PAP Downloads: What can we learn from them?

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Disclosures

No significant disclosures.

Objectives

How to access PAP download data.

Learn about the science behind the data.

Interpretation and clinical significance of PAP download data.

Introduction

Positive Airway Pressure PAP Devices are primarily used to treat sleep disordered breathing including Obstructive Sleep Apnea (OSA).

We routinely monitor adherence to and efficacy of PAP devices subjectively.

Concomitant objective assessment is possible by accessing downloadable data from PAP devices.

Introduction

What are the settings?

Is the patient wearing their PAP device?

Does the PAP work?

Why is the patient not wearing PAP and/or why is PAP not working?

Introduction

Downloadable data from PAP devices has advantages when compared to in-lab PSG

- No overnight stay is required.
- Multiple night data can be accessed.
- Patient can access data and learn from trends.

Introduction

Downloadable data from PAP devices has disadvantages when compared to in-lab PSG

- Less accurate at detecting events.
- Complex sleep disorders can be difficult to diagnose.

Accessing Device Data

All modern PAP devices are able to be externally accessed, and the stored data can be downloaded or reviewed.

The clinician should be aware of what device is being used by the patient and how information can be accessed from it.

With increasing use of telemedicine outpatient care, remote access to data with use of modem devices or wireless transmission is increasingly important.

Accessing Device Data

Secure Digital Cards

- SD Cards
- Can be used to externally download data using a SD Card reader and software provided by device manufacturer
- Can be removed by patient or medical supply company

Accessing Device Data

Modem Device

- Modems can be externally attached to a device or internal to the device
- Remotely send data to an online database

Accessing Device Data

Wireless Transmission

- Wireless transmission technology is incorporated into some PAP machines.
- Data is uploaded to an online database as long as machine is connected to an electrical outlet.
- Machines using 3G network are no longer transmitting as all US carriers have shut down 3G networks in 2022.

Download Report

Basic report consists of:

- Machine Settings
- Usage data
- Effectiveness (rAHI)
- Leak
- Can be populated over varying date ranges

What are the settings?

CPAP download data provides information on what pressure settings are being used.

Fixed vs Auto PAP.

Download Report

Usage	06/23/2016 - 07/22/2016
Usage days	**30/30 days (100%)**
>= 4 hours	**26 days (87%)**
< 4 hours	**4 days (13%)**
Usage hours	153 hours 13 minutes
Average usage (total days)	5 hours 6 minutes
Average usage (days used)	5 hours 6 minutes
Median usage (days used)	5 hours 8 minutes

AirSense 10 CPAP	
Serial number	
Mode	CPAP
Set pressure	8 cmH2O
EPR	Fulltime
EPR level	2

Therapy		
Leaks - L/min	95th percentile:	**15.0**
Events per hour	AHI:	**5.5**

Selected date range for download

Percent adherence based on four hours or more of use per night

Hours used per night for the days used

Air leak expressed as 95th percentile

Calculated AHI based upon flow data (AHI_{flow})

Compliance

Payor	Standard

Usage

07/08/2023 - 08/06/2023

Usage days	**28/30 days (93%)**
>= 4 hours	**18 days (60%)**
< 4 hours	**10 days (33%)**
Usage hours	136 hours 27 minutes
Average usage (total days)	4 hours 33 minutes
Average usage (days used)	4 hours 52 minutes
Median usage (days used)	4 hours 50 minutes
Total used hours (value since last reset - 08/06/2023)	309 hours

AirSense 11 AutoSet

Serial number	[redacted]
Mode	AutoSet
Min Pressure	5 cmH2O
Max Pressure	20 cmH2O
EPR	Off
Response	Standard

Therapy

Pressure - cmH2O	Median:	**8.9**	95th percentile:	**13.1**	Maximum:	**14.8**
Leaks - L/min	Median:	**0.4**	95th percentile:	**26.2**	Maximum:	**105.1**
Events per hour	AI:	**1.8**	HI:	**0.6**	AHI:	**2.4**
Apnea Index	Central:	**0.3**	Obstructive:	**1.0**	Unknown:	**0.5**
RERA Index						**0.2**
Cheyne-Stokes respiration (average duration per night)						**0 minutes (0%)**

EPR

A common complaint in many patients with OSA using CPAP is the uncomfortable feeling of exhaling against positive pressure.

This consequence is one potential barrier to the long-term acceptance of CPAP therapy.

Several PAP manufacturers have developed EPR systems in an attempt to remedy this potential problem.

EPR device technologies allow pressure relief during exhalation with the goal of making CPAP therapy more comfortable.

EPR

EPR technology briefly reduce’s the CPAP pressure, between 1 and 3 cm H2O, during exhalation and then return the pressure to its set CPAP setting before the initiation of inspiration.

The amount of pressure relief varies on a breath-by-breath basis, depending on the actual patient's airflow, and is also dictated by the patient's preference setting on the device.

Are they wearing it?
ADHERENCE

CPAP download data provides information on duration and frequency of use

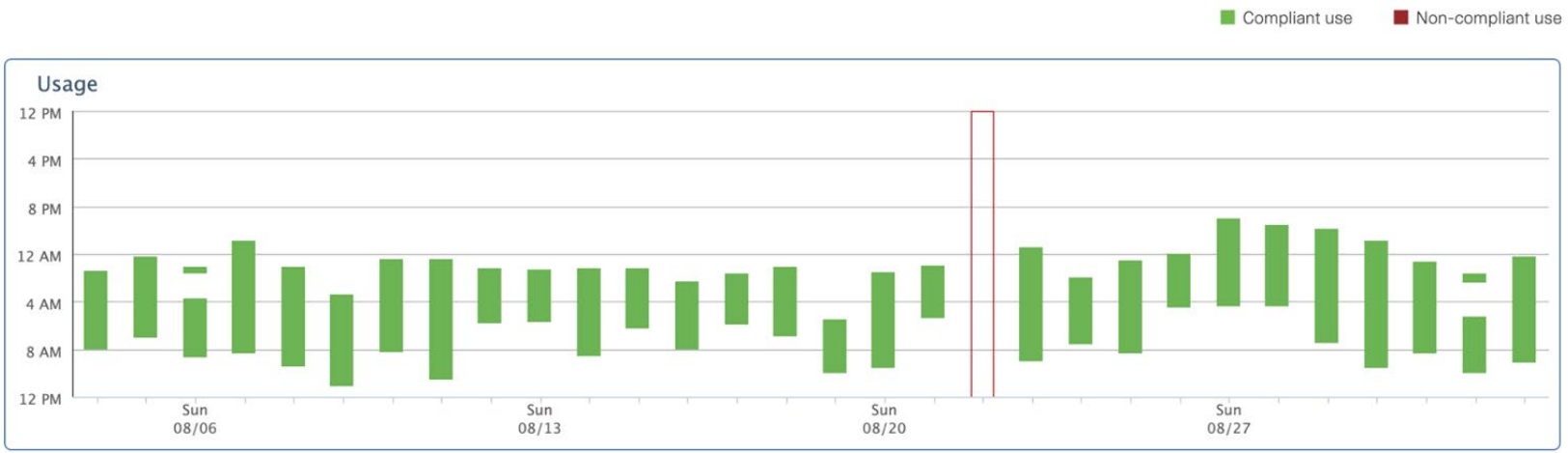
Usage >4 hours/night on > 70% of nights

Mask on vs Machine on time

If non- adherent- Investigate the reasons

Detailed Usage Report

Fixed time period | 30 | day period ending | 09/02/2023 | Update



Is it working?

Devices determine effectiveness by measuring average apnea hypopnea index.

AHI on a polysomnogram is A+H/TST.

A/H on PSG are determined based on oximetry data, arousals and airflow.

CPAP AHI data is only based on airflow and hence provide a surrogate for the AHI.

Is it working?

An AHI-flow of <10 events per hour is usually considered adequate therapy.

It should be noted that it is an estimate only.

Respiratory effort-related arousals (RERAs) are also reported.

Since there is no measure of sleep or arousal on a CPAP device, RERAs are estimated based on progressive flow limitation in an event that does not meet criteria for apnea or hypopnea.

Is it working?

Several studies have compared device-calculated AHI-flow with polysomnographic measurement of AHI (ie, the gold standard).

There have been somewhat variable results.

The results depend on the population studied and the definition of hypopnea.

Is it working?

A study in 2009 compared the AHI by APAP (RemStar AutoPAP, Philips-Respironics) versus manually scored PSG.

A device cutoff AHI of 8 events/hr predicted a PSG AHI > 10 events/hr with a sensitivity of 0.94 and a specificity of 0.90.

The PSG criteria for hypopnea in this study included a decrease in air flow with either a ≥ 4% decrease in the arterial oxygen saturation or an arousal.

Desai H, Patel A, Patel P, et al. Accuracy of auto-titration CPAP to estimate the residual Apnea-Hypopnea Index in patients with obstructive sleep apnea on treatment with auto-titrating CPAP. Sleep Breath. 2009;13:383–390.

Is it working?

Another study compared PSG and PAP device event detection (REMstar Auto M-Series, Philips-Respironics)

They required PSG hypopneas to have an associated 4% arterial oxygen desaturation and arousals were not considered(c/w CMS criteria).

The positive predictive value was 0.67 and negative predictive value was 0.92.

The high negative predictive value means that if the device AHI is < 10/hr, the PSG AHI is almost always less than 10/hr (good treatment). If the device AHI was > 10/hr, then the PSG AHI was > 10/hr about 70% of the time.

The reason for the false positives was that the device detected “hypopneas” based on air flow that were not associated with desaturation on the PSG (hypopnea not scored).

Berry RB, Kushida CA, Kryger MH, et al. Respiratory event detection by a positive airway pressure device. Sleep. 2012;35(2):261–267

Is it working?

In addition, it is important to note that definitions of apnea and hypopnea event detection are not uniform among manufacturers.

Each device manufacturer has a unique algorithm to determine AHI-flow.

For example, one commercial entity uses a 50 percent decrease from baseline ventilation as a hypopnea and a 75 percent decrease from baseline ventilation as an apnea.

Conversely, a different commercial entity uses a 40 to 80 percent reduction in flow to determine hypopneas and a greater than 80 percent reduction in flow to determine apneas .

Is it working?
Obstructive vs Central

Recent PAP devices have the ability to detect “clear airway apneas” and obstructive airway apneas.

“Clear airway” is used rather than central apnea because some central apneas may be associated with a closed upper airway.

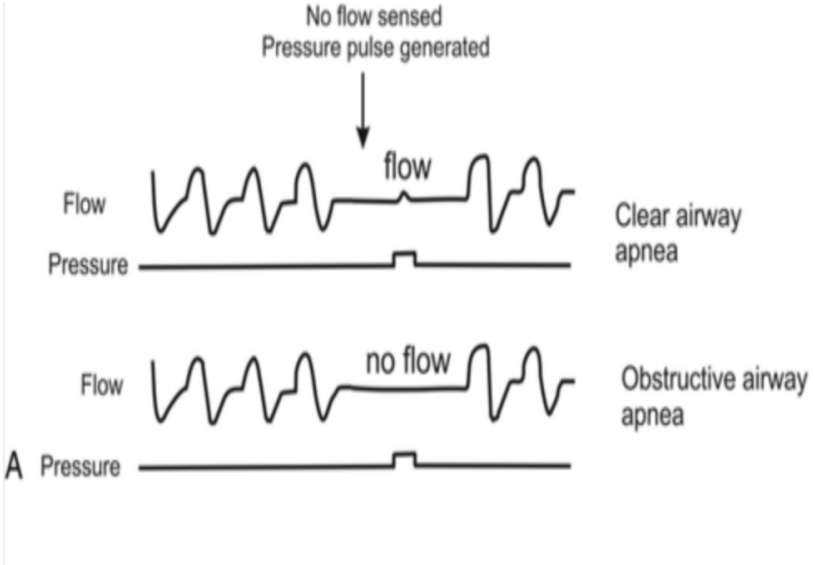
The devices cannot assess respiratory effort so that some “obstructive airway apneas” may actually be central in nature.

Obstructive vs Central

Philips-Respironics:Pressure Pulse Technology.

The pulse occurs after a period of no (or minimal) air flow; the exact duration is proprietary information but is usually on the order of 6 seconds.

If air flow resumes before 10 seconds, the event would not be classified as an apnea.

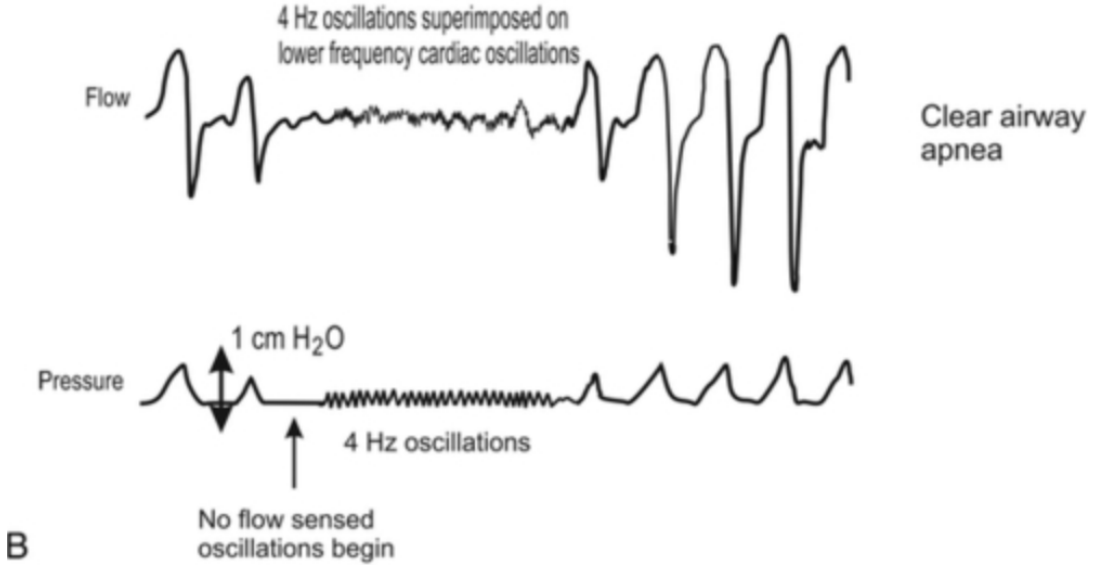


Obstructive vs Central

ResMed:

Forced oscillation technique—a low pressure oscillation with a frequency of 4Hz is superimposed on the current treatment pressure.

If oscillations are also detected in the flow signal, the airway is “clear” (open).



Obstructive vs Central?

One study done in China , 45 patients with OSA and complex sleep apnea

PAP device data identifying the type of respiratory event and whether the airway during a device-detected apnea was open or obstructed were compared to time-synced, manually scored respiratory events on simultaneous PSG recording.

The device detected that the airway was obstructed in 87.4% of manually scored obstructive apneas. Of the device-detected apneas with clear airway, a minority (15.8%) were manually scored as obstructive apneas.

Li QY, Berry RB, Goetting MG, et al. Detection of upper airway status and respiratory events by a current generation positive airway pressure device. Sleep 2015; 38:597.

Leak

Excessive airflow leak

- via the mask (eg, ineffective seal from an ill-fitting mask)
- Via the mouth (eg, mouth breathing with nasal mask in place)

Can alter the effectiveness of PAP therapy by failure to deliver the desired airway pressure.

Leak data definitions differ among device manufacturers.

Note- a certain amount of mask leak is intentional.

Leak

Devices also vary in how they report leak:

- Unintentional leak only (ie, that above the intentional amount)
- "Percent time in large leak." This is typically describing the percent of time the patient's leak is greater than two times the intentional leak

Leak

The threshold for determining excessive leak also varies among devices. Examples :

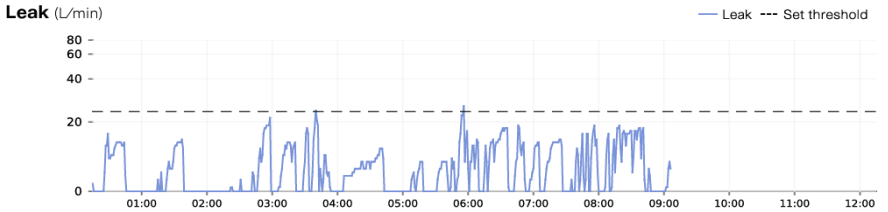
- A leak level that exceeds a preset "flow versus pressure" curve (the averaged leak through all mask exhalation ports at various pressure).
- A patient spends >1 hour during therapy with a large leak.
- The 95th percentile unintentional leak >24 L/minute (with correct mask interface programmed into device).

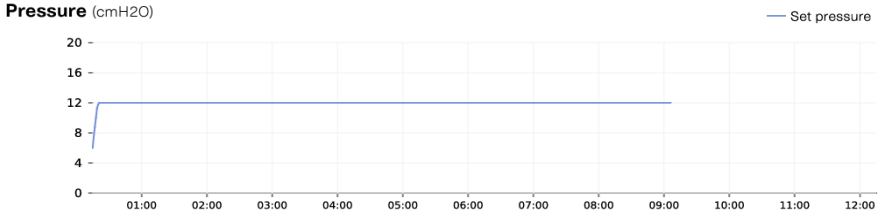
Fixing the Leak

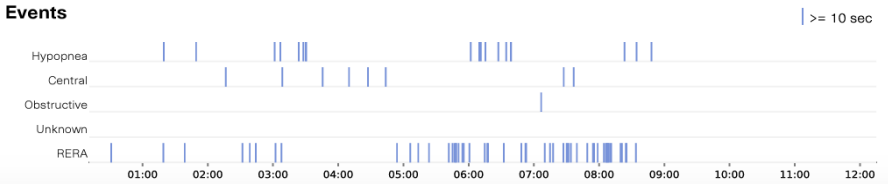
- Changing the mask type.
- Ensuring the mask size is correct.
- Refitting the mask.
- Use of a chin strap.

Detailed Report

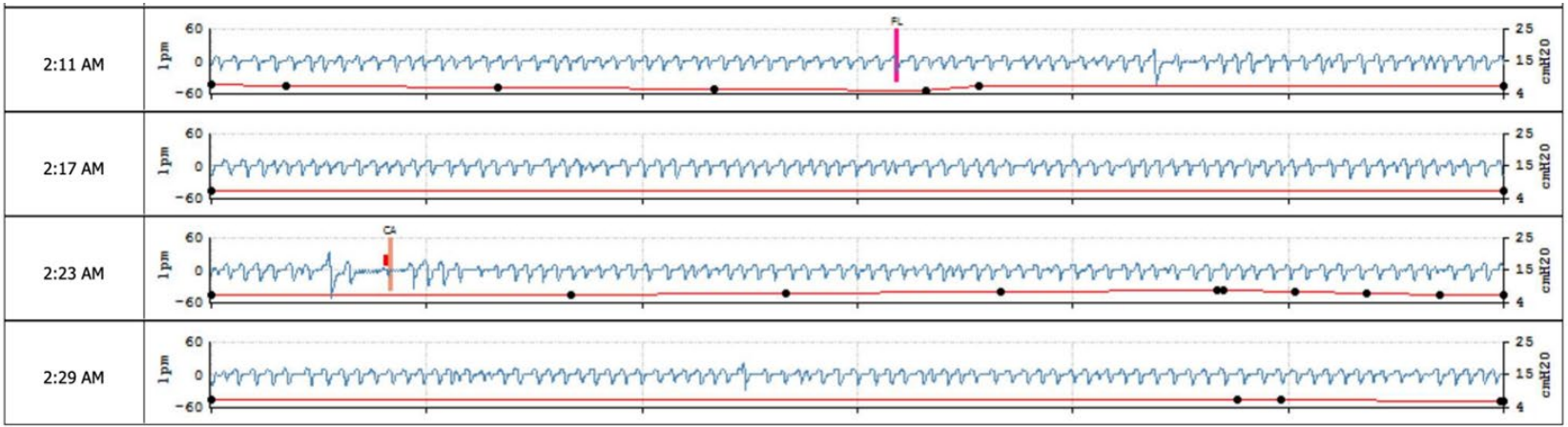
Mode / set pressure						**CPAP / 12.0 cmH2O**
EPR / level						**Off**
Statistics						
Usage						**8 hr 52 min**
Leak - L/min			Median:	**2.4**	95th %:	**16.8**
Events per hour	AHI:	**3.1**	AI:	**1.0**	HI:	**2.1**
	Central:	**0.9**	Obstructive:	**0.1**	Unknown:	**0.0**
					RERA	**6.0**
Cheyne-Stokes respiration (duration)						**0 min (0.0%)**







Flow
CPAP
IPAP
EPAP
PP - Pressure Pulse
CA - Clear Airway Apnea
OA - Obstructed Airway Apnea
H - Hypopnea
FL - Flow Limitation
RE - RERA
ES - Excessive Vibratory Snore
LL - Large Leak
PB - Periodic Breathing



The Path Forward

Standardization of respiratory event and leak definitions among manufacturers.

Determining ways to more easily integrate PAP adherence data into the various electronic medical record software programs.

Education of non–sleep specialists on interpretation of the available adherence information.

Thank You