Telemonitoring and Sleep Apnea: Effect on CPAP Adherence

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Overview

- Background on sleep apnea and CPAP therapy
- Overview of telehealth studies in sleep apnea
- Presentation of two CPAP telemonitoring studies
Introduction to OSA

• OSA = Obstructive Sleep Apnea
  – Repetitive cessations of breath during sleep
  – Comprised of apneas and hypopneas
  – AHI = apneas + hypopneas/hour of sleep

• OSA is associated with serious cardiovascular and psychosocial co-morbidities, and with increased rates of mortality

• >80% of all Sleep Clinic diagnoses are OSA

• OSA is a prevalent chronic disease
  – 2-4% middle aged adults; ~30-40% older adults
Introduction to CPAP Therapy

- CPAP = continuous positive airway pressure therapy
- Comprised of flow generator, hose, and mask
- Prescribed for use whenever asleep
- Gold-standard therapy
- Fixed, bi-level, auto-adjusting
Background

- Obstructive sleep apnea historically has been underdiagnosed
- Large emphasis on diagnosis
  - Many factors (increased awareness, increased capacity) resulting in increased numbers of OSA patients
- Evolving emphasis on treatment initialization & follow-up
- Medicare 90-day rule has had large recent influence

Stepnowsky & Moore, 2004; Flemons et al, 2004
CPAP Adherence Rates

- Continuous positive airway pressure (CPAP) therapy adherence rates generally considered suboptimal
  - 75-80% of OSA patients give CPAP a try
  - ~50% continue to use at one year
  - Of those that continue to use, mean use=3-4hrs/nt
- CPAP prescribed for use all night, every night, including naps
- Majority of patients are engaging in partial use patterns
CPAP Adherence Patterns

• Consistent and inconsistent users can be distinguished within the first week (Weaver et al, 1997; Aloia et al 2007)

• Adherence in week 1 associated with:
  – adherence at 6 months (Aloia et al 2007)

• Adherence at 1 mo is associated with:
  – adherence at 3 months (Kribbs et al, 1993)
  – adherence at 6 months (Reeves-Hoche et al, 1994)

• Adherence at 3 mo is associated with:
  – adherence at 22 months (McArdle et al, 1999)
CPAP Adherence – First 2 Weeks

Data from Usual Care group from recent study

Drop of >50% in first 2 weeks of use

Figure 2: CPAP adherence over first 14 days
CPAP Use Pattern- Summary

• Adherence use patterns seem to be established early in the treatment initialization process
• Use patterns are variable; they tell a story
• This variability is important to monitor over time because it can help inform when to intervene when tracked prospectively
• Technologically, we can do this
• Key issue: current system is not well set up to take advantage of it
Interventional Studies

• Educational
  – Provision of pamphlets, group education

• Clinical Support
  – Provision of additional telephone/clinic visits with focus on therapeutic changes/advice

• Behavioral Change
  – Motivational Enhancement, Cognitive-Behavioral Therapy, Self-Management, etc.

• Health information technology
  – Telemedicine, Telephone-linked care
Health Buddy Study

• Home telehealth device
• Intervention consisted of branching questions
  – Symptom management
  – Health behavior
  – Knowledge
• No difference in adherence
  – 4.2 vs. 4.3 hrs/nt

Health Buddy Appliance, Health Hero Network, Palo Alto, CA

Taylor et al, 2006
Video Teleconferencing (VTC) Study

- Sample: non-adherent patients over prior 3 mos
- Randomized to VTC or control (vitamin placebo)
- VTC group had higher adherence (90% vs. 44%; p=0.03)
- >4hrs/nt on >9 out of 14 nights

Video phone, 8x8, Inc, Santa Clara, CA

Smith et al, 2006
Interactive Voice Response: TLC-CPAP Study

• Full-Scale Study
  – Incorporation of motivational enhancement
  – RCT of Telephone-linked Care (TLC)-CPAP vs. attention control
    • n=100+ per group
  – Weekly phone calls in 1 mo; monthly thereafter
  – 12 mo study, with assessment at 6 mos
  – 2.4 vs. 1.5 hrs/nt at 6 mos

• Of concern: magnitude of use

Sparrow et al, 2010
Our Work
CPAP Telemonitoring System

Resmed AutoSet Spirit + ResTraxx wireless module = AutoSet + ResTraxx

Data transmitted via pager/cell network next day in “store & forward” manner
CPAP Telemonitoring Using ResTraxx Data Center (RDC):

- Demographics – background data
- Prescription – allows for setting of thresholds
- Monitoring – calendar format reporting of data
- Compliance

- Only provider access (i.e., no patient access)
ResTraxx Data Center - Prescription

### Prescription Information

* Indicates Required Field

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<td>Threshold Leak</td>
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<td>Threshold Usage</td>
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<th>Threshold Usage (Hours)</th>
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Save Prescription
# ResTraxx Data Center Calendar

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<td>0.1 l/sec</td>
</tr>
</tbody>
</table>

Report Date: September 21, 2005

Patient Name

Monitoring Start Date: May 23, 2005

Physician

Monitoring End Date: July 25, 2005

Date Of Birth

Total Days Monitored: 63

Compliance Percentage: 87.3 %
Provider
Treatment
Algorithm:

Green/green pathway

I. Set-up
- CPAP instruction
- Educate patient

Go to Step III
- Daily use meets or exceeds daily threshold
- Mask leak and AHI within normal limits
- Confirm wireless module attached and powered on
- Begin monitoring

II. Week 1
- Monitor usage / efficacy data daily
- Daily use meets or exceeds daily threshold
- Mask leak and AHI within normal limits

Red / Yellow Pathway
- Go to Step III

III. Week 2
- Monitor usage / efficacy data every other day
- Use, leak and AHI within normal limits
- Continue monitoring weekly adherence and efficacy data

Red / Yellow Pathway
- Go to Step IV

IV. Weeks 3, 4
- Monitor usage / efficacy data weekly
- Use, leak and AHI within normal limits
- Continue monitoring weekly adherence and efficacy data

Red / Yellow Pathway
- Go to Step V

V. Months 2 & 3
- Monitor usage / efficacy data weekly for remainder of study
- Use, leak and AHI within normal limits
- Continue monitoring weekly adherence and efficacy data

Red / Yellow Pathway
Provider Treatment Algorithm:

Red/yellow pathway

CPAP Red-Yellow Pathway

- Low Adherence
  - Assess Problem
    - Consider:
      - Side effects
      - Claustrophobia
      - Difficulty breathing
    - See Intervention Matrix

- High Leak
  - Assess Problem
    - Consider:
      - Mask
      - Nasal/Oral Pressure
    - See Intervention Matrix

- High AHI
  - Assess Problem
    - Consider:
      - Pressure too low
      - APAP trial
    - Increase Pressure

Continue Monitoring
Study 1 – CPAP Telemonitoring

- Examined effect of CPAP telemonitoring on improving CPAP adherence
  - Provider had access to CPAP adherence and efficacy data
  - Could act proactively
  - No specific intervention on the patient-side (i.e., clinical support study)

Stepnowsky et al, 2007
Methods

• Randomized trial comparing two groups:
  – Usual clinical care (UCC)
  – Enhanced clinical care (ECC)

• 20 patients per group

• **ECC receive tailored feedback from clinical staff based on wireless data collection**

• Participants were followed for 2 months
CPAP Data Measurement

• Objective measurement of both adherence and efficacy data

  – **Adherence** – amount of time treatment was worn at the prescribed pressure

  – **Efficacy**
    • AHI – CPAP unit is able to measure the AHI while the device is worn
    • Leak – measure of the amount of air leak; to the extent that leak is high, treatment less efficacious
UCC vs. ECC

Clinical Process

OSA Diagnosis

(+)

CPAP Prescription Ordered

CPAP Set-up

Introduction to CPAP
CPAP set-up

Follow-up #1
1 week Phone Call

Follow-up #2
1 month Clinic Visit
Data download

Follow-up #3
2 month Clinic Visit
Data download

Usual Clinical Care (UCC)

Enhanced Clinical Care (ECC)

Follow-up #1
1 week Phone Call

Follow-up #2
1 month Clinic Visit
Data download

Follow-up #3
2 month Clinic Visit
Data download

Provider access to
daily data

Provider access to
monthly data
Clinical Care Differences

• Both ECC and UCC have data access
  – ECC – Daily data access
  – UCC – Monthly data access
• ECC providers can proactively intervene
  – UCC providers limited to time points
  – However, patients could always call/drop-in
• Key difference was essentially in that first 30 day period.
Sample Characteristics*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
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<td>Age</td>
<td>59</td>
<td>14.3</td>
<td>23-80</td>
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<tr>
<td>Body Mass Index (kg/m²)</td>
<td>32.8</td>
<td>5.7</td>
<td>26.0-45.9</td>
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<tr>
<td>Apnea-Hypopnea Index (AHI)</td>
<td>39</td>
<td>16.8</td>
<td>20.7-93.7</td>
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<tr>
<td>Oxygen Desat Index (ODI)</td>
<td>43.4</td>
<td>20.1</td>
<td>16.5-89.3</td>
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<td>CPAP pressure (cm H₂O)</td>
<td>10.3</td>
<td>1.6</td>
<td>8-13</td>
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<tr>
<td>Epworth Sleepiness Scale</td>
<td>12.6</td>
<td>5.8</td>
<td>4-23</td>
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<td>FOSQ*</td>
<td>13.8</td>
<td>3.8</td>
<td>6.2-19.3</td>
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</table>

* There were no significant differences on any of these sample characteristic variables between the 2 groups
Data on Adherence, AHI and Mask Leak by Overall Group and Intervention Arms

<table>
<thead>
<tr>
<th></th>
<th>Total Sample</th>
<th>Usual Clinical Care</th>
<th>Enhanced Clinical Care</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Adherence (hrs/night)*</td>
<td>3.5 ± 2.1</td>
<td>0.2 – 6.8</td>
<td>2.8 ± 2.2</td>
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<tr>
<td>AHI (e/hr)</td>
<td>6.8 ± 5.3</td>
<td>.14 – 25.6</td>
<td>8.8 ± 5.7</td>
</tr>
<tr>
<td>Mask Leak (l/sec)</td>
<td>.44 ± .36</td>
<td>.05 – 2.2</td>
<td>.50 ± .47</td>
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<tr>
<td>% Nights with CPAP Use (&gt;0)*</td>
<td>65 ± 31%</td>
<td>0-100%</td>
<td>60 ± 32%</td>
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<tr>
<td>% Nights with &gt; 4hrs/nt</td>
<td>44 ± 32%</td>
<td>0-93%</td>
<td>37 ± 34%</td>
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</table>

Note: * p<0.10 (trend); ** p<0.05
Results: Adherence level (in hrs/nt) by Group

<table>
<thead>
<tr>
<th></th>
<th>Usual</th>
<th>Enhanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adherence</td>
<td>2.8</td>
<td>4.1</td>
</tr>
</tbody>
</table>

p-value=0.07
Results: Mean Leak by Group
Conclusions

- Trend for both greater CPAP adherence levels and lower mask leak levels in ECC relative to UCC
- All patients had acceptable leak levels and AH1 levels, on average, over the 2-month intervention period
- Overall, enhanced clinical care patients were satisfied with their care, are very likely to continue to use CPAP, and were not concerned about wireless monitoring of their CPAP data
Study 2: Telemonitoring + Interactive Website

• Develop and evaluate a CPAP adherence intervention using the internet

• Key features:
  – Telemonitoring of CPAP adherence and efficacy data
  – Feeding that data back to both patients and providers
  – Creating online resource for participants
Methods

• Randomized, controlled trial comparing two groups:
  – Usual Care (UC)
  – Patient-Centered Collaborative Care (PC3) – emphasize collaboration between provider and patient
• 120 patients per group
• Recruited from UCSD Sleep Clinic
  – Supplemented by word-of-mouth referrals
• Inclusion criteria: AHI≥10
**OSA Diagnosis**

**CPAP Prescription Ordered**

**CPAP Set-up**

**Clinical Process**

**Usual Care (UC)**

**Patient-Centered Collaborative Care (PC3)**

**Follow-up #1**
1 week Phone Call

**Follow-up #2**
1 month Clinic Visit Data download

**Follow-up #3**
2 month Clinic Visit Data download

**Introduction to CPAP CPAP set-up**

**Introduction to CPAP CPAP set-up**

**Follow-up #1**
1 week Phone Call

**Follow-up #2**
1 month Clinic Visit Data download

**Follow-up #3**
2 month Clinic Visit Data download

**Provider access to daily data**

**Provider access to monthly data**

**Data download**

UC vs. PC3
Chronic Illness Care - IOM

- What patients with chronic illnesses need:
  - A “continuous, healing relationship”
  - Regular assessments of how they are doing
  - Effective clinical management
  - Information and ongoing support for self-management
  - Shared care plan
  - Active, sustained follow-up

Crossing the Quality Chasm, Institute of Medicine (IOM), 2001
PC3 based in large part on the Chronic Care Model

- Data transmitted via cellular network next day in “store & forward” manner (ie, not real-time)
- Other similar systems include Encore Anywhere (Philips Respironics)
Model of Wireless CPAP Telemonitoring
Patient Side: PC3 Website

• Interactive website designed to “off-load” those tasks that tend to be repetitive to provider:
  – Learning Center – OSA and CPAP

• Add interactive components:
  – My Charts
  – Troubleshooting Guide
PC3 Website Login

Welcome!

The University of California at San Diego's Department of Medicine and the California Institute for Telecommunications and Information Technology have developed this website, called The Virtual CPAP Clinic, designed specifically for sleep apnea sufferers who want to control their disease and improve their lives. We invite you to come in, explore the site, and discover for yourself how you can make a positive difference in your health.

We invite you to come in, explore the site, and discover for yourself how you can make a positive difference in your health.

Please Sign In

User Name:

Password:

Remember me next time.

Sign In
Welcome car!

Thank you for signing in today, Friday, June 10, 2011

It looks as though you have not yet completed your Baseline assessment. Please click here to begin your baseline assessment.

Click here to view your latest CPAP data.
Learning Center

Part 1: Obstructive Sleep Apnea
Lesson 1: What is Obstructive Sleep Apnea?
Lesson 2: Why Sleep Apnea is not just snoring
Lesson 3: How you know you have Sleep Apnea
Lesson 4: What Sleep Apnea feels like
Lesson 5: Sleep Apnea being a vicious cycle
Lesson 6: How Sleep Apnea affects your body
Lesson 7: Why you have Sleep Apnea

Part 2: CPAP
Lesson 1: CPAP
Lesson 2: What CPAP looks and feels like
Lesson 3: How to use CPAP
Lesson 4: Adjusting to CPAP
Lesson 5: How CPAP benefits you
The data on this page displays the average values of your CPAP data since the start of treatment. The average values are a general indication of how your treatment is progressing.

**Nightly Average to Date**

- Usage (hours): 5:40
- AHI (events/hour): 4.37
- Leak (liters/sec): .12

You may drill further into the data by selecting the links on the right.
CPAP Adherence data

Nightly CPAP Usage

- Usage is the amount of time CPAP is in use during a single night.
- The recommended nightly minimum usage is 4 hours (shown in green).

Next Done
CPAP Residual AHI Data

The Apnea-Hypopnea index (AHI) is the number of apneas+hypopneas occurring per hour of CPAP use.

- An AHI below 10 events/hour is considered 'normal'.
- An AHI above 10 events/hour indicates a need for additional CPAP management.
CPAP Leak Data

- Average leak is an indication of much air is escaping from your mask per hour of CPAP use.
- Average leak less than 0.4 liters/sec is considered 'normal'.
- Average leak above 0.4 liters/sec is an indication that your mask or fittings may require attention.
Troubleshooting & Manual

We hope that you aren’t experiencing any problems with your CPAP treatment, but in case you are, this is the part of the website where you can look up solutions for some commonly experienced problems. As you will see, most of the corrections can be done by you at home. Some, however, require that you contact your care provider. If contact is necessary we will help you do so.

“Note: If you would like to print out a complete list of problems and their possible corrections included in this section, simply click on the icon “Full List of Troubleshooting” below and print the page. You can post this list near where you sleep in case you experience some of these problems.
## Sample Baseline Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Both Groups</th>
<th>PC3 <em>(N=126)</em></th>
<th>Usual Care*(N=114)*</th>
<th>P-value</th>
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<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>52.1 ± 13.3</td>
<td>52.2 ± 13.0</td>
<td>51.9 ± 13.6</td>
<td>NS</td>
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<tr>
<td>Body Mass Index (kg/m²)</td>
<td>32.4 ± 8.0</td>
<td>32.1 ± 8.3</td>
<td>32.8 ± 7.8</td>
<td>NS</td>
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<tr>
<td>Apnea-Hypopnea Index (AHI)</td>
<td>36.5 ± 25.9</td>
<td>36.3 ± 24.9</td>
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<td>Epworth Sleepiness Scale</td>
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<td>10.7 ± 5.2</td>
<td>10.5 ± 5.4</td>
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* No significant differences between UC and PC3 groups
CPAP Adherence level between UC and PC3 at 2-months

![Bar graph showing CPAP adherence levels between UC and PC3 at 2-months.]

- UC: CPAP adherence (hrs/nt) - 3
- PC3: CPAP adherence (hrs/nt) - 4

p-value = 0.016; d-index = 0.34
CPAP Adherence level between UC and PC3 at 4-months

p-value = .035; d-index = 0.30
Nightly Use Rates over first 90 days

Graph showing nightly use rates with two lines labeled UC and PC3.
## Outcome Measures – 2 months

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<th>Usual Care (N=114)</th>
<th>P-value</th>
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<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
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<tr>
<td>Epworth Sleepiness Scale</td>
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<td>8.9 ± 5.3</td>
<td>8.1 ± 5.5</td>
<td>NS</td>
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<tr>
<td>Sleep Apnea Quality of Life</td>
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<td>2.5 ± 1.0</td>
<td>2.4 ± 1.2</td>
<td>NS</td>
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<tr>
<td>CES-D*</td>
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<td>8.1 ± 5.5</td>
<td>NS</td>
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<tr>
<td>Patient Satisfaction</td>
<td>1.7 ± 1.2</td>
<td>1.7 ± 1.1</td>
<td>1.8 ±1.3</td>
<td>NS</td>
</tr>
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</table>

*CES-D=Center for Epidemiological Studies-Depression*
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<th>Variable</th>
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<th>Usual Care (N=114)</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
</tr>
<tr>
<td>Epworth Sleepiness Scale</td>
<td>6.5 ± 4.2</td>
<td>7.1 ± 4.5</td>
<td>5.7 ± 3.6</td>
<td>NS</td>
</tr>
<tr>
<td>Sleep Apnea Quality of Life</td>
<td>2.3 ± 1.1</td>
<td>2.4 ± 1.1</td>
<td>2.2 ± 1.2</td>
<td>NS</td>
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<tr>
<td>CES-D</td>
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<tr>
<td>Patient Satisfaction</td>
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<td>1.9 ± 1.3</td>
<td>NS</td>
</tr>
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</table>

*CES-D=Center for Epidemiological Studies-Depression
Study 3 – in progress

• Four-group design:
  – CPAP Telemonitoring
  – Individualized Self-Management
  – Telemonitoring + Self-Management
  – Usual Care
Conclusions

- CPAP telemonitoring has provided the basis for several of our studies
  - Allows for timely **objective** data review
  - Provides the basis for productive interactions between patient and provider
- The PC3 intervention has the potential to help improve CPAP adherence in clinical settings
- The ~1hr/nt difference held at both 2-mo and 4-mo time points
Conclusions

• CPAP adherence interventions based on health IT have potential to be cost effective relative to more labor-intensive interventions
• May be useful as part of a stepped care plan
• Patient engagement with health IT tools is variable: consider incentives/rewards
• Future studies would do well to include forums and other peer support, as well as electronic communication with provider
• “Tool” vs. clinical issue/process
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Questions?

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