TeleSleep: A TELEMEDICINE PROGRAM FOR DIAGNOSING & MANAGING SLEEP-DISORDERED BREATHING

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OBJECTIVES

Upon concluding this activity, participants should be able to...

1. Describe the purpose, methods, advantages & limitations of home sleep testing (HST)
2. Describe the purpose, methods, advantages & limitations of using auto-adjusting positive airway pressure (APAP) therapy
3. Explain how HST & APAP fit into a telemedicine program for diagnosing and managing sleep-disordered breathing
Sleep Medicine Program Evolution

- Traditional sleep clinic and PSG lab
- Home Sleep Testing (HST) added for diagnosing patients highly suspected as having sleep apnea
- Triage for HST formalized
- APAP added for uncomplicated titration cases
- APAP with oximetry added
- HST set-up, APAP set-up, & follow-up visits standardized for export to remote clinics
- Telemedicine system incorporated into process for patient contact
- QC, QA, & TQI metrics implemented
Sleep Program that Includes HST

Sleep Clinic

HST

Laboratory PSG

Sleep Follow Up Clinic
Sleep Program Schematic

Sleep Clinic

HST

Laboratory PSG

Sleep Follow Up Clinic

PSG is a tool of discovery

1. PSG led to our understanding of sleep physiology
2. PSG led us to understanding normal sleep pattern
3. PSG led us to discovery of sleep disorders
HST is a tool of verification

1. The only thing Level III HST can do is verify the presence of sleep related breathing disorder (SRBD)
2. It **CANNOT** rule out SRBD
Why can’t HST rule out SRBD?
HST is less sensitive!
Why is it less sensitive?
  a- Does not measure RERA
  b- Is more prone to technical problems
  c- AHI based TIB not TST (thus, index is diluted)

Therefore...
Only-Only-Only use HST when pre-test probability for SRBD is High !!!
When severe, SRBD is easily recognized

- Loud disruptive snoring
- Awakenings with gasping &/or choking
- Morning dry mouth &/or headaches
- Excessive sleepiness (including involuntary dozing & “asleep at wheel”)
- Witnessed apnea
- Awakens unrefreshed
- However, the patient may be unaware!

*Hirshkowitz & Sharafkhaneh 2010*
HST Triage: Case Finding Tool

1. STOP-BANG Score > 5
   - Snoring
   - BMI >30
   - Tired
   - Age >50 y
   - Observed Apnea
   - Neck Circumference > 16 cm
   - High Blood Pressure
   - Gender Male

2. No suspicion of narcolepsy or seizure

3. Not being used as a regulatory test
DO NOT use HST when chain of custody is crucial
Review & Interpretation of HSTs

• It is pretty easy when all channels are intact.
• Distinguishing central-type from obstructive-type apnea can be a challenge.
• You can quickly determine if PAP titration is needed. *Especially if the patient desaturated.*
<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording Time</td>
<td>408</td>
</tr>
<tr>
<td># Central Apnea</td>
<td>78</td>
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<tr>
<td># Obstr Apnea</td>
<td>177</td>
</tr>
<tr>
<td># Mixed Apnea</td>
<td>147</td>
</tr>
<tr>
<td># Hypopnea</td>
<td>155</td>
</tr>
<tr>
<td>AHI</td>
<td>81.9</td>
</tr>
<tr>
<td>Mins SaO2 &lt; 85%</td>
<td>8</td>
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<tr>
<td>SaO2 Nadir</td>
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<td>------------------</td>
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<td>Mins SaO2 &lt; 85%</td>
<td>12.5</td>
</tr>
<tr>
<td>SaO2 Nadir</td>
<td>71</td>
</tr>
</tbody>
</table>

![Graph of HR, BPM, CA, sec, OA, sec, MA, sec, HYPO, sec over time from 6:32:19 PM to 3 AM]
Oximetry problems compromise hypopnea scoring & reduce HST sensitivity

• OK at first and then malfunctions
• Intermittent
• Absent
<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
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<td>50</td>
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<td>53</td>
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<tr>
<td># Mixed Apnea</td>
<td>27</td>
</tr>
<tr>
<td># Hypopnea</td>
<td>92</td>
</tr>
<tr>
<td>AHI</td>
<td>25.5</td>
</tr>
<tr>
<td>Mins SaO2 &lt; 85%</td>
<td>11.5</td>
</tr>
<tr>
<td>SaO2 Nadir</td>
<td>77</td>
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<td>PARAMETER</td>
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<td># Obstr Apnea</td>
<td>52</td>
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<td># Mixed Apnea</td>
<td>20</td>
</tr>
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<td># Hypopnea</td>
<td>22</td>
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<tr>
<td>AHI</td>
<td>14.2</td>
</tr>
<tr>
<td>Mins SaO2 &lt; 85%</td>
<td>0</td>
</tr>
<tr>
<td>SaO2 Nadir</td>
<td>88</td>
</tr>
<tr>
<td>PARAMETER</td>
<td>VALUE</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Recording Time</td>
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<tr>
<td># Obstr Apnea</td>
<td>212</td>
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<td># Mixed Apnea</td>
<td>136</td>
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<td># Hypopnea</td>
<td>0</td>
</tr>
<tr>
<td>AHI</td>
<td>58.2</td>
</tr>
<tr>
<td>Mins SaO2 &lt; 85%</td>
<td>0</td>
</tr>
<tr>
<td>SaO2 Nadir</td>
<td>n/a</td>
</tr>
</tbody>
</table>

![Graph showing HR, BPM, SpO2, %, CA, sec, OA, sec, and MA, sec over time.]
<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording Time</td>
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</tr>
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<td># Central Apnea</td>
<td>8</td>
</tr>
<tr>
<td># Obstr Apnea</td>
<td>30</td>
</tr>
<tr>
<td># Mixed Apnea</td>
<td>5</td>
</tr>
<tr>
<td># Hypopnea</td>
<td>0</td>
</tr>
<tr>
<td>AHI</td>
<td>4.9</td>
</tr>
<tr>
<td>Mins SaO2 &lt; 85%</td>
<td>0</td>
</tr>
<tr>
<td>SaO2 Nadir</td>
<td>n/a</td>
</tr>
</tbody>
</table>

![Graph showing HR, BPM, SpO2%, CA, sec, OA, sec, MA, sec, Pos, N, and S over time from 1:09:23 AM to 9 AM.]
Other HST Problems

- Effort channel problems
- Multiple channel problems
- Short study duration & severity index
<table>
<thead>
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<th>VALUE</th>
</tr>
</thead>
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<td># Central Apnea</td>
<td>318</td>
</tr>
<tr>
<td># Obstr Apnea</td>
<td>1</td>
</tr>
<tr>
<td># Mixed Apnea</td>
<td>2</td>
</tr>
<tr>
<td># Hypopnea</td>
<td>123</td>
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<tr>
<td>AHI</td>
<td>53.4</td>
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<tr>
<td>Mins SaO2 &lt; 85%</td>
<td>6.5</td>
</tr>
<tr>
<td>SaO2 Nadir</td>
<td>72</td>
</tr>
</tbody>
</table>

Effort Channel not functioning
# Airflow Channel Intermittent

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording Time</td>
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</tr>
<tr>
<td># Obstr Apnea</td>
<td>17</td>
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<tr>
<td># Mixed Apnea</td>
<td>3</td>
</tr>
<tr>
<td># Hypopnea</td>
<td>99</td>
</tr>
<tr>
<td>AHI</td>
<td>17</td>
</tr>
<tr>
<td>Mins SaO2 &lt; 85%</td>
<td>0</td>
</tr>
<tr>
<td>SaO2 Nadir</td>
<td>88</td>
</tr>
</tbody>
</table>

![Graph showing HR, BPM, SpO2, CA, OA, MA, HYPO, and Pos over time from 11:58:31 PM to 7 AM.](image)
Short recording, it’s a good thing he had what looks like a REM episode at 2 AM
HST Tracings
HST Recording (5 mins): SaO2, airflow, respiratory effort, & snore sensor all functioning
HST Recording (5 mins): SaO2 not functioning
HST Recording (5 mins): SaO2 and effort channel not functioning

Patient appears to have mix of central and obstructive events but it is uncertain
HST Recording (5 mins): SaO2 not functioning and snoring not seen (possibly not recording)- WWSMD?
Inconclusive recording, overall AHI = 11.1, PSG is needed.

<table>
<thead>
<tr>
<th></th>
<th>SaO2</th>
<th>HR</th>
<th>Airflow</th>
<th>Resp Effort</th>
<th>Snore</th>
</tr>
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<tbody>
<tr>
<td></td>
<td><img src="image" alt="SaO2 Graph" /></td>
<td><img src="image" alt="HR Graph" /></td>
<td><img src="image" alt="Airflow Graph" /></td>
<td><img src="image" alt="Resp Effort Graph" /></td>
<td><img src="image" alt="Snore Graph" /></td>
</tr>
</tbody>
</table>
HST Recording (5 mins): No airflow, no snoring.

ODI=14.4, event type unknown - do you titrate?
HST Recording (5 mins): SaO2 not functioning. Can you diagnose, should you titrate?

Snore channel helps here- patient has obstructive sleep apnea & needs titration
Logistics of interpreting and reporting home sleep test results
<table>
<thead>
<tr>
<th>iScore</th>
<th>Data Recorder Channels</th>
<th>Interpretability Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>X x X x</td>
<td>Pattern can diagnose obstructive or central SRBD</td>
</tr>
<tr>
<td>9</td>
<td>X x x</td>
<td>Pattern can diagnose obstructive or central SRBD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pattern can diagnose SRBD of unknown type(^1)</td>
</tr>
<tr>
<td>8</td>
<td>X x x</td>
<td>Pattern can diagnose SRBD of unknown type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pattern can diagnose obstructive or central SRBD if there are a sufficient # of apnea episodes(^2)</td>
</tr>
<tr>
<td>7</td>
<td>X x</td>
<td>Pattern can diagnose SRBD of unknown type if there are a sufficient # of apnea episodes(^2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Snoring may help identify obstructive apnea episodes.</td>
</tr>
<tr>
<td>6</td>
<td>X</td>
<td>Pattern can diagnose SRBD of unknown type if there are a sufficient # of apnea episodes(^2)</td>
</tr>
<tr>
<td>5</td>
<td>X x x</td>
<td>Pattern may strongly suggest (but not diagnose) obstructive or central SRBD(^3)</td>
</tr>
<tr>
<td>4</td>
<td>X x</td>
<td>Pattern may strongly suggest (but not diagnose) SRBD of unknown type(^4)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Pattern may strongly suggest (but not diagnose) SRBD of unknown type</td>
</tr>
<tr>
<td>2</td>
<td>X x</td>
<td>Pattern may weakly suggest (but not diagnose) possible central or obstructive SRBD</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>Pattern may weakly suggest (but not diagnose) central SRBD(^5)</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>Not interpretable</td>
</tr>
</tbody>
</table>

Notes:  
1. Snoring can sometimes serve as a surrogate for effort when hypopnea episodes are occurring (i.e., increased resistance producing vibration) allowing diagnosis of obstructive and central SRBD.  
2. Hypopnea episodes may be suggested but are unconfirmed; thereby, increasing the chance of a false negative study.  
3. When both effort and sat drops an event of unknown type likely has occurred; if effort drops but sat does not then there may be a central apnea episode, if sat drops but effort does not then an obstructive event has likely occurred.  
Ultimately, even though some events are identifiable, the proportion of central to obstructive cannot be determined; consequently, diagnosis cannot be determined.  
4. Snoring can potentially help classify the SRBD events as obstructive.  
5. An important limitation is that the pattern can potentially identify only central apnea episodes.
HST Report Data: Elemental, Derived, & Technical Comments

Data Points Required
1- Duration of Recording (in minutes)
2- Number of Central Apnea Episodes
3- Number of Obstructive Apnea Episodes
4- Number of Mixed Apnea Episodes
5- Number of Hypopnea
6- Number of Minutes SaO2 was below 85% (or 88% if you prefer)
7- SaO2 Nadir during the Recording
8- Apnea+Hypopnea Index

Comments about Recording’s Technical Quality
9a- Study quality not sufficient to make interpretation
9b- Study quality is compromised but available data indicate SRBD
9c- Study quality is good and patient clearly shows SRBD pattern
Possible HST Outcomes

1. This patient has Obstructive SRBD & is candidate for PAP titration
2. This patient has Obstructive SRBD & is candidate for PAP titration, negative pressure, an oral appliance, or expiratory nasal valves
3. This patient has Central or Complex SRBD & may need BPAP or AVAPS
4. This patient has an undetermined type of SRBD but is a possible candidate for PAP titration
5. This HST recording is not interpretable due to technical problems; therefore, we recommend attended PSG
6. This HST recording is not interpretable due to insufficient data or test duration; therefore we recommend attended PSG
7. This patient did not meet diagnostic threshold; therefore, we recommend an attended diagnostic PSG
The advantages and limitations of HST compared to PSG

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>More natural environment</td>
<td>BUT Less control over environment</td>
</tr>
<tr>
<td>Easier to review when recording is intact</td>
<td>BUT More technically flawed recordings because</td>
</tr>
<tr>
<td></td>
<td>(a) patient self-attaches monitoring devices &amp;</td>
</tr>
<tr>
<td></td>
<td>(b) technician not available to correct technical problems</td>
</tr>
<tr>
<td>Less data processing</td>
<td>BUT Less data available</td>
</tr>
<tr>
<td>Uses less program resources</td>
<td>BUT Diagnostically less sensitive</td>
</tr>
<tr>
<td>(when proper indications are used)</td>
<td>CAN NOT RULE OUT SRBD</td>
</tr>
<tr>
<td>Less expensive for payer</td>
<td>BUT Lower reimbursement</td>
</tr>
</tbody>
</table>
Adding APAP to the Program
Traditional Sleep Program

Sleep Clinic

Laboratory PSG

Sleep Follow Up Clinic
Sleep Program that Includes HST

Sleep Clinic

HST

Laboratory PSG

Sleep Follow Up Clinic
<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto adjusts pressure to reduce flow limitation</td>
<td>BUT (a) Metrics used to detect SRBD events &amp; make pressure adjustments differ from those used during PSG</td>
</tr>
<tr>
<td></td>
<td>(b) Without an oximetry option, hypoxemia is not detected</td>
</tr>
<tr>
<td>Does not require overnight PSG in laboratory</td>
<td>BUT No information concerning sleep fragmentation, quantity, architecture, and quality; or other sleep disorders.</td>
</tr>
<tr>
<td>Less data processing</td>
<td>BUT Less data available</td>
</tr>
<tr>
<td>Proper use can facilitate treatment and uses less program resources</td>
<td>BUT Often used improperly</td>
</tr>
<tr>
<td>Less expensive for payer</td>
<td>BUT Lower reimbursement</td>
</tr>
</tbody>
</table>
Hybrid Sleep Program PSG Triage

Schedule Patient for Attended PSG If ...
1. Low clinical suspicion for SRBD
2. Being studied for regulatory purposes
3. High suspicion for narcolepsy
4. Need to differentiate seizure from parasomnia
5. Had negative HST
6. Needs in-lab titration (see APAP rule-outs below)
7. Was an APAP failure

APAP Rule-outs
1. COPD, daytime hypoxemia or hypercapnia
2. CHF or other heart disease
3. Morbid obesity (BMI≥40)
4. prior UPPP
5. Opioid analgesics use
6. Neuromuscular, neurological or neurodegenerative disease; history of stroke; or seizure disorder
7. Unable to mentally or physically use machine and interface
APAP Follow Up Step-1

Inquire about problems and do trouble shooting:

• If patient has mask, especially if there are leaks: check fit, **review A-B-Cs of mask adjustment**
• If patient has full-face mask: determine if it is necessary
• If patient has dry mouth: explain effect of mouth breathing, give nose breathing practice instructions, review humidifier operation, consider chinstrap
• If there is a rainout problem: explain condensation and its relationship to heat/cold
• If there is a pressure problem: determine if it is too high or too low.
# A-B-Cs of Mask Adjustment

<table>
<thead>
<tr>
<th>A</th>
<th>Tighter is <strong>NOT</strong> better</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Adjust the mask with pressure <strong>ON</strong> (adjusting a mask without pressure is a waste of time)</td>
</tr>
</tbody>
</table>
| C    | • Take your time and get it right  
     |   • Mask adjustment **IS** the **MOST** *important step*  
     |   • *If it doesn’t fit right, it won’t be worn* |
There is a Large Selection of Nasal-Oral Masks, Nasal, Masks, Hybrid Masks, & Nasal Pillows

Note- Use nasal-oral “Full Face” masks only when absolutely needed and avoid them when autoPAP is used. Also, high pressure can create problems with nasal pillows.
APAP Follow Up Step-2

• Read data card for utilization
• Record % of nights used [with time frame-prefer last 30 days] and average time per night
• If patient is not using machine enough:
  – Encourage use
  – Emphasize the reason for PAP therapy
  – Indicate that we may need to do a lab titration if we can’t find pressures with APAP
  – Reschedule patient for this clinic in 10-30 days.
Machine Usage

Data

- 2013
- September

- 15
- 14
- 13
- 12
- 11
- 10
- 09
# PAP Adherence

<table>
<thead>
<tr>
<th></th>
<th>How much PAP usage is enough?</th>
</tr>
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<tbody>
<tr>
<td>a</td>
<td>More than 4 hours for 70% of nights during a 30 day consecutive period?</td>
</tr>
<tr>
<td>b</td>
<td>Average of 6 hours per night?</td>
</tr>
<tr>
<td>c</td>
<td>Enough to feel alert all day?</td>
</tr>
<tr>
<td>d</td>
<td>Other</td>
</tr>
</tbody>
</table>

Answer: According to CMS... a (but this is arbitrary)
APAP Follow Up Step-3A (Standard)

• Read data card for dwell times and pressures ($P$)
• If there is enough data:
  – Consider $\text{max } P$ as 90-95$^{\text{th}}$ %tile +2 cmH$_2$O
  – Consider $\text{min } P$ as either
    • Integer half way between mean (or median) $P$ & 90-95$^{\text{th}}$ %tile or
    • $P$ at which AHI drops below 5 (see Tower of Babel)
  – Set ramp at $\text{min } P$ – 3 cmH$_2$O or at 5 (whichever is higher) with a 5 minute incline (or longer in special circumstances)
### The Tower of Babel

<table>
<thead>
<tr>
<th>Term</th>
<th>PSG Scoring</th>
<th>PAP Machine</th>
<th>Degree of Similarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apnea (A)</td>
<td>Cessation of air flow for 10 s</td>
<td>Flow cessation for 10 s (Preferred term is Flow Cessation [FC])</td>
<td>Similar</td>
</tr>
<tr>
<td>Hypopnea (H)</td>
<td>Decreased flow by 30% or more <strong>accompanied by 4% SaO2 drop</strong></td>
<td>Flow limitations or flow-curve flattening (Preferred term is flow limitation [FL])</td>
<td>Very Different</td>
</tr>
<tr>
<td>Respiratory Effort Related Arousal (RERA)</td>
<td>Decreased flow leading to a CNS arousal.</td>
<td><strong>No equivalent</strong></td>
<td>n/a</td>
</tr>
<tr>
<td>AHI</td>
<td>Apnea + Hypopnea <strong>per hour of total sleep time</strong></td>
<td>Flow cessations + flow limitations <strong>per hour of time on mask (FCL Index)</strong></td>
<td>Very Different</td>
</tr>
<tr>
<td>Respiratory Disturbance Index (RDI)</td>
<td>Apnea + Hypopnea + RERA per hour of total sleep time</td>
<td><strong>No equivalent</strong></td>
<td>n/a</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of flow cessations</td>
<td>Flow cessations are the absence of airflow for 10 seconds, or more. This parameter closely approximates what is more commonly called an episode of sleep apnea.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of flow cessations judged to be nonobstructive</td>
<td>Some APAP systems have algorithms to help determine if a flow cessation is obstructive or nonobstructive. While the reliability may vary, this information may be useful clinically.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of flow limitations or flow-curve flattenings</td>
<td>Flow reduction is defined differently by different manufactures. Moreover, most systems incorrectly refer to flow reductions as sleep-related hypopnea. In general, these events constitute decreased signal amplitude or flow-curve flattenings derived from pressures in the device’s pneumotachometer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLC index</td>
<td>Flow cessations + flow limitations per hour of time on mask. This parameter is usually (and erroneously) labeled apnea + hypopnea index.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean or median pressure</td>
<td>Mean and median pressures serve as estimates of the central tendency of a patient’s pressure requirement. In principle, the machine will dwell at a particular pressure until flow cessations or limitations occur. Thus, the average pressure provides a global representation of a night’s actuarial outcome. Since the APAP machine raises and lowers pressures in response to flow-curve changes, nightly the mean or median can also inform a clinician about night-to-night variability in pressure needs. Some systems provide the mean (parametric) while others report median (nonparametric); either appears sufficient in this application.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90th percentile pressure</td>
<td>The 90th percentile pressure indicates at what pressure the machine dwelled at or below for 90% of the time. Thus, it represents one way to estimate a single pressure that should relieve the vast majority of the patient’s flow cessations and limitations (as successfully as possible using the machine’s titration algorithm).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum pressure</td>
<td>The maximum pressure is the highest pressure the machine self-adjusted to during the course of a night.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: APAP, automatic self-adjusting positive airway pressure; FLC, flow limitation and cessation.

\(^a\)See text for details relating to this issue.

\(^b\)Some APAP machines provide the 95th percentile pressure.
APAP Follow Up Step-3B (with OXY)

- Read data card for dwell times and pressures ($P$)
- If there is enough data:
  - Consider $\text{max } P$ as 90-95th %tile +2 cmH$_2$O
  - Consider $\text{min } P$ as either (a) Integer half way between mean (or median) $P$ & 90-95th %tile or (b) $P$ at which AHI drops below 5 (see Tower of Babel)
  - Verify that SaO2 at does not drop below 88% when $P$ is between $\text{max } P$ and $\text{min } P$ (& leak is not significant)
  - If SaO$_2$ drops significantly below 88%... schedule a laboratory attended PAP titration
  - If SaO2 remains above 88%... Set $\text{max } P$, $\text{min } P$, and ramp at $\text{min } P$ – 3 or at 5 (whichever is higher) with a 5 minute incline (or longer in special circumstances)
What is Significant leak?

Our Rule of Thumb
At 10 cmH2O > 35
At 20 cmH2O > 45
At 30 cmH2O >55
### One Day Summary View (Good)

**Viewing Range**
- 1 Day
- 9/15/2013 to 9/15/2013

**Product**: S9 AutoSet

**Serial No.**: 23131285287

**Apnea & AI events/hour**
- Apnea index: 0.3
- Obstructive: 0.3
- Central: 0.0
- Unknown: 0.0
- Hypopnea index: 0.0
- AHI: 0.3

**Device Settings**
- Therapy Mode: AutoSet
- Minimum Pressure: 5.0 cmH2O
- Maximum Pressure: 20.0 cmH2O
- EPR: Full_Time
- EPR Level: 3.0 cmH2O

**Usage**
- Total hours used (hrs:min): 7:47
- Median daily usage (hrs/day of used days): 7:47
- Average daily usage (total hrs/total days): 7:47
- Used Days >= 4 hrs: 1 days
- Used Days < 4 hrs: 0 days
- Days not used: 0 days
- Total days: 1 days
- % Used Days >= 4 hrs: 100%

**Leak L/min**
- Median: 2.4
- 95th Percentile: 18.0
- Maximum: 81.6

**Pressure cmH2O**
- Median: 8.5
- 95th Percentile: 12.7
- Maximum: 15.0
### One Day Summary View (Problem)

<table>
<thead>
<tr>
<th>Viewing Range</th>
<th>1 Day</th>
<th>or</th>
<th>9/11/2013</th>
<th>to</th>
<th>9/11/2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>S9 AutoSet</td>
<td></td>
<td>Serial No.</td>
<td>23131285804</td>
<td></td>
</tr>
</tbody>
</table>

#### AHI & AI events/hour
- Apnea index: 13.4
- Obstructive: 3.1
- Central: 10.3
- Unknown: 0.0
- Hypopnea index: 0.4
- AHI: 13.8

#### Device Settings
- Therapy Mode: AutoSet
- Minimum Pressure: 5.0 cmH2O
- Maximum Pressure: 20.0 cmH2O
- EPR: Full_Time
- EFR Level: 3.0 cmH2O

#### Usage
- Total hours used: 8:02
- Median daily usage: 8:02
- Average daily usage: 8:02
- Used Days >= 4 hrs: 1 days
- Used Days < 4 hrs: 0 days
- Days not used: 0 days
- Total days: 1 days
- % Used Days >= 4 hrs: 100%

#### Leak L/min
- Median: 2.4
- 95th Percentile: 7.2
- Maximum: 27.6

#### Pressure cmH2O
- Median: 7.4
- 95th Percentile: 10.4
- Maximum: 12.6
# One Week Summary View (Good)

## Viewing Range
- **Product**: S9 AutoSet
- **Serial No.**: 23131285287

### AHI & AI events/hour
- **Apnea index**: 0.3
- **Obstructive**: 0.3
- **Central**: 0.0
- **Unknown**: 0.0
- **Hypopnea index**: 0.0
- **AHI**: 0.3

### Device Settings
- **Therapy Mode**: AutoSet
- **Minimum Pressure**: 5.0 cmH2O
- **Maximum Pressure**: 20.0 cmH2O
- **EPR**: Full_Time
- **EPR Level**: 3.0 cmH2O

### Usage
- **Total hours used**: 58:36
- **Median daily usage**: 7:47
- **Average daily usage**: 8:22
- **Used Days >= 4 hrs**: 7 days
- **Used Days < 4 hrs**: 0 days
- **Days not used**: 0 days
- **Total days**: 7 days
- **% Used Days >= 4 hrs**: 100%

### Leak L/min
- **Median**: 1.2
- **95th Percentile**: 18.0
- **Maximum**: 36.0

### Pressure cmH2O
- **Median**: 9.4
- **95th Percentile**: 13.8
- **Maximum**: 15.7
### One Week Summary View (Problem)

#### Viewing Range
- **Product**: S9 AutoSet
- **Serial No.**: 23131285804
- **Viewing Range**: 7 Days
- **Date Range**: 9/5/2013 to 9/11/2013

#### AH1 & AI
- **Apnea index**: 11.5
- **Obstructive**: 1.0
- **Central**: 10.3
- **Unknown**: 0.0
- **Hypopnea index**: 0.5
- **AHI**: 12.0

#### Device Settings
- **Therapy Mode**: AutoSet
- **Minimum Pressure**: 5.0 cmH2O
- **Maximum Pressure**: 20.0 cmH2O

#### Usage
- **Total hours used (hrs:min)**: 26:17
- **Median daily usage (hrs/day of used days)**: 8:17
- **Average daily usage (total hrs/total days)**: 3:45
- **Used Days >= 4 hrs**: 3 days
- **Used Days < 4 hrs**: 0 days
- **Days not used**: 4 days
- **Total days**: 7 days
- **% Used Days >= 4 hrs**: 42%

#### Leak
- **Median**: 6.0
- **95th Percentile**: 12.0
- **Maximum**: 27.6

#### Pressure
- **Median**: 7.0
- **95th Percentile**: 9.2
- **Maximum**: 11.2
APAP-OXY Detail View
SaO2 OK but SRBD Events are a problem
APAP-OXY Detail View
Leak causing SaO2 and SRBD event problem
APAP-OXY Detail View
No SRBD Events but SaO2 is a problem
## Oximetry Summary View

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Median</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum:</td>
<td>42</td>
<td>55</td>
<td>88</td>
</tr>
<tr>
<td>SpO2 was less than 90% for 00:03:27 hh:mm:ss</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpO2 was less than 87% for 00:01:34 hh:mm:ss</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpO2 was less than 80% for 00:00:03 hh:mm:ss</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum:</td>
<td>79</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>ODI for the session:</td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APAP Follow Up Step-4

- If $\text{max } P < 15$, suggest/offer nasal pillows (have patient put them on with pressure & adjust flow resistance)
- Check that machine is blowing the pressures you just set
- Physically inspect machine, reservoir, hose, mask, and filters
- If necessary... order mask, hose, filters
- Review what you’ve done, review instructions, explain that mask-hose-filters can be ordered by phone (when needed), and tell patient when next appointment should be.
- Finally, ask if there are any other questions.
Lessons Learned from Fast-Track Program

1. HST is an excellent case finding tool
2. HST allows us to use the laboratory more for performing full-night titrations
3. A well developed Sleep Specialty Clinic is essential for using HST/APAP effectively
4. A fully operational PSG laboratory is essential for a HST/APAP program to function properly
5. HST DID NOT decrease the demand for polysomnography. In fact referral rate went from 90 to 200 per month and wait-time started to increase.
Tele-Sleep Program: Networking the HST-APAPoxy Program
Steps Taken to Evolve Our Program

✓ Streamline HST diagnostic procedures
✓ Streamline auto-PAP titration procedures
✓ Test & integrate new auto-PAP devices for (a) reliability of handling central apnea episodes & (b) oximetry follow-up in cases now “ruled-out”
✓ Systematize & Formalize the “diagnostic-therapeutic” algorithm, train personnel, & perform field testing
✓ Evaluate the program for (a) frequently occurring problems, (b) cost effectiveness, (c) patient access to care
✓ Network the program on a larger scale using telemedicine equipment connected to community based outpatient clinics (CBOCs), monitor, & re-evaluate
Networking HST-APAPoxy Program

Clinic Identifies Patient

Nurse or PA sets patient up for HST

HST device reset/cleaned & sent back to clinic

Patient wears monitor & mails it to Central Lab

Central Lab reads HST & posts R&Rs

Telemedicine Conference/Contacts at Green Highlighted Process Points

Notation:
HST- Home Sleep Test
PA- Physician’s Assistant
R&R- Result & Recommendation
Fig. 3  Tele-sleep diagnostic/treatment schematic.
# Satisfaction Survey for Tele-sleep Program

1) VA Clinic Name:  
2) Gender:  
3) Age:  
4) Distance of your home from VA clinic:  

### How satisfied are you with:

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>No opinion</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am satisfied with receiving health care using Tele-health technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The information given to me during my visit, was clear and adequate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The staff treated me with kindness, courtesy and an opportunity to ask questions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The use of the equipment was demonstrated in a way that I could understand</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The location, parking, and access to the CBOC clinic was convenient</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The facility/conference room was comfortable for my visit</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The waiting time and length of appointment was acceptable.</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Would you recommend this type of Tele-health technology to others?  
[ ] Yes  [ ] No

How would you rate your overall care from the Tele-sleep program?  
[ ] Excellent  [ ] Very Good  [ ] Good  [ ] Fair  [ ] Poor
Summary, Conclusions & Lessons Learned

1- Perform HST only on patients with high SRBD pretest probability because HST can **rule-in** but **NOT rule-out** SRBD.

2- To be effective, HST & APAP **must** be part of a comprehensive sleep program because…
   a- Inconclusive tests must be followed up with attended PSG.
   b- Technically deficient tests must be followed up with PSG.
   c- Many patients need attended PAP titration with PSG.

3- **HST & APAP are tools; tools are only as good as those using them.**

4- HST, APAP, & APAP with oximetry can be used to build an efficient & effective Tele-sleep medicine program.
Participants should now be able to...

1. Describe the purpose, methods, advantages & limitations of home sleep testing (HST)
2. Describe the purpose, methods, advantages & limitations of using auto-adjusting positive airway pressure (APAP) therapy
3. Explain how HST & APAP fit into a telemedicine program for diagnosing and managing sleep-disordered breathing
References


