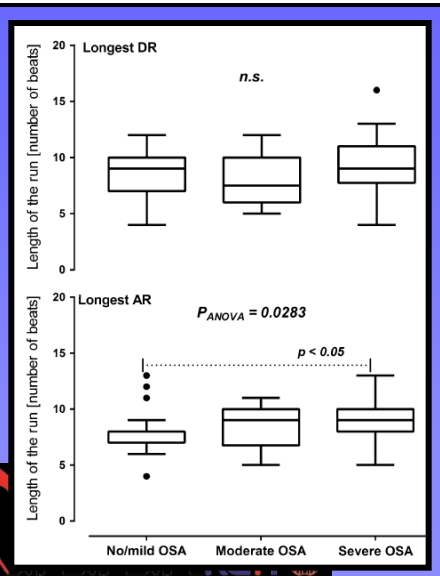


Table 3 Proportion of deceleration and acceleration runs of different lengths as well as the length of the longest runs in relation to the severity of OSA

	No/mild OSA $N = 19$	Moderate OSA $N = 18$	Severe OSA $N = 41$	p value
DR1 proportion (%)	16.2 ± 6.3	18.9 ± 4.4	15.0 ± 5.5	0.0305
DR2 proportion (%)	17.8 ± 4.9	14.8 ± 3.9	16.7 ± 5.4	n.s.
DR3 proportion (%)	7.7 ± 4.0	6.2 ± 2.6	7.4 ± 3.5	n.s.
DR4 proportion (%)	1.7 ± 1.5	2.2 ± 1.5	2.3 ± 2.1	n.s.
DR5 proportion (%)	0.5 ± 0.4	0.9 ± 0.7	1.0 ± 0.7	0.0185
DR6 proportion (%)	0.2 ± 0.2	0.5 ± 0.5	0.6 ± 0.5	0.0281
DR7 proportion (%)	0.09 ± 0.09	0.26 ± 0.31	0.32 ± 0.34	0.0216
DR8 proportion (%)	0.04 ± 0.05	0.15 ± 0.26	0.13 ± 0.16	0.0250
DR9 proportion (%)	0.02 ± 0.04	0.04 ± 0.06	0.07 ± 0.11	n.s.
DR10 proportion (%)	0.02 ± 0.03	0.02 ± 0.04	0.05 ± 0.09	n.s.
AR1 proportion (%)	32.6 ± 12.9	37.6 ± 8.7	29.3 ± 10.8	0.0252
AR2 proportion (%)	17.2 ± 4.7	15.2 ± 3.4	17.4 ± 4.9	n.s.
AR3 proportion (%)	8.0 ± 4.4	6.3 ± 2.3	8.0 ± 3.6	n.s.
AR4 proportion (%)	2.59 ± 3.88	2.24 ± 1.39	2.66 ± 1.62	n.s.
AR5 proportion (%)	0.9 ± 1.6	1.0 ± 0.8	1.2 ± 0.9	0.0182
AR6 proportion (%)	0.3 ± 0.6	0.6 ± 0.7	0.7 ± 0.6	0.0155
AR7 proportion (%)	0.14 ± 0.22	0.33 ± 0.47	0.38 ± 0.36	0.0202
AR8 proportion (%)	0.06 ± 0.14	0.14 ± 0.19	0.21 ± 0.26	0.0115
AR9 proportion (%)	0.01 ± 0.03	0.07 ± 0.10	0.10 ± 0.14	0.0006
AR10 proportion (%)	0.00 ± 0.01	0.03 ± 0.08	0.04 ± 0.06	0.0055
Longest deceleration run (beats)	8.4 ± 2.2	8.1 ± 2.4	9.3 ± 2.4	n.s.
Longest acceleration run (beats)	7.8 ± 2.2	8.3 ± 2.0	9.1 ± 2.0	0.0283

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Conclusions

1. SA is highly prevalent in patients with arrhythmias & cardiac devices
2. SA is associated with AF, & with post CV & RF recurrence
3. SA is associated with ventricular arrhythmia
4. SA is not associated with post-RF AFL recurrence
5. AOP does not improve SA
6. CRT improves Central SA
7. OSA predicts post-CABG AF
8. CPAP improves electrical and anatomical substrate. Does it reduce AF?

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Sleep Apnea & CD
Research projects 2014-2015

1. Reveal XT-SA: to determine the association between SA and AF (symptomatic and asymptomatic) by using ILR (Medtronic funded – Follow-up phase)
2. Basic Science: Can Apixaban reduce hypoxia-induced pro-coagulation states?

Anybody interested in collaborating on this topic?

barancha@kgh.kari.net

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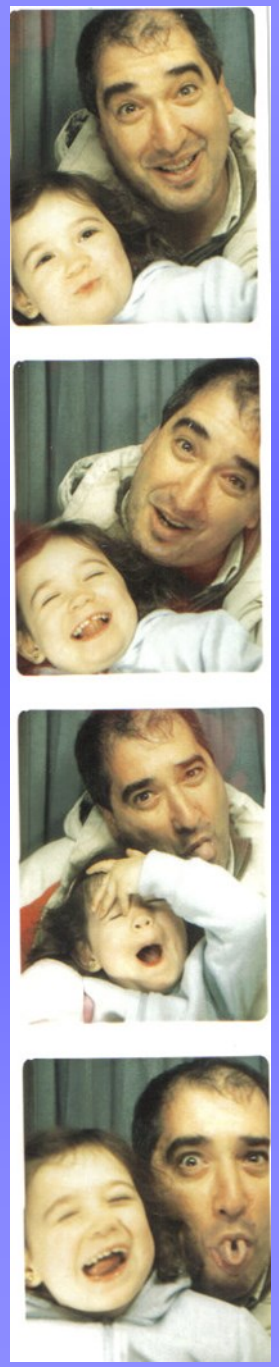
"THE GIANT FELL ASLEEP AMONGST HIS GOLD AND BEGAN TO SNORE LIKE THUNDER …"



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