Taking Sleep to Heart

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Outline

• Methodology & Rationale – Sympathetic Nervous System and Blood Pressure

• Sleep, Sleep Deprivation, and Cardiovascular Disease

• Why Sex Matters

• Sleep Deprivation and Neural Cardiovascular Control
  ▪ Carter et al., Am J Physiol – Heart Circ Physiol, 2012
  ▪ Yang et al., J Appl Physiol, 2012

• What Can You Do?
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• Future Directions
# Arterial Blood Pressure

<table>
<thead>
<tr>
<th>Category</th>
<th>Systolic (mmHg)</th>
<th>Diastolic (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypotensive</td>
<td>&lt; 90</td>
<td>&lt; 60</td>
</tr>
<tr>
<td>Normal</td>
<td>90 – 120</td>
<td>60 – 80</td>
</tr>
<tr>
<td>Prehypertensive</td>
<td>120 – 139</td>
<td>80 – 89</td>
</tr>
<tr>
<td>Hypertensive</td>
<td>140 – 159</td>
<td>90 – 99</td>
</tr>
<tr>
<td>Extreme hypertension</td>
<td>≥ 160</td>
<td>≥ 100</td>
</tr>
</tbody>
</table>
Muscle Sympathetic Nerve Activity (MSNA)
Arterial Blood Pressure
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• What Can You Do?
Sleep Stages

Non-REM vs. REM

Stages of sleep

BP & HR↓
Grow
Restore
Repair

Brain Plasticity
Dreaming
Learning

SWS

Hours of sleep

mean arterial blood pressure (mmHg)

Regulation of Sleep

- **Homeostatic sleep drive** (Process S)
- **Circadian drive for arousal** (Process C)

Sleep gate

Awakening

Sleep gate

Awakening

Consequences of Sleep Deprivation

**Normal Sleep**

Adults: 7-8 hours

- Hypertension
- Motor Vehicle Accidents
- Memory Loss
- Depression
- Metabolism
- Diabetes
- Obesity

37.1% of U.S. adults reported regularly sleeping <7hrs/night
Source: 2005-2008 NHANES
Short duration of sleep (≤5hrs vs. 7 hrs) was associated with higher risk of hypertension in **women**, but not men (n=5766).
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Sex vs. Gender

Institute of Medicine Recommendations:

**Sex:** “classification according to the reproductive organs and functions that derive from chromosomal compliment”

**Gender:** “person’s self-representation as male or female”
Lower MSNA

Orthostatic Intolerance

Lower BP

Narkiewicz et al., *Hypertension* (2005)
Higher MSNA

Higher BP

Hypertension & CVD

Narkiewicz et al., *Hypertension* (2005)
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Sleep Deprivation and MSNA


Kato et al.: n=8
Ogawa et al.: n=6

12 men, 2 women

Ogawa et al., *Sleep* (2003)
Experimental Design

**Subjects:**
Healthy young (age, 22±1 yrs)
15 men vs. 15 women
14 men vs. 14 women

**Protocol:**
- Randomized, crossover design (sleep dep vs. normal sleep)
  - *One month apart to control for menstrual cycle (EF phase only)*
- Screen for obstructive sleep apnea (OSA) using the at-home ApneaLink
- Wrist actigraphy (Actiwatch-64) for the 3 days prior to each trial
**Protocol:**

On each testing day:

- 3 seated resting BP recording
- Venous blood sample (sex steroid levels)
- Standard breakfast
- Autonomic and hemodynamic instrumentation
- 10 min supine baseline
- Mental stress trial (5 min BL, 5 min MS, 5 min Rec)
- Cold pressor test trial (3 min BL, 2 min CPT, 3 min Rec)

**Measurements:**

- MSNA (microneurography)
- Resting BP (automated sphyg)
- Beat-to-beat BP (finger pleth.)
- Heart rate (ECG)
- Limb Blood flow (VOP)
Sleep Deprivation and MSNA

Baroreflex Operating Point

Stress and Disease

Mental Stress

Neuroendocrine Response

Adrenal Medulla
- ↑ Epinephrine
- ↑ Norepinephrine

Adrenal Cortex
- ↑ Cortisol

Nervous System
- ↑ Sympathetic N.S.
- ↓ Parasympathetic N.S.

Walter Cannon

Hans Selye
CVR Hypothesis

Exaggerated cardiovascular reactivity:
(1) is a marker of elevated disease risk
(2) plays a causal role

Laboratory stressor -- controlled, short-term physical, cognitive, and/or emotional challenges.
- Cold pressor test
- Mental stress

Recent research suggests:
- Aggregation across tasks improves ‘generalizability’
- Recovery responses may be a useful predictor
Sleep Deprivation and HR Reactivity

Huan et al., *J Appl Physiol* (2012)
Summary

• Sex differences exist regarding sympathetic neural responsiveness to sleep deprivation.
  – Total sleep deprivation elicits acute hypertension in both sexes, but only men demonstrate concurrent reductions in resting MSNA
  – Possible baroreflex dysfunction and/or testosterone influence

• Sleep deprivation augmented HR reactivity to acute laboratory stress. Importantly, this augmented HR reactivity persisted:
  – Across both MS and CPT stressors (Aggregation Theory)
  – During both MS and CPT recovery (Recovery Theory)

• These findings provide new insight regarding emerging links between sleep deprivation and CVD.
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Sleep Tips

- Acknowledge that **sleep** is a major pillar of health

- **7-8 hours of regular sleep**
  - Avoid being a weekend warrior
  - Let your body be your guide; don’t force yourself to sleep in

- **Practice good ‘sleep hygiene’**
  - Create a bedtime ritual*
  - Set a regular bed time; consider an earlier bed time
  - Comfortable bed/pillow and room cool (~65°F)

- **Maximize Light during Day, Melatonin at Night**
  - Let there be light… and remove your sunglasses sometimes
  - Avoid TV, computer, and backlit reading devices in late evening
  - Make sure your room is dark (i.e., summer)

- **Eat right and get regular exercise**
  - Avoid alcohol, caffeine, nicotine (discuss alcohol myth)
  - Avoid late evening snacks and fluid drinking
Sleep Tips

Possible Sleep Routine
- Take a warm bath or shower
- Read a book or magazine by soft light
- Stretching, yoga, other relaxation/mindfulness routines
- Simple preparations for the next day (i.e., iron)
- Reserve the bed for ‘sleep and sex’
- Listen to soft music

Falling Back Asleep
- Stay out of your own head
- Postpone worrying and brainstorming
- Make relaxation, not sleep, your goal
- Focus on your own breathing pattern
- If your up for more than 15 min, consider non-stimulating activity
- Keep light off or low for bathroom breaks (i.e., flashlight)

Focus on Cognitive Behavioral Approaches
- Avoid sleeping pills
- Avoid melatonin pills
Be Your Own Advocate

- Make sleep something you discuss with your primary care physician
- Know when to get a new physician or see a sleep physician

Consider seeing a sleep physician if you have:
- Loud snoring and pauses in breathing
- Chronic difficulty falling or staying asleep
- Frequent morning headaches
- Restless sensations in your legs or arms at night
- Inability to move while falling asleep or waking up
- Physically acting out your dreams
- Falling asleep at inappropriate times
- Chronic daytime sleepiness or fatigue
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