

Summary of AASM Clinical Guidelines for the Manual Titration of Positive Airway Pressure in Patients with Obstructive Sleep Apnea

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SUMMARY: Sleep technologists are team members who work under the direction of a physician practicing sleep disorders medicine. Sleep technologists are trained in patient interaction, age related competencies, facilitating patient education and the diagnostic and therapeutic modalities used in sleep technology. One therapeutic process involves the use of a positive airway pressure (PAP) device to correct sleep related airway obstruction and/or increase airway patency thereby reducing or eliminating sleep related breathing disturbances. The PAP device must be worn by the patient during sleep. The PAP pressure must be adjusted by a sleep technologist, who observes the polysomnogram for respiratory and sleep disturbances and increases airway pressure until the disturbances are eliminated.

PAP devices are used to treat patients with sleep related breathing disorders (SRBDs), which include obstructive sleep apnea (OSA), hypopnea, respiratory effort related arousals (RERAs), and snoring. Continuous positive airway pressure (CPAP) allows the technologist to increase positive airway pressure throughout the polysomnographic recording to determine the single fixed pressure that will eliminate respiratory disturbances during subsequent nightly usage at home. A bilevel positive airway pressure (BPAP) device may be used when a patient demonstrates difficulty acclimating to high airway pressure during the expiration phase of breathing. BPAP allows the sleep technologist to separately increase inspiratory or expiratory pressures during the polysomnography to arrive at two pressures for subsequent use in the home. The servoventilation device (SV) uses a servocontroller (a computer-controlled valve) to adjust airway pressure breath by breath to maintain steady ventilation. This modality may be beneficial for patients with periodic breathing abnormalities such as Cheyne Stokes respiration and central apnea seen in heart failure or patients with complex sleep apnea.

The 2008 American Academy of Sleep Medicine (AASM) clinical guidelines indicate that manual titration of PAP pressures during attended polysomnography is the current standard for selection of the optimal patient therapeutic pressure. PAP devices must be administered and titrated by a well-trained sleep technologist, preferably a sleep technologist registered by the Board of Registered Polysomnographic Technologists (BRPT), the American Board of Sleep Medicine (ABSM) or the National Board of Respiratory Care (NBRC). All potential PAP titration candidates must have an initial physician evaluation, PAP education, a hands-on equipment demonstration, careful mask fitting and acclimation to the device prior to titration.

KEY DEFINITIONS:

Apnea-hypopnea index (AHI) refers to total apneas and hypopneas per hour of sleep.

Bilevel positive airway pressure (BPAP) is performed using a PAP device with two adjustments; one adjustment for inspiratory and one for expiratory pressure (IPAP and EPAP).

Continuous positive airway pressure (CPAP) is performed using a PAP device with one adjustment for both inspiratory and expiratory pressures.

Positive airway pressure (PAP) is a standard treatment for patients with obstructive sleep apnea. The PAP delivery system consists of a mechanical air pump that compresses room air to a prescribed level, tubing to deliver the air to the patient, and a flexible, size-adjusted mask that completes the circuit from the device to the patient.

Respiratory disturbance index (RDI) (defined for use with Type I studies) refers to the total apneas, hypopneas and RERAs per hour of sleep.

Respiratory effort related arousals (RERAS) may be estimated by flattening of the inspiratory airflow profile associated with an arousal, when airflow changes do not meet apnea or hypopnea criteria or by changes in the esophageal pressure recording.

Servoventilation (SV) is performed with a PAP device that uses a computer-controlled valve to deliver airflow and pressure to the patient on a breath-by-breath basis.

Sleep facility refers to any sleep center whether it is hospital based or independent

Sleep technologist refers to those who have passed the American Board of Sleep Medicine (ABSM) examination and are identified by the Registered Sleep Technologist (RST) credential or the Board of Registered Polysomnographic Technologists (BRPT) examination, and are identified by the Registered Polysomnographic Technologist (RPSGT) credential or National Board of Respiratory Care examination and are identified by the Sleep Disorders Specialist (SDS) credential.

Snoring may be estimated by a sawtooth pattern recorded from the microphones applied to the neck, unfiltered airflow or mask pressure tracings, or the detection of vibration using piezoelectric transducers.

Type 1 device/study is comprehensive attended polysomnography.

1.0 SCOPE

This guideline addresses PAP use and titration and is based on the 2008 AASM Clinical Guidelines. The scope of this guideline is restricted to adult (>12 years) and pediatric (<12 years) patients with obstructive sleep apnea; these recommendations do not apply to such conditions as neuromuscular disease or intrinsic lung disease. PAP titration should be performed in an AASM-accredited sleep facility by a registered sleep technologist and reviewed by a board-certified sleep specialist. This guideline does not cover PAP titration in the home, nor the use of servoventilation or autotitrating devices.

1.1 Indications for Positive Airway Pressure

PAP is indicated for patients who are diagnosed with mild, moderate or severe OSA.

Adult \geq 12 years	mild	moderate	Severe
RDI	5 to < 15	15 to 30	> 30
Children < 12 years	mild	moderate	Severe
RDI	1 to < 5	5 to <10	>10

1.2 Patient Referral

PAP titration is performed following the diagnosis of OSA made after an initial clinical evaluation and review of a polysomnogram (PSG) that uses a nasal air pressure transducer, a thermal sensor, and calibrated or un-calibrated respiratory inductance plethysmography (RIP) to detect apneas, hypopneas and respiratory effort related arousals (RERAs) occurring during sleep.

2.0 RECORDING TECHNIQUES

PAP (full-night or split-night) titration should be performed using Type 1 attended polysomnography in an AASM-accredited sleep facility using the sensors and data collection parameters reflected in the *AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications* standards. The results should be validated, interpreted and reported by a board-certified sleep physician.

2.1 Physiological and Recording Parameters

EEG electrodes should be placed at F3, C3, O1, M1, F4, C4, O2 and M2 according to the International 10-20 System for Electrode Placement. The recommended EEG derivation is F4-M1, C4-M1, and O2-M1 recorded at a minimum sampling rate of 200 Hz with impedances of 5 K Ω or less. The recommended sampling rate is 500 Hz. Filter settings for this parameter are LFF 0.3 Hz and HFF 35 Hz.

EOG electrodes should be placed at E1 and E2 according to *AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications* standards. The recommended EOG derivation is E1-M2, E2-M2 recorded at a minimum sampling rate of 200 Hz with impedances of 5 K Ω or less. The recommended sampling rate is 500 Hz. Filter settings for this parameter are LFF 0.3 Hz and HFF 35 Hz.

Chin EMG electrodes should be placed above and below the mandible on the mental and submental muscles of the chin as specified in the *AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications* standards. The derivation for recording chin EMG consists of a submental electrode referred to the electrode placed above the mandible on the mental muscle. The minimum sampling rate is 200 Hz. The recommended sampling rate is 500 Hz. Filter settings for this parameter are LFF 10 Hz and HFF 100 Hz.

The recommended airflow sensor for use during PAP titration is the airflow signal generated by the PAP device. Use of an oral-nasal thermal sensor under the PAP interface is not recommended. The recommended respiratory effort sensor is calibrated or un-calibrated respiratory inductance plethysmography (RIP). The minimum acceptable sampling rate for the collection of respiratory data is 25 Hz. The preferred sampling rate is 100 Hz, which improves the ability to assess artifact and visualize cardiogenic oscillations. Filter settings for the respiratory data parameters are LFF 0.1 Hz, HFF 15 Hz.

The recommended blood oxygen sensor is a pulse oximeter with an averaging time of < 3 seconds. Finger probe placement is recommended. The minimum recommended sampling rate is 10Hz. The preferred sampling rate is 25 Hz, which improves the ability to recognize artifact.

The minimum acceptable sampling rate for recording body position is 1 Hz.

A pulse rate is generally obtained from the pulse oximeter. The minimum acceptable sampling rate is 10 Hz. The preferred sampling rate is 25 Hz, which improves the ability to recognize artifact. When it is used in conjunction with the oximetry signal, the pulse rate signal may assist with oximeter artifact detection.

Modified Lead II is the recommended placement for recording the electrocardiogram (ECG). The minimum acceptable sampling rate is 200 Hz. The recommended sampling rate of 500 Hz improves waveform definition. Filter settings for ECG are LFF 0.3 (which minimizes waveform distortion), HFF 70 Hz.

The minimum acceptable sampling rate for the collection of snoring sound or vibration data is 200 Hz. The preferred sampling rate is 500 Hz, which improves waveform definition. Filter settings are LFF 10 Hz, HFF100 Hz.

2.2 Description and Methodology for Manual PAP Titration

The following titration protocols should be used as a guideline in conjunction with sleep center protocols to attain an appropriate titration for each individual patient. Significant variation from the protocol should be documented with appropriate rationale.

2.2.1 CPAP Titration

Patients < 12 years old	Patients ≥ 12 years old
CPAP minimum = 4 cm H ₂ O	CPAP minimum = 4 cm H ₂ O
CPAP maximum = 15 cm H ₂ O	CPAP maximum = 20 cm H ₂ O

Increase pressure by a minimum of 1 cm H₂O with an interval of no less than 5 minutes when you see the following:

Patients < 12 years old	Patients ≥ 12 years old
1 obstructive apnea	2 obstructive apneas
1 hypopnea	3 hypopneas
3 RERAs	5 RERAs
1 min. of loud or unambiguous snoring	3 min. of loud or unambiguous snoring

You have achieved an optimal titration when you see the following:

1. The Respiratory Disturbance Index (RDI) is < 5 per hour for a period of at least 15 minutes at the selected pressure and within the manufacturer's acceptable leak limit.
2. The SpO₂ is above 90% at the selected pressure.
3. Supine REM sleep at the selected pressure is not continually interrupted by spontaneous arousals or awakenings.

You have achieved a good titration when you see the following:

1. The Respiratory Disturbance Index (RDI) is < 10 per hour (or is reduced by 50% if the baseline RDI was < 15) for a period of at least 15 minutes at the selected pressure and within the manufacturer's acceptable leak limit.
2. The SpO₂ is above 90% at the selected pressure.
3. Supine REM sleep at the selected pressure is not continually interrupted by spontaneous arousals or awakenings.

You have achieved an adequate titration when you see the following:

1. The Respiratory Disturbance Index (RDI) is NOT < 10 per hour, but the RDI is reduced by 75% from baseline.
2. Criteria for optimal or good titration is met but you did NOT get a sample of supine REM at the selected pressure.

An unacceptable titration does not meet any of the above grades. Repeat titration should be considered.

2.2.2 Bilevel Positive Airway Pressure

Titration guidelines for when and how to switch to BPAP:

1. When the patient complains that he/she is uncomfortable or is intolerant of high CPAP pressures. (Document this on the record.)
2. When CPAP level is 15 cm H₂O and respiratory disturbances continue. (Document this on the record.)

Begin BPAP at EPAP 4 cm H₂O or the CPAP level at which obstructive apnea was eliminated; set IPAP 4 cm H₂O higher.

Patients < 12 years old	Patients ≥ 12 years old
Minimum IPAP = 8, EPAP = 4 cm H ₂ O	Minimum IPAP = 8, EPAP = 4 cm H ₂ O
Maximum IPAP = 20 cm H ₂ O	Maximum IPAP = 30 cm H ₂ O
Minimum I/E difference = 4 cm H ₂ O	Minimum I/E difference = 4 cm H ₂ O
Maximum I/E difference = 10 cm H ₂ O	Maximum I/E difference = 10 cm H ₂ O

Increase both IPAP and EPAP pressures by a minimum of 1 cm H₂O with an interval of no less than 5 minutes when you see the following:

Patients < 12 years old	Patients ≥ 12 years old
1 obstructive apnea	2 obstructive apneas

Increase IPAP pressure by a minimum of 1 cm H₂O with an interval of no less than 5 minutes when you see the following:

Patients < 12 years old	Patients ≥ 12 years old
1 hypopnea	3 hypopneas
3 RERAs	5 RERAs
1 min. of loud or unambiguous snoring	3 min. of loud or unambiguous snoring

You have achieved an optimal titration when you see the following:

1. The Respiratory Disturbance Index (RDI) is < 5 per hour for a period of at least 15 minutes at the selected pressure and within the manufacturer's acceptable leak limit.
2. The SpO₂ is above 90% at the selected pressure.

3. Supine REM sleep at the selected pressure is not continually interrupted by spontaneous arousals or awakenings.

You have achieved a good titration when you see the following:

1. The Respiratory Disturbance Index (RDI) is < 10 per hour (or is reduced by 50% if the baseline RDI was < 15) for a period of at least 15 minutes at the selected pressure and within the manufacturer's acceptable leak limit.
2. The SpO₂ is above 90% at the selected pressure.
3. Supine REM sleep at the selected pressure is not continually interrupted by spontaneous arousals or awakenings.

You have achieved an adequate titration when you see the following:

1. The Respiratory Disturbance Index (RDI) is NOT < 10 per hour, but the RDI is reduced by 75% from baseline.
2. Criteria for optimal or good titration is met but you did NOT get a sample of supine REM at the selected pressure.

An unacceptable titration does not meet any of the above grades. Repeat titration should be considered.

2.2.3 Determining the Optimum Pressure

The patient must be able to sleep in order for PAP titration to be successful. The AASM PAP Titration Task Force recommends that if the patient awakens and complains the pressure is too high, the pressure should be reduced to a level at which the patient is able to return to sleep. Mask and mouth leaks should be promptly addressed. Pressure relief technologies may be implemented to improve patient comfort. BPAP may be utilized for patients who are intolerant of high CPAP pressures.

Techniques such as "exploration" and "down" titration can be utilized to assist in the determination of the optimum pressure settings during CPAP and BPAP titration. PAP or IPAP pressure may be increased by 2 to 5 cm H₂O above the setting where respiratory events are controlled in order to eliminate upper airway resistance and repetitive arousals. Down titration may be utilized following a minimum of 30 minutes of recording where obstructive events have been eliminated. Reduce PAP or IPAP pressure by a minimum of 1 cm H₂O with an interval of no less than 10 minutes until obstructive events reappear, then increase pressure by a minimum of 1 cm H₂O with an interval of no less than 5 minutes until obstructive events are eliminated.

2.2.4 Supplemental Oxygen

Supplemental oxygen should be administered based on sleep center protocols to attain an appropriate titration for each individual patient. Significant variation from the protocol should be documented with appropriate rationale. AASM Clinical Guidelines recommend the use of supplemental O₂ during PAP titration when awake supine SpO₂ on room air is less than 88% for

5 minutes or longer. Supplemental oxygen should be introduced into the PAP device at the device tubing connection using a T connector, not at the PAP mask. The recommended minimum starting rate for adult and pediatric patients is 1 L/min. Titrate O₂ in 1 L/min increments with an interval of no less than 15 minutes until SpO₂ is between 88% and 94%. Supplemental O₂ levels can sometimes be reduced in patients on BPAP when IPAP level is increased.

2.2.5 Split-Night Studies

Split-night studies must be performed using algorithms identical to those used for full-night PAP titration and should include greater than 3 hours of titration time. Split-night studies should not be performed in children less than 12 years old. Due to the reduced titration time available during split-night studies, increase PAP pressures by a minimum of 2 cm H₂O with an interval of no less than 5 minutes.

2.2.6 Repeat Titration Studies

A repeat PAP titration is indicated when the initial titration does not meet criteria for an optimal or good titration (as defined above), or when a split-night study does not meet standard criteria of greater than 3 hours of titration time.

3.0 DOCUMENTATION

As per the PSG protocol, the sleep technologist is responsible for ensuring that all required documentation (history, physical exam, previous test results, referral and insurance information, questionnaires, etc.) is available prior to the PAP titration.

3.1 Technical Documentation

Technical documentation includes the PSG-generated recording with PAP pressures either recorded manually on the record or automatically recorded by a signal from the PAP device. Technical documentation includes a technologist generated log of all events, observations and interventions that occurred during the PSG/PAP titration.

The sleep technologist records the following information:

- a. Beginning and ending pressures
- b. Pressure or delivery mode changes and rationale
- c. Body position
- d. Sleep stage
- e. Patient behavior (restless, complaints)
- f. Snoring
- g. SpO₂
- h. The reason for changing from one mask or device to another.

3.1.1 Recording Summary

The scoring technologist stages and event scores the PSG/PAP titration recording and generates a preliminary findings report for the board-certified sleep physician to review.

4.0 RESULTS REPORTING

The sleep physician is responsible for reviewing the raw scored data from the PSG/PAP titration and the preliminary report. The sleep physician generates the final report with recommendations for PAP pressures during home use.

5.0 STANDARDS OF PRACTICE

5.1 Qualifications of Sleep Technologists

Sleep technologists performing PAP titration studies should demonstrate knowledge of the application and limitations of PAP devices, mask interfaces, and the PSG recording instruments. The sleep technologist educates and instructs patients and caregivers in the use of PAP equipment. The sleep technologist must be able to accurately assess and summarize both PAP and PSG recordings to arrive at the optimal therapeutic PAP pressure settings for the patient.

5.2 Sleep Facility Organization and Record Keeping

Sleep technologists performing PSG/PAP titration studies should follow the sleep facility departmental policy and procedure manual guidelines. Patient charts, in either print or electronic format, should be organized and available for use in the sleep facility. HIPAA guidelines should be followed to meet documentation and confidentiality requirements. Equipment and sensor use and maintenance should meet manufacturer standards. Records and recordings should be secure and retrievable and stored in accordance with state guidelines for the length of time designated by the statutes (generally a seven-year minimum).

5.3 Equipment Safety

All electronic equipment used for diagnostic and therapeutic sleep testing must be inspected and maintained by a trained biomedical technician and those actions must be documented.

5.4 Infection Control

Sleep technologists must use universal precautions to prevent the spread of infectious disease. Frequent hand washing is essential for protection of both patient and technologist, and should be performed before and after all patient contact and after glove removal. The technologist will also wear gloves when handling contaminated equipment.

5.4.1 Equipment Decontamination

All equipment and sensors, masks and belts coming into contact with the patient will be handled as contaminated per sleep facility policy and procedure. Clean and dirty equipment must be kept in distinct areas designated as clean or dirty. All dirty equipment must be cleaned and disinfected after each use according to manufacturer guidelines. Single use items are to be discarded after each use.

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