Maternal Obstructive Sleep Apnea:
Why Snoring is Bad for Both Mothers and Babies

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Background

Factors Which Increase the Risks for OSA in Pregnancy

- Increased upper airway resistance
- Decreased pharyngeal diameter
- Estrogen induced nasal congestion and rhinitis
- Hypocapnia and associated respiratory alkalosis
- Greater negative inspiratory pressure leading to increased tendency for upper airway collapse
Background

- Snoring and excessive daytime sleepiness are classic symptoms of obstructive sleep apnea (OSA), a condition associated with significant pathophysiologic sequelae, including intermittent hypoxemia and hypertension.

- The presence of these pathophysiologic sequelae during pregnancy could result in significant untoward consequences to both the mother and the fetus.
Obstructive Sleep Apnea in pregnancy

- Hypertensive disorders of pregnancy
- Gestational diabetes
- Fetal compromise
Potential Interaction Between Obstructive Sleep Apnea and Hypertensive Disorders of Pregnancy

Obstructive Sleep Apnea

Episodic hypoxia

Inflammation

Endothelial dysfunction

Sympathetic activation

Hypertension

Pre-eclampsia

Placental ischemia

Upper airway edema
Potential Interaction Between Obstructive Sleep Apnea and Gestational Diabetes

Obstructive Sleep Apnea

- Episodic hypoxia
  - Inflammation
  - Reduced adiponectin
    - Insulin resistance
  - Sympathetic activation
    - Increased cortisol
  - Gestational diabetes
Preeclampsia

- One of the top three causes of maternal death
- Affects about 7% of all pregnant women
- Usually begins after twenty weeks of pregnancy
- Represents a serious medical condition characterized by high blood pressure, proteinuria, and rapid weight gain
- Associated with maternal liver and kidney disease
- Approximately 1 in 20 women with preeclampsia will develop eclampsia, characterized by seizures
- Preeclampsia resolves following delivery
Gestational Diabetes

- Like other kinds of diabetes, gestational diabetes affects how a pregnant woman’s cells use glucose.
- Extra glucose in the mother’s bloodstream crosses the placenta and triggers the developing baby’s pancreas to make too much insulin.
IUGR

- Defined as a fetus who is at or below the tenth percentile in weight for his/her gestational age
- Secondly, there is a pathological process present that prevents the expression of normal growth potential.
- Commonly associated with uteroplacental insufficiency, as seen in preeclampsia
Early Studies

- Franklin and colleagues studied 502 women with singleton pregnancies.

- They reported that snoring was an independent predictor of maternal hypertension and fetal growth restriction (Chest 2000; 117: 137-141).
Early Studies

- Izci and co-investigators studied 167 healthy women and 82 preeclamptic women in the third trimester of pregnancy and 160 non-pregnant women (Sleep Medicine 2005, 6: 163-169).

- They found that snoring and sleepiness increased in the last trimester, particularly in patients with pre-eclampsia.
Later Studies

- Louis and colleagues (AJOG 2010;202:261.e1-5) analyzed 57 pregnancies complicated by OSA, diagnosed by standard 15-channel polysomnography.
  - OSA patients had more preeclampsia and preterm births.
- Reid and co-investigators (SLEEP 2011;34(8):1033-1038) compared 34 women with gestational hypertension to 26 healthy women with uncomplicated pregnancies and found more SDB in the more obese gestational hypertensive group.
Objective

The objective of our study was to determine if snoring and/or excessive sleepiness during pregnancy were associated with unfavorable pregnancy outcomes.
Methodology

- The study group consisted of postpartum mothers on the obstetrics floor at The Valley Hospital in Ridgewood, NJ. between 5/08 and 5/09

- The study was approved by The Valley Hospital Institutional Review Board, and parental consent for study participation and chart reviews were obtained.
Methodology

- The mothers had delivered a healthy infant within the previous 24-hour period.

- Mothers were randomly selected and asked to complete two standardized questionnaires (the Epworth Sleepiness Scale and the Snoring Symptoms Inventory) used to identify symptoms of obstructive sleep apnea, specifically excessive daytime sleepiness and snoring.
# The Epworth Sleepiness Scale

<table>
<thead>
<tr>
<th>SITUATION</th>
<th>CHANCE OF DOZING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting and reading</td>
<td></td>
</tr>
<tr>
<td>Watching TV</td>
<td></td>
</tr>
<tr>
<td>Sitting inactive in a public place (e.g. theater or a meeting)</td>
<td></td>
</tr>
<tr>
<td>As a passenger in a car for an hour without a break</td>
<td></td>
</tr>
<tr>
<td>Lying down to rest in the afternoon when circumstances permit</td>
<td></td>
</tr>
<tr>
<td>Sitting and talking to someone</td>
<td></td>
</tr>
<tr>
<td>Sitting quietly after a lunch without alcohol</td>
<td></td>
</tr>
<tr>
<td>In a car, while stopped for a few minutes in traffic</td>
<td></td>
</tr>
</tbody>
</table>

- **0** = no chance of dozing
- **1** = slight chance of dozing
- **2** = moderate chance of dozing
- **3** = high chance of dozing

- **0 - 9** = Normal Range
- **10 - 12** = Borderline
- **13 - 24** = Abnormal
Snoring Symptoms Inventory

- 25 questions pertaining to the potential presence of obstructive sleep apnea

**Score:**
- Strongly agree=4
- Agree=3
- Neither=2
- Disagree=1
- Strongly disagree=0
Snoring Symptoms Inventory

1) My sleep is disturbed
2) My family complains about my snoring
3) I feel tired
4) I am concerned about disturbing my partner’s sleep or the sleep of others in the home
5) I have a dry mouth or throat
6) I am embarrassed when I stay overnight with friends or relatives
7) I have a blocked nose
8) Because of my snoring, I sometimes have to sleep in a separate room to my partner or others in the home
Snoring Symptoms Inventory

9) I am concerned that my snoring puts a strain on my personal relationship(s)
10) I worry about falling asleep whilst driving
11) I am embarrassed when I am on holiday or staying in hotels
12) I feel bad tempered and irritable
13) I sometimes fall asleep during the day
14) I have a sore throat
15) My sex life has been affected by my snoring
16) I have problems concentrating on my work
Snoring Symptoms Inventory

17) I am unable to concentrate during the day
18) I lack self confidence
19) I have a choking feeling
20) I feel depressed because I cannot do anything about my snoring
21) I get headaches
22) I have problems breathing
23) I feel frightened of going to sleep
24) I am embarrassed by my snoring
25) My neighbours complain about my snoring
Methodology

- Medical chart reviews were conducted
  - Maternal data regarding age, race, smoking, alcohol use, health status, medications, pregnancy, labor, and delivery information were noted

- Newborn infant charts were also reviewed
  - Gestational age, birthweight, and Apgar scores were recorded
Results- Maternal Data

- 107 mothers enrolled in study
- Mean age was 34 years old with a standard deviation of 5 years
Results - Maternal Data

- Caucasian- 82.2%
- Hispanic- 6.5%
- Asian- 5.6%
- African American- 3.7%
- Other- 2.8%

- Smoked during pregnancy- 3.7%
- Used alcohol during pregnancy- 5.6%
## Methods of Delivery

<table>
<thead>
<tr>
<th>Methods of Delivery</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled C/Section</td>
<td>38.7</td>
</tr>
<tr>
<td>NSVD</td>
<td>29.2</td>
</tr>
<tr>
<td>Unscheduled C/Section</td>
<td>23.6</td>
</tr>
<tr>
<td>Emergency C/Section</td>
<td>0.9</td>
</tr>
</tbody>
</table>
Relationship of Epworth Sleepiness Scale (ESS) to Snoring Symptoms Inventory (SSI)

- In 107 observations, the overall means and standard deviations for the 2 measures were:
  - ESS = 8.8 +/- 4
  - SSI = 25.6 +/- 16

- The relationship between these measures was assessed using a Pearson Correlation Statistic (r), which showed a high correlation between the measures (r = 0.486; p < 0.0001).
Relationship of Epworth Sleepiness Scale (ESS) to Snoring Symptoms Inventory (SSI)

Pearson Correlation Statistic was used to assess the relationship between ESS and SSI totals and total maternal weight gain, labor duration (hrs), systolic and diastolic blood pressures, infant gestational age (wks), and infant birthweight (gms).
# Relationship of ESS and SSI Totals to Pregnancy Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Mean ± s.d.</th>
<th>ESS</th>
<th>SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Weight Gain</td>
<td>34 ± 13</td>
<td>r= 0.085</td>
<td>p= 0.391 r= 0.136</td>
</tr>
<tr>
<td>Labor Duration (hrs)</td>
<td>4.0 ± 5</td>
<td>r= 0.000</td>
<td>p= 0.997 r= 0.011</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>124 ± 17</td>
<td>r= -0.102</td>
<td>p= 0.311 r= 0.083</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>75 ± 11</td>
<td>r= -0.125</td>
<td>p= 0.212 r= 0.045</td>
</tr>
<tr>
<td>Infant weight (gms)</td>
<td>3430 ± 496</td>
<td>r= -0.216</td>
<td>p= 0.026 r= -0.113</td>
</tr>
<tr>
<td>Gestational Age (wks)</td>
<td>38.7 ± 1</td>
<td>r= -0.236</td>
<td>p= 0.016 r= -0.243</td>
</tr>
</tbody>
</table>
# Relationship of ESS and SSI to Preeclampsia

<table>
<thead>
<tr>
<th></th>
<th>ESS mean ± s.d.</th>
<th>p-value</th>
<th>SSI mean ± s.d.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preeclampsia No</td>
<td>8.5 ± 4</td>
<td></td>
<td>24.8 ± 16</td>
<td></td>
</tr>
<tr>
<td>Preeclampsia Yes</td>
<td>12.7 ± 4</td>
<td><strong>0.009</strong></td>
<td>36.4 ± 9</td>
<td>0.065</td>
</tr>
</tbody>
</table>
Conclusions

- In our population, pregnant women who demonstrated excessive daytime sleepiness also had symptoms of sleep disturbance due to snoring.

- Elevated scores on the ESS and SSI were associated with adverse maternal and neonatal outcomes, specifically preeclampsia and lower infant birthweights and younger gestational ages.
Maternal OSA in NICU Babies

- Our second study looked at mothers on the post-partum floor who had delivered an infant admitted to the NICU within the past 24 hours.
- The Institutional Review Board at The Valley Hospital approved this study, and maternal consent for participation and chart reviews was obtained.
- Data was collected between 6/09 - 3/12.
Conclusions: NICU

- In this population, pregnant women who demonstrated excessive daytime sleepiness again had symptoms of sleep disturbances due to snoring.

- Elevated scores on the SSI were associated with adverse maternal outcomes, specifically, higher Hb and Hct and **pre-eclampsia** (p=0.001).

- Elevated SSI scores correlated with an increased incidence of **gestational diabetes** (p=0.003), and both preeclampsia and gestational diabetes correlated with the incidence of fetal **IUGR** (p=0.006 and p=0.045, respectively).

- High SSI scores were associated with lower 5 minute Apgar scores at birth.
Conclusions

- In our population of pregnant women who demonstrated excessive daytime sleepiness, there were also symptoms of sleep disturbance due to snoring.
- Elevated scores on the SSI were associated with adverse maternal outcomes, specifically, higher Hb and Hct, preeclampsia, and gestational diabetes. In addition, poorer infant outcomes were likely.
Acknowledgements

- Kim Cahill, RN, MSN
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- Richard Shaw
- Labor and Delivery, Newborn Nursery, and NICU nurses
OSA and Maternal Deaths

- Study published in May, 2014 in SLEEP (Louis et al) found that after controlling for obesity and other potential confounders, OSA was found to be associated with preeclampsia (OR 2.5), eclampsia (OR 5.4), cardiomyopathy (OR 9.0), and pulmonary embolism (OR 4.5).
- Risk of in-hospital mortality was more than 5 times higher in women with OSA.
- Adverse effects of OSA on these outcomes was exacerbated by obesity.
Population-Based Study of OSA in Pregnancy

- Bin and co-investigators in New South Wales used linked birth and hospital records for all women who gave birth from 2002-2012 (n=636,227).
- Sleep apnea in the year before pregnancy or during pregnancy was identified from hospital records.
- Sleep apnea was significantly associated with pregnancy hypertension (adjusted RR 1.43), planned delivery (1.15), preterm birth (1.50), 5 minute Apgar <7 (1.60), NICU admission (1.26), LGA infant (1.27).

Bin et al., J Clin Sleep Med, June, 2016
Summary

- Maternal OSA has been associated with gestational diabetes, preeclampsia, eclampsia, cardiomyopathy, pulmonary embolus and maternal death.
- Maternal OSA has been associated with fetal growth restriction and poorer infant outcomes.
Evaluation for OSA

- Clinical tools, questionnaires and prediction algorithms should not be used alone to diagnose OSA
- Home Sleep Testing (if negative, inconclusive, or technically inadequate)
- In Lab Polysomnography
In Lab Polysomnography

- Patients with significant cardiorespiratory disease
- Potential muscle weakness due to neuromuscular disorder
- Awake hypoventilation or suspected sleep related hypoventilation
- Chronic opioid medication use
- History of stroke
- Severe insomnia

Treatment for Maternal OSA

- Positive Airway Pressure
- AutoPAP
- CPAP
Key to Effective Treatment

- Early testing
- Early initiation of treatment
Suggested Screening for OSA in Pregnancy

Mothers with the following factors are considered to be high risk:

(1) Previous diagnosis of OSA
(2) Obesity
(3) Hypertension
(4) Cardiac disease (i.e., cardiomyopathy, arrhythmia)
(5) Previous pregnancy complicated by preeclampsia
Screening for OSA in Pregnancy

Mothers with the following potential risk factors may benefit from screening:

(1) History of previous losses during pregnancy
(2) History of habitual snoring or worsening snoring during pregnancy
(3) Excessive sleepiness worsening during pregnancy
"Was I snoring again?"