

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

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

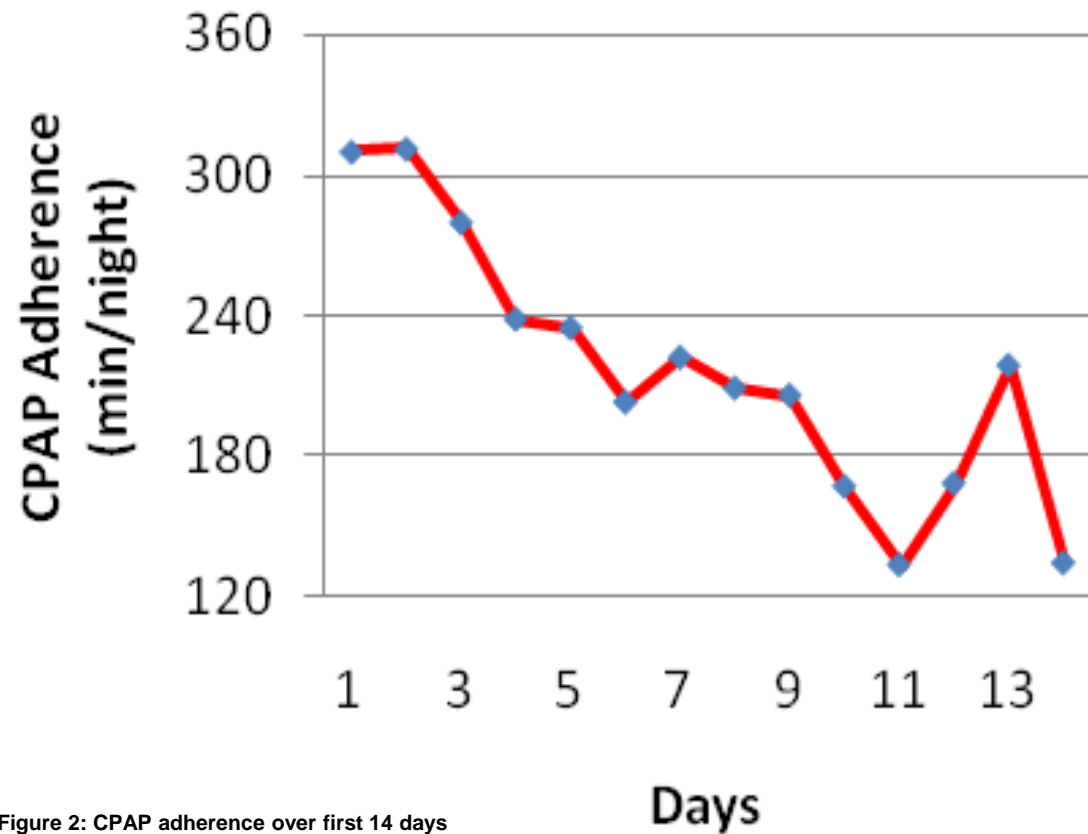
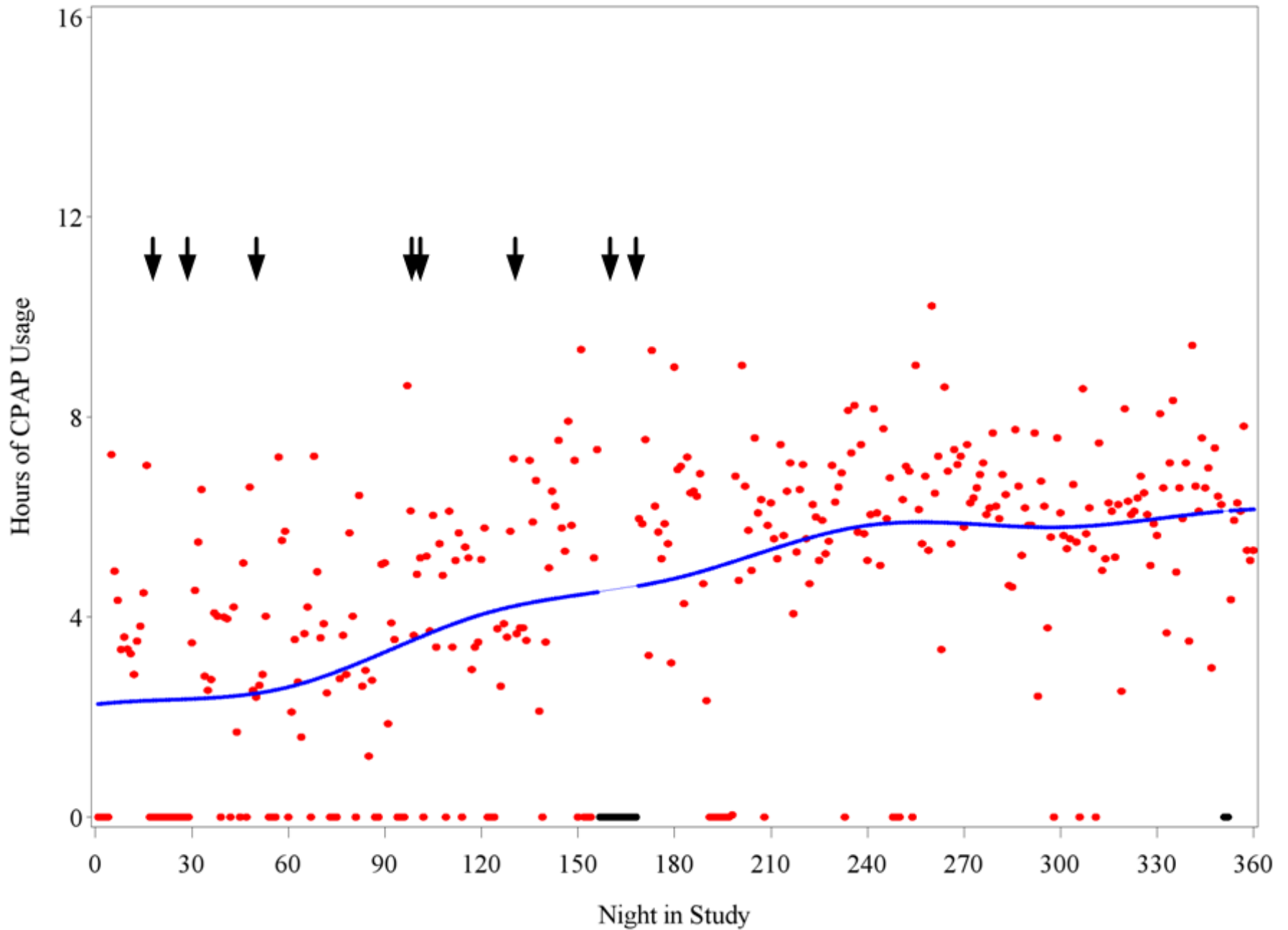


Figure 2: CPAP adherence over first 14 days

Adherence in Hours vs. Night -- Missing in Black -- Model in Blue

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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

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



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

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

Save Prescription

Effective Date:  *

Physician: ▼

Product Mode: ▼ *

Threshold AHI: ▼ e/hr *

Threshold Leak: ▼ l/sec *

Threshold Usage: ▼ Hours *

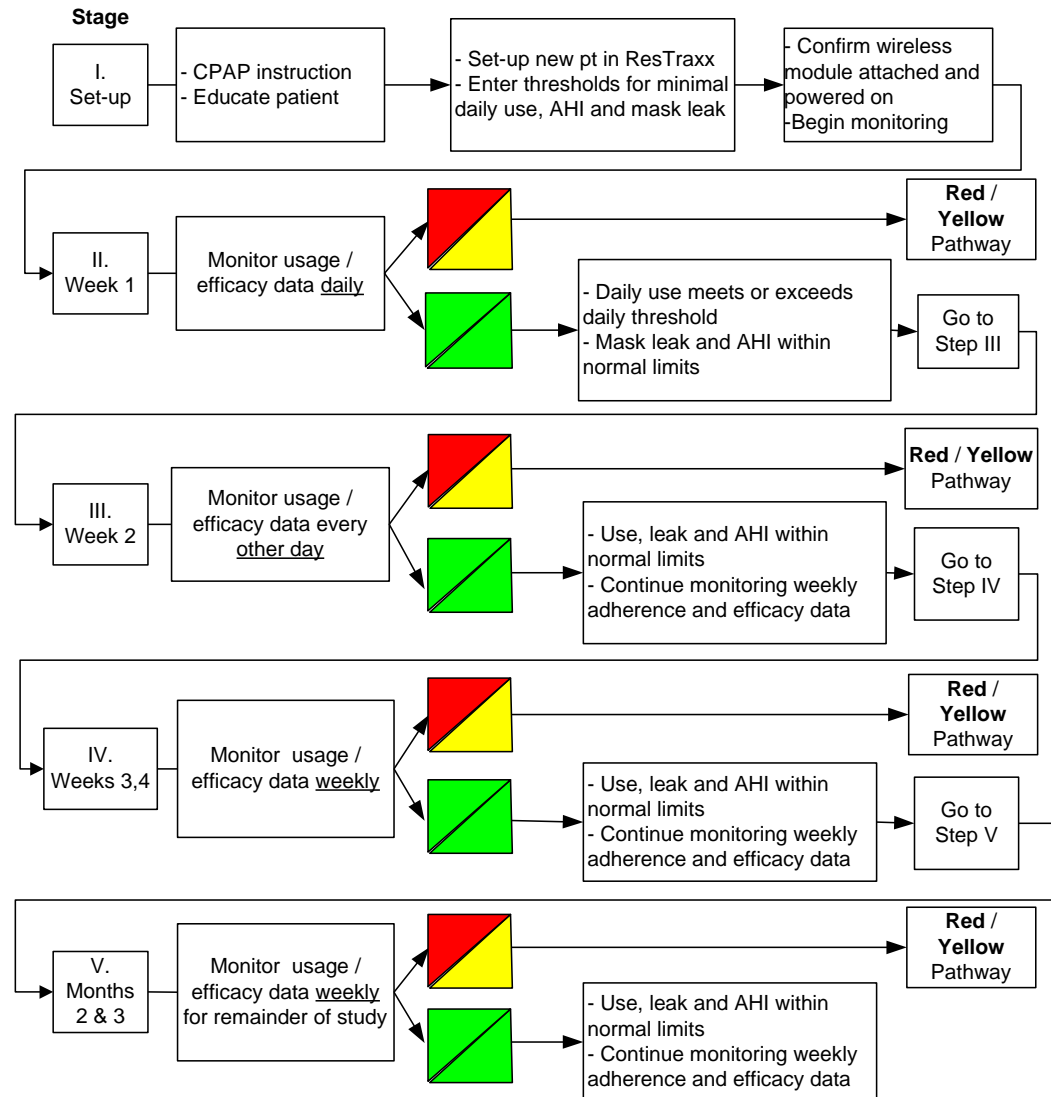
Save Prescription

Prescription History:

Effective Date	End Date	Product Mode	Threshold AHI (e/hr)	Threshold Leak (l/sec)	Threshold Usage (Hours)	Created By	Date/Time Created
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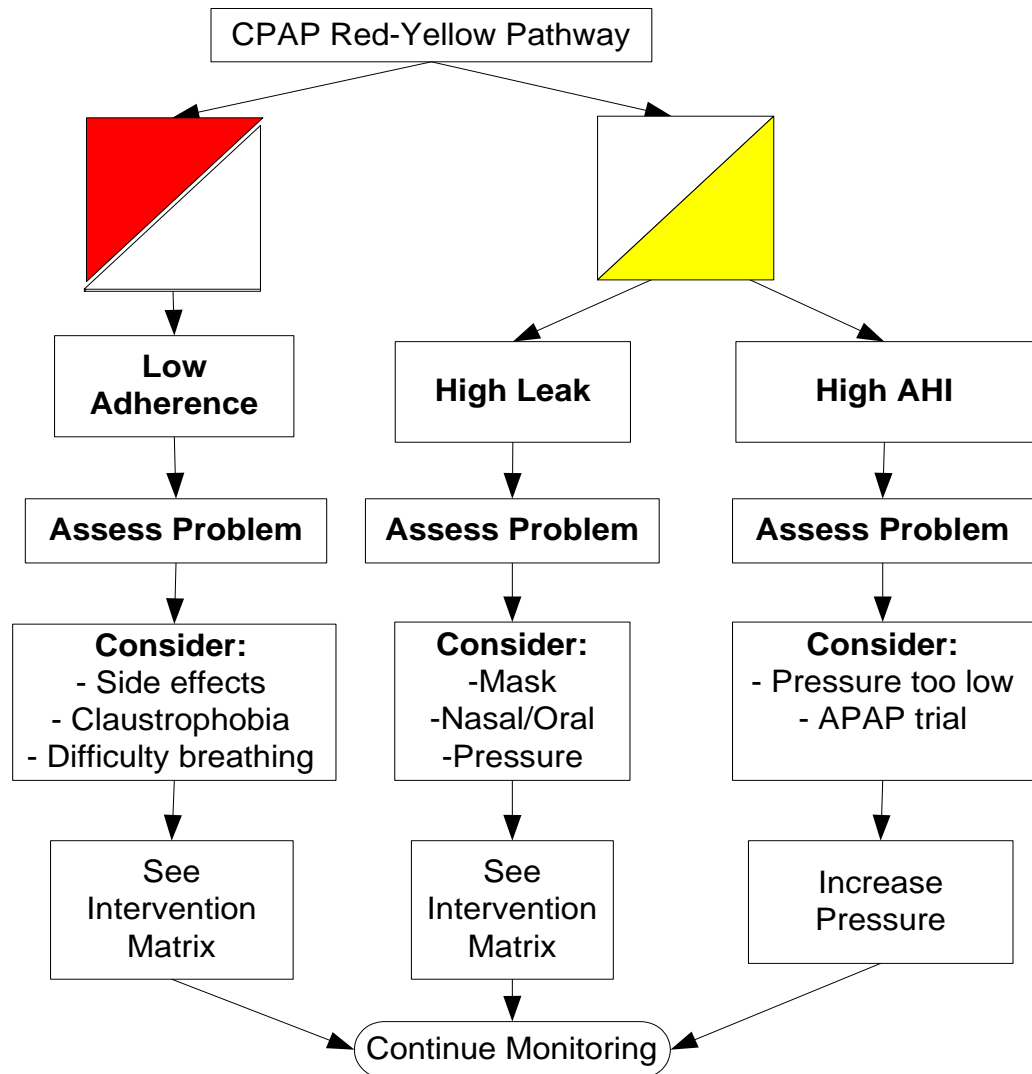
Provider Treatment Algorithm:

Green/green pathway



Provider Treatment Algorithm:

*Red/yellow
pathway*



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)

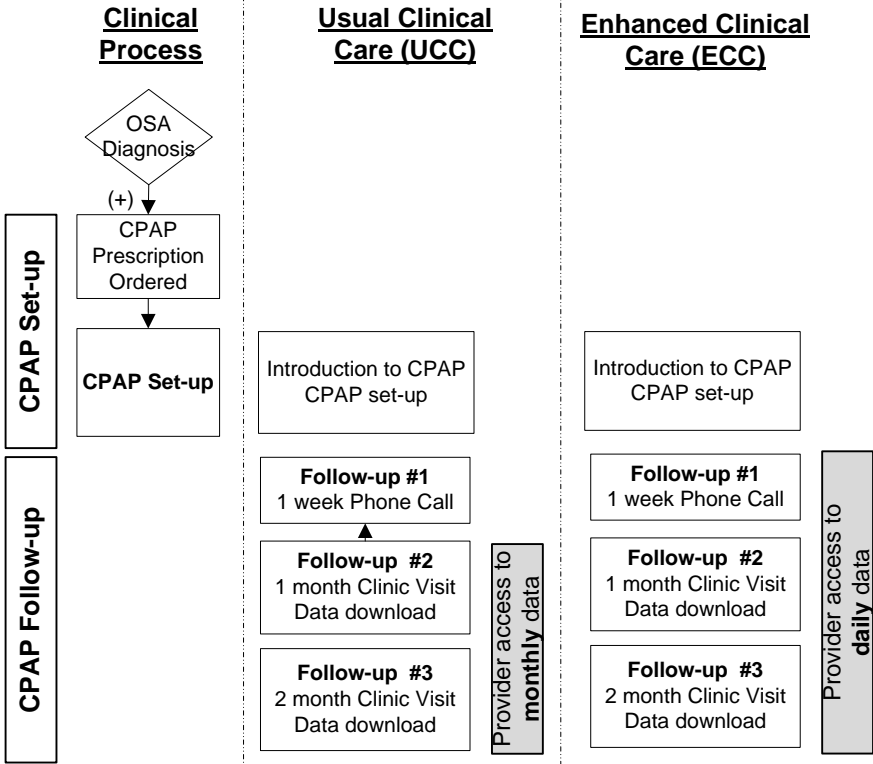
Methods

- 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 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*

Variable	Mean	SD	Range
Age	59	14.3	23-80
Body Mass Index (kg/m ²)	32.8	5.7	26.0-45.9
Apnea-Hypopnea Index (AHI)	39	16.8	20.7-93.7
Oxygen Desat Index (ODI)	43.4	20.1	16.5-89.3
CPAP pressure (cm H ₂ O)	10.3	1.6	8-13
Epworth Sleepiness Scale	12.6	5.8	4-23
FOSQ*	13.8	3.8	6.2-19.3

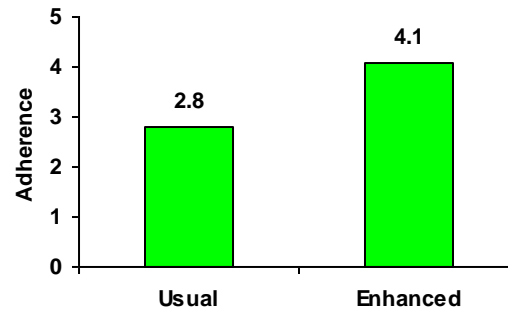
* There were no significant differences on any of these sample characteristic variables between the 2 groups

Data on Adherence, AHI and Mask Leak by Overall Group and Intervention Arms

	Total Sample		Usual Clinical Care		Enhanced Clinical Care	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Adherence (hrs/night)*	3.5 ± 2.1	0.2 – 6.8	2.8 ± 2.2	0.2 – 6.2	4.1 ± 1.8	.01 – 6.8
AHI (e/hr)	6.8 ± 5.3	.14 – 25.6	8.8 ± 5.7	3.4 – 25.6	4.8 ± 4.0	.14 – 13.3
Mask Leak (l/sec)	.44 ± .36	.05 – 2.2	.50 ± .47	.05 – 2.2	.38 ± .18	.17 - .82
% Nights with CPAP Use (>0)*	65 ± 31%	0-100%	60 ± 32%	5-100%	78 ± 22%	24-98%
% Nights with > 4hrs/nt	44 ± 32%	0-93%	37 ± 34%	0-89%	52 ± 27%	0-93%

Note: * p<0.10 (trend); ** p<0.05

Results: Adherence level (in hrs/nt) by Group



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 AHI 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

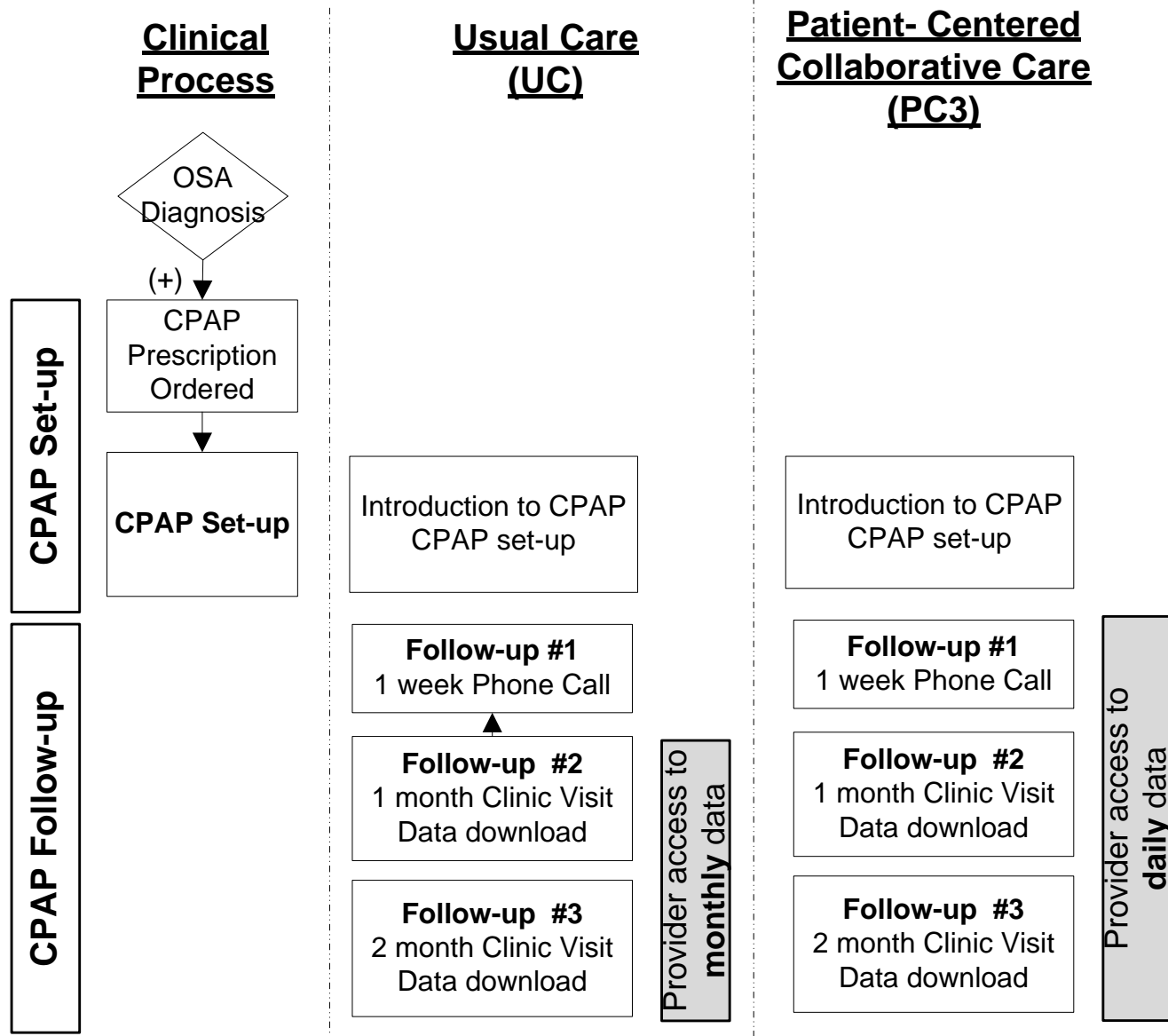
Study 2: Telemonitoring + Interactive Website

- 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: $AHI \geq 10$

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

PC3 based in large part on the Chronic Care Model

The Chronic Care Model



Provider Side: CPAP Telemonitoring System



ResMed AutoSet Spirit

+



ResTraxx wireless
module

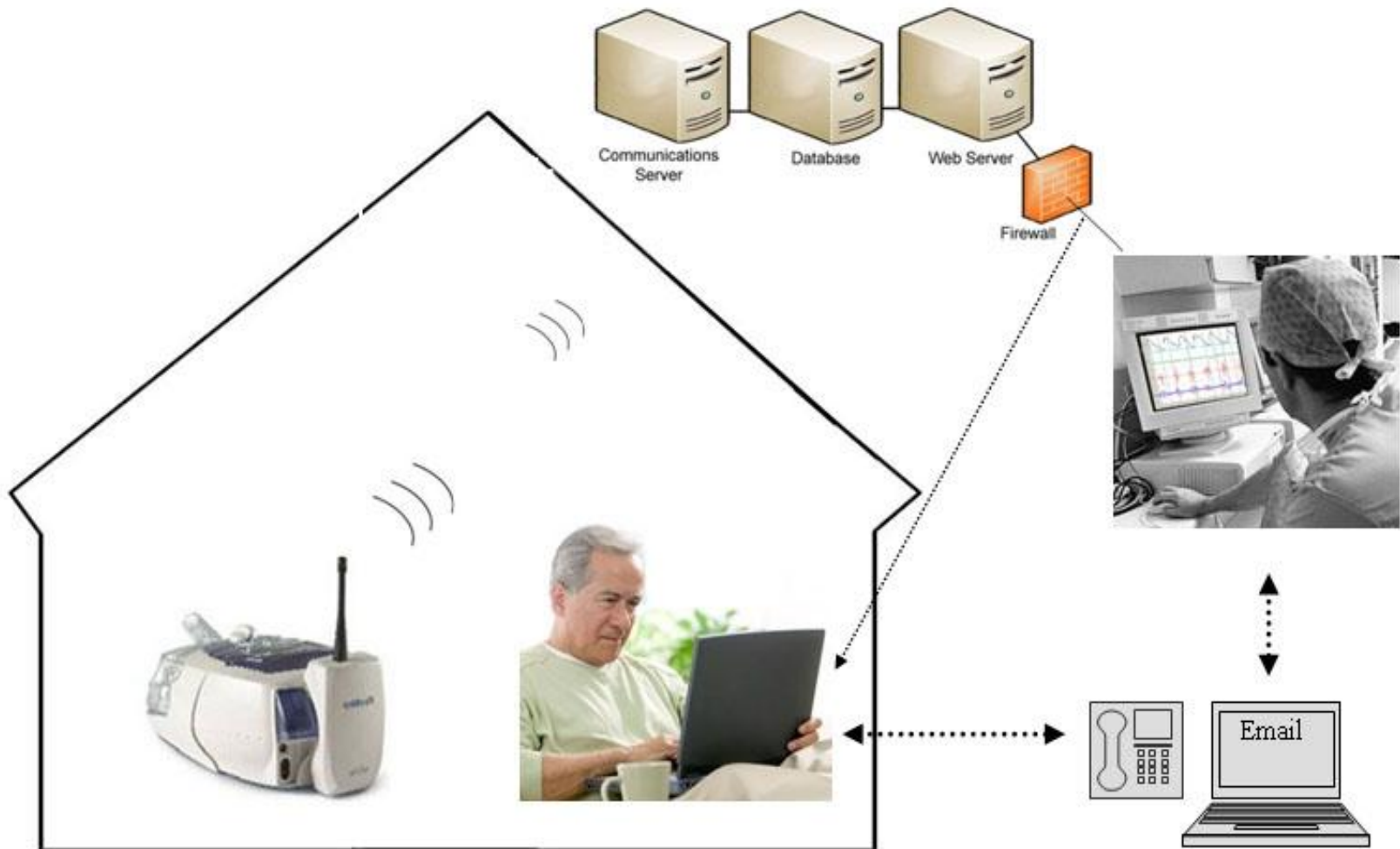
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AutoSet + ResTraxx

- 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
 - Reference Manual
- Add interactive components:
 - My Charts
 - Troubleshooting Guide

PC3 Website Login

The Virtual CPAP Clinic - Windows Internet Explorer

http://mycpap.calit2.net/MyCPAP/

File Edit View Favorites Tools Help

The Virtual CPAP Clinic

Virtual CPAP Clinic Home

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

Sponsored by VA San Diego Medical Center
The California Institute for Telecommunications and Information Technology

Contact Us

Internet 100%

PC3 Website Homepage

The Virtual CPAP Clinic - Windows Internet Explorer

http://mycpap.calit2.net/MyCPAP/Welcome.aspx

File Edit View Favorites Tools Help

The Virtual CPAP Clinic

Virtual CPAP Clinic Home > Welcome

[Manage User Accounts](#) [Logout](#)

Welcome carl!

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.

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Internet 100%

Learning Center



The screenshot shows a Windows Internet Explorer browser window displaying the website 'The Virtual CPAP Clinic'. The address bar shows the URL 'http://mycpap.calit2.net/MyCPAP/TheLearningCenter/TheLearningCenter.aspx'. The page header includes the logo for 'Sleep Apnea CPAP VA Medical Research Foundation' and a navigation menu with icons for a bar chart, a checklist, an open book, a wrench, a person, and an envelope. Below the header, the page title is 'The Learning Center' and there is a 'Logout' link. The main content area is divided into two columns: 'Part 1: Obstructive Sleep Apnea' and 'Part 2: CPAP'. Each part lists five lessons.

The Learning Center

[Virtual CPAP Clinic Home](#) > [The Learning Center](#) [Logout](#)

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

Charts Page

The screenshot shows a Windows Internet Explorer browser window displaying a web page titled "My Charts - Windows Internet Explorer". The address bar shows the URL "http://mycpap.calit2.net/MyCPAP/MyCharts/MyCharts.aspx". The page content includes a header for "Sleep Apnea CPAP VA Medical Research Foundation" and a navigation menu. The main content area displays the following information:

Virtual CPAP Clinic Home > My Charts [Logout](#)

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.

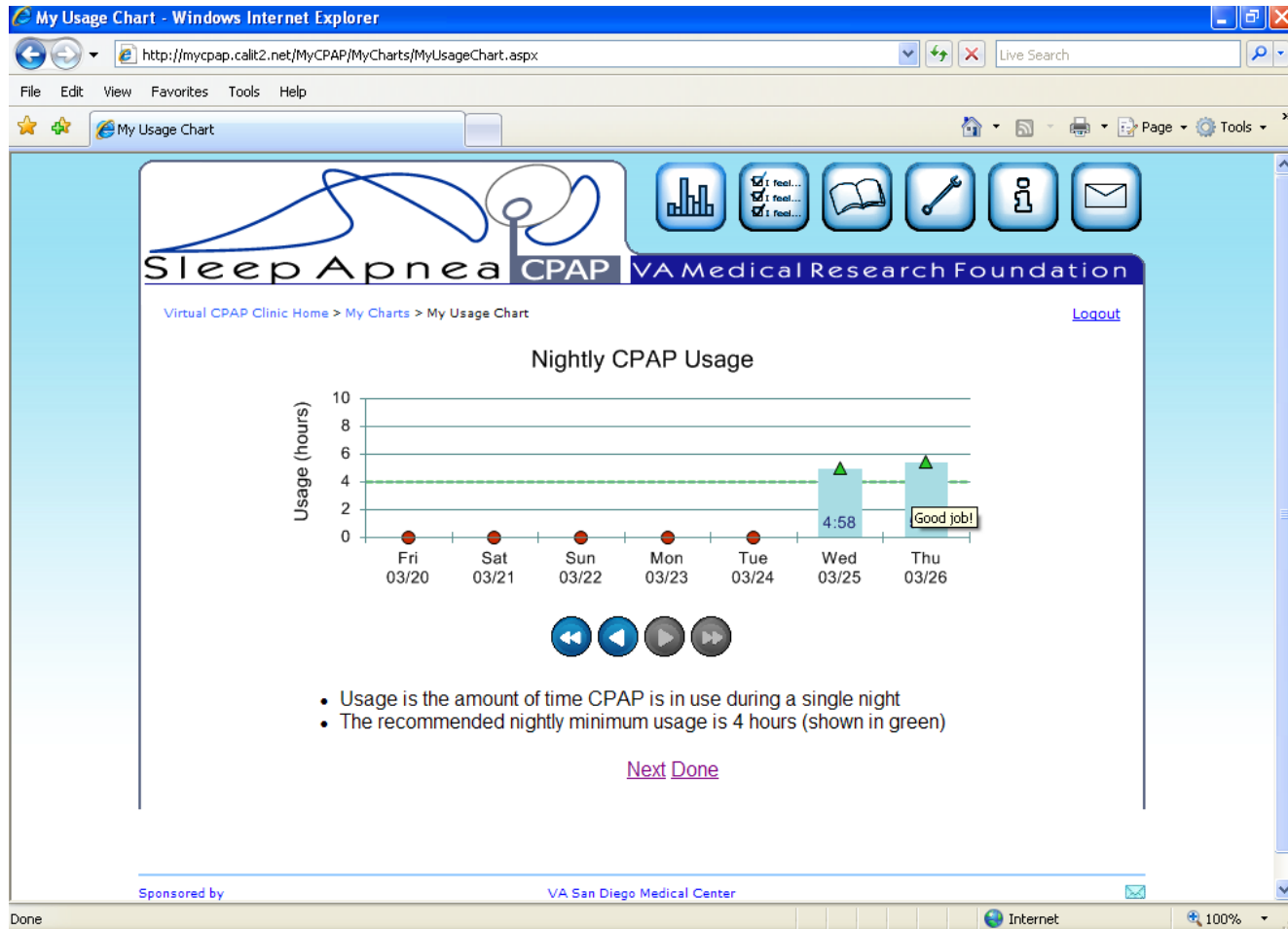
Nightly Average to Date

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

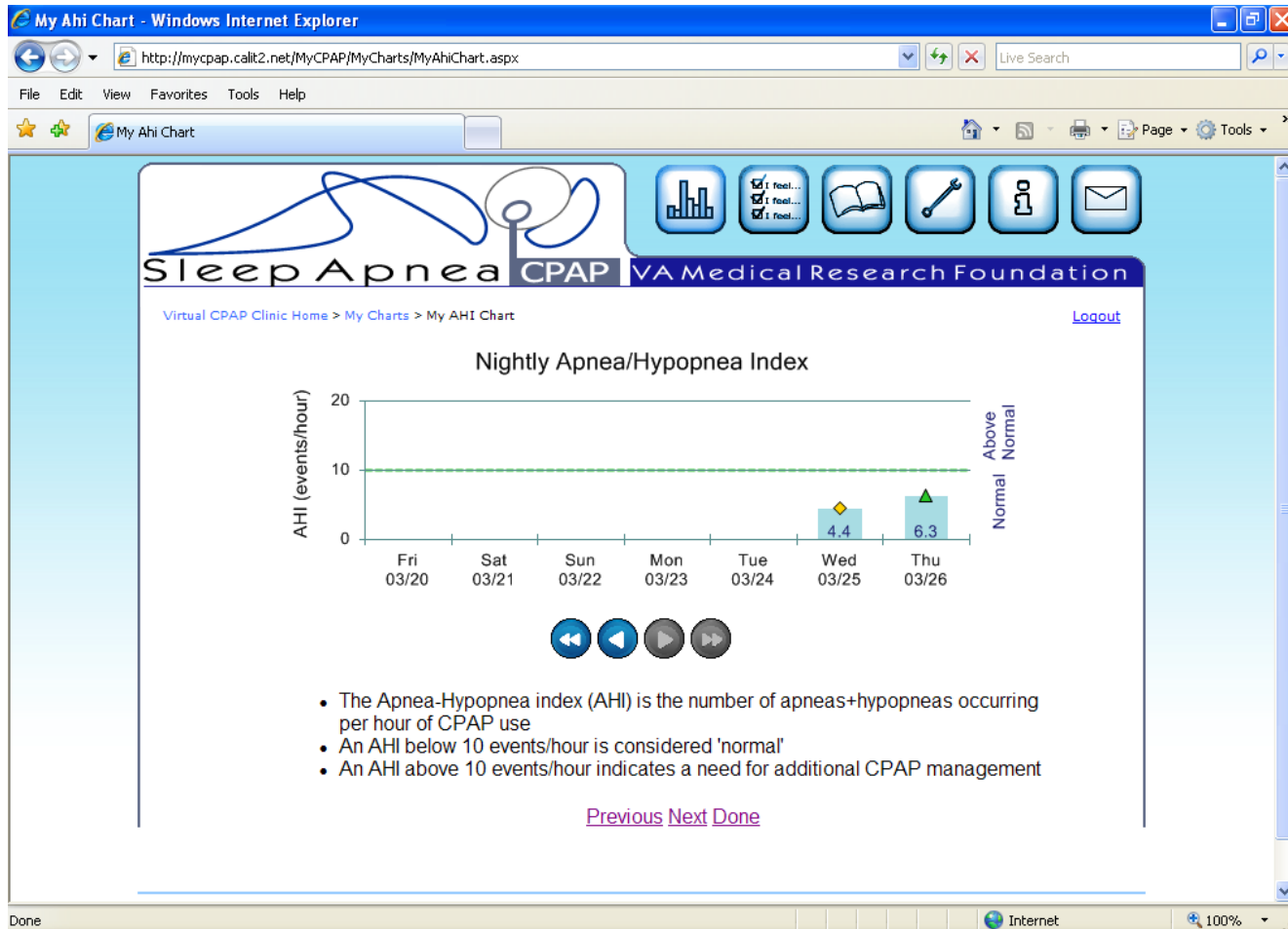
You may drill further into the data by selecting the links on the right.

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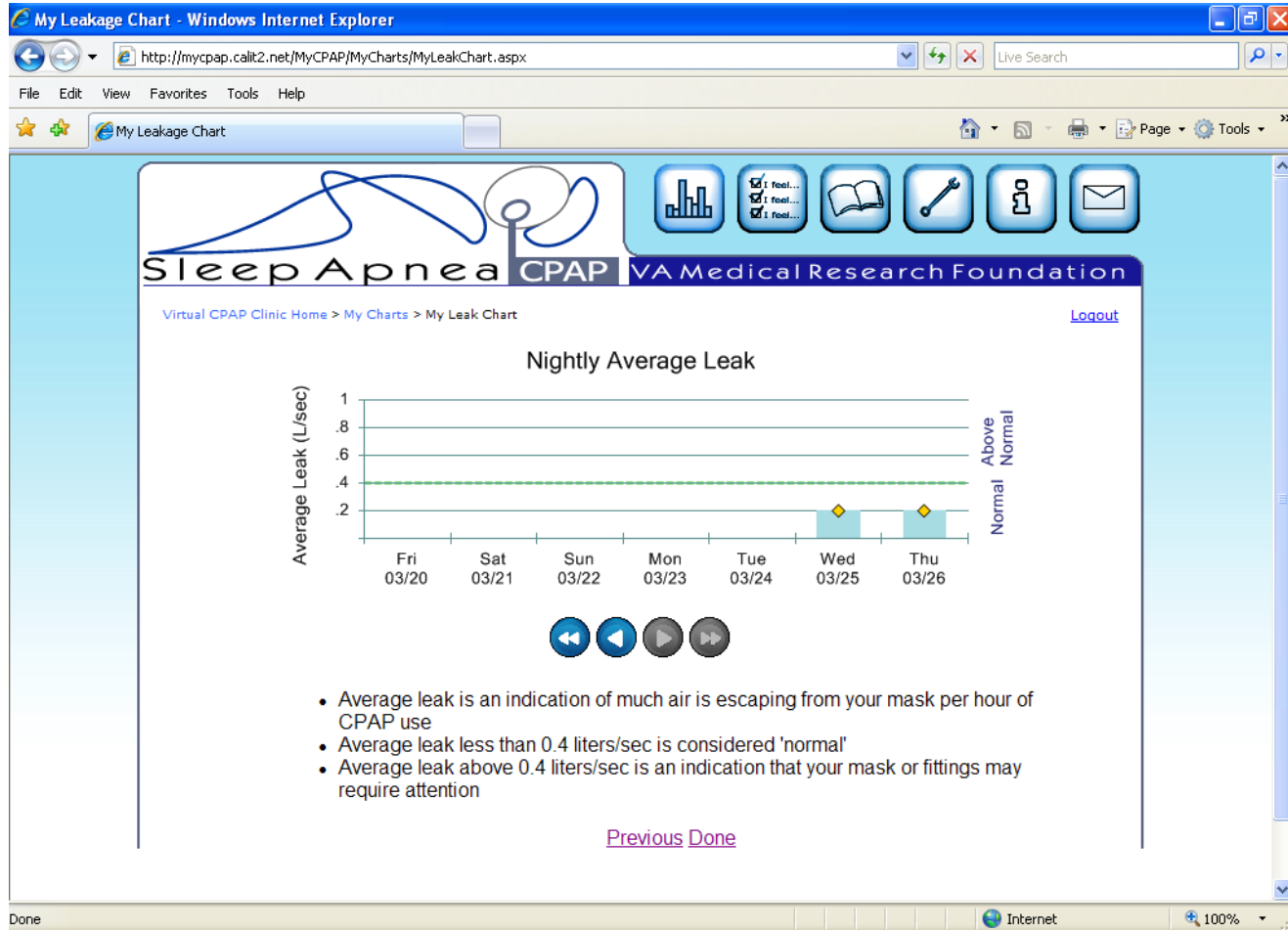
CPAP Adherence data



CPAP Residual AHI Data



CPAP Leak Data



Troubleshooting & Manual

The Virtual CPAP Clinic - Windows Internet Explorer

http://mycpap.calit2.net/MyCPAP/Troubleshooting/Troubleshooting.aspx

File Edit View Favorites Tools Help

The Virtual CPAP Clinic

Virtual CPAP Clinic Home > Troubleshooting [Logout](#)

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


[Click Here](#)
if you would like to
troubleshoot problems using your CPAP


[Click Here](#)
if you would like to view the
CPAP Machine Reference Guide

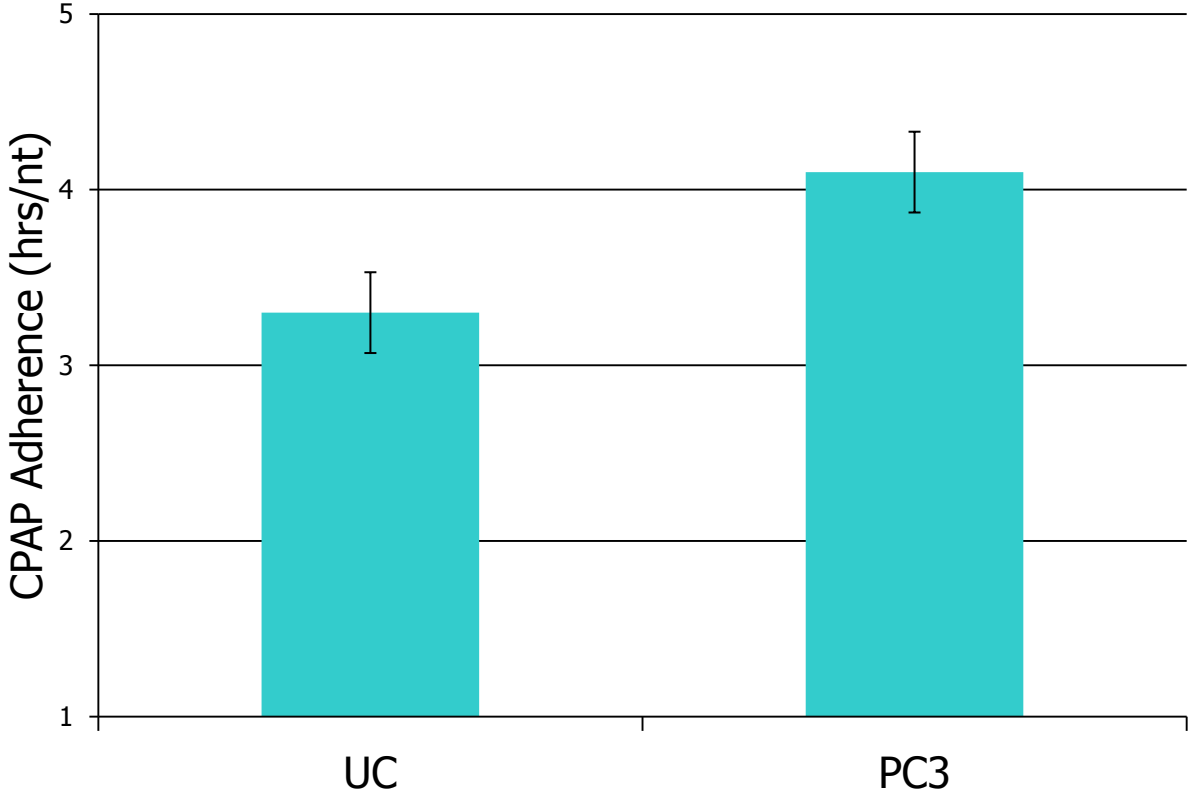
Internet 100%

Sample Baseline Characteristics

Variable	Both Groups	PC3 * (N=126)	Usual Care* (N=114)	P-value
	Mean \pm SD	Mean \pm SD	Mean \pm SD	
Age	52.1 \pm 13.3	52.2 \pm 13.0	51.9 \pm 13.6	NS
Body Mass Index (kg/m ²)	32.4 \pm 8.0	32.1 \pm 8.3	32.8 \pm 7.8	NS
Apnea-Hypopnea Index (AHI)	36.5 \pm 25.9	36.3 \pm 24.9	36.6 \pm 27.0	NS
Epworth Sleepiness Scale	10.6 \pm 5.3	10.7 \pm 5.2	10.5 \pm 5.4	NS

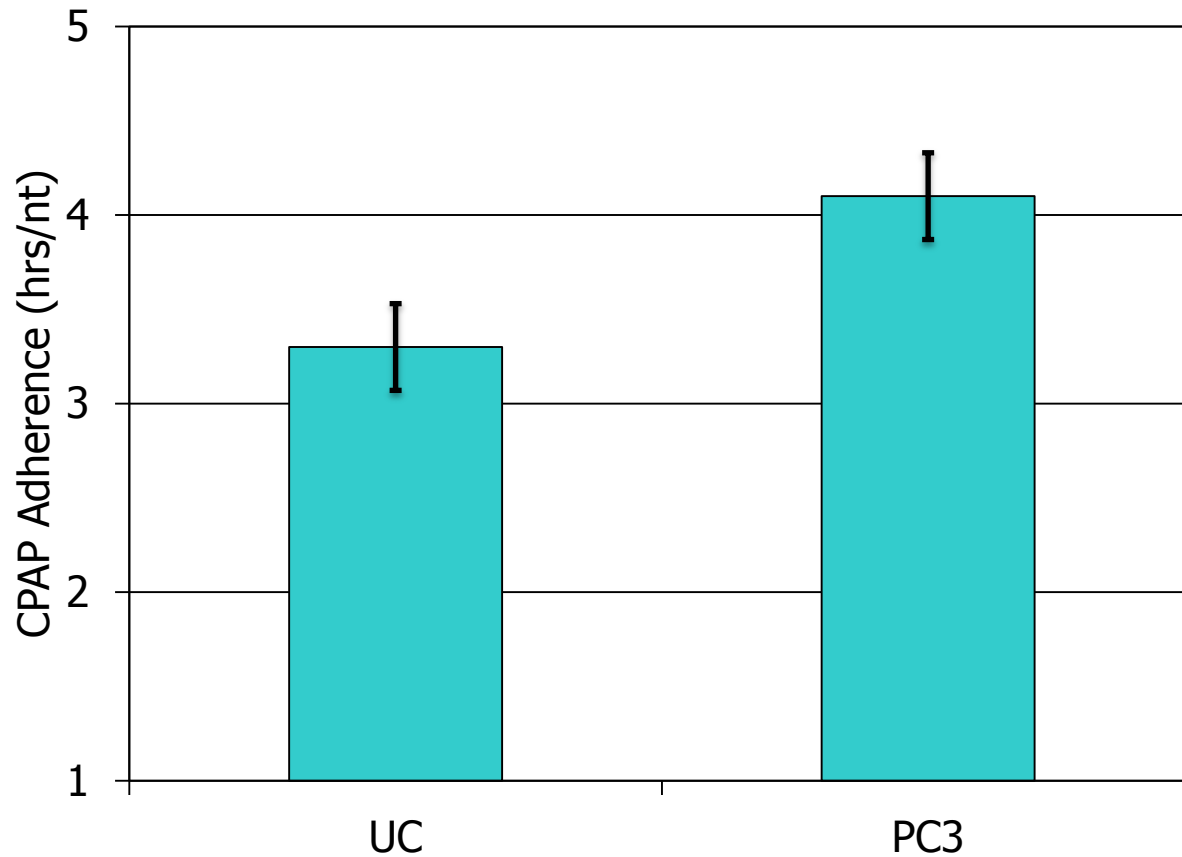
* No significant differences between UC and PC3 groups

CPAP Adherence level between UC and PC3 at 2-months



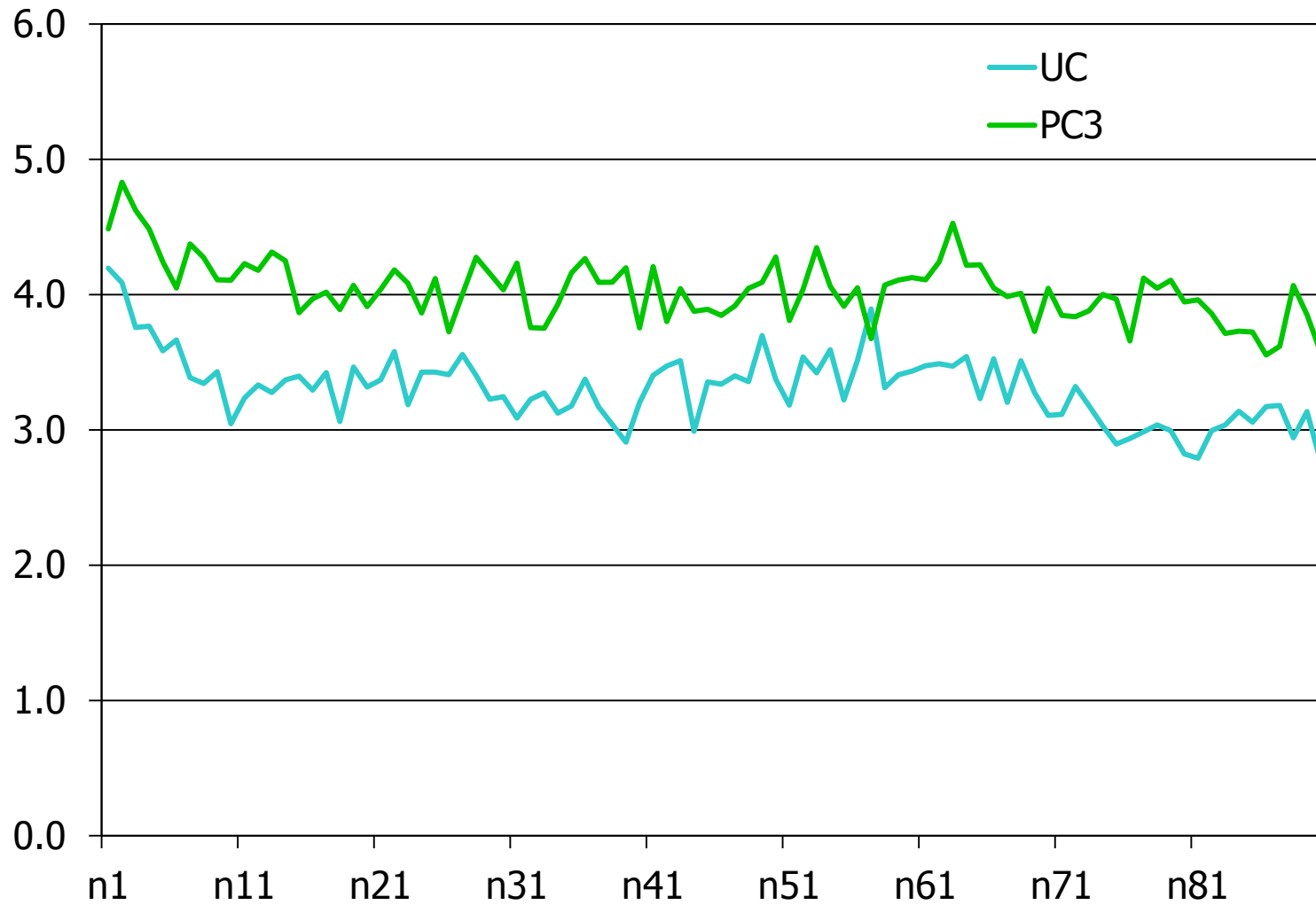
p-value=.016; d-index = 0.34

CPAP Adherence level between UC and PC3 at 4-months



p-value = .035; d-index = 0.30

Nightly Use Rates over first 90 days



Outcome Measures – 2 months

Variable	Both Groups	PC3 (N=126)	Usual Care (N=114)	P-value
	Mean \pm SD	Mean \pm SD	Mean \pm SD	
Epworth Sleepiness Scale	8.5 \pm 5.4	8.9 \pm 5.3	8.1 \pm 5.5	NS
Sleep Apnea Quality of Life	2.4 \pm 1.1	2.5 \pm 1.0	2.4 \pm 1.2	NS
CES-D*	8.5 \pm 5.4	8.9 \pm 5.3	8.1 \pm 5.5	NS
Patient Satisfaction	1.7 \pm 1.2	1.7 \pm 1.1	1.8 \pm 1.3	NS

*CES-D=Center for Epidemiological Studies-Depression

Outcome Measures – 4 months

Variable	Both Groups	PC3 (N=126)	Usual Care (N=114)	P-value
	Mean \pm SD	Mean \pm SD	Mean \pm SD	
Epworth Sleepiness Scale	6.5 \pm 4.2	7.1 \pm 4.5	5.7 \pm 3.6	NS
Sleep Apnea Quality of Life	2.3 \pm 1.1	2.4 \pm 1.1	2.2 \pm 1.2	NS
CES-D	7.9 \pm 5.2	8.6 \pm 5.5	7.1 \pm 4.9	NS
Patient Satisfaction	1.8 \pm 1.2	1.7 \pm 1.1	1.9 \pm 1.3	NS

*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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- Project team and Colleagues:
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Questions?

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