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 allied health professionals who work as part of a team under the general supervision of a licensed physician**.** Credentialed by the Board of Registered Polysomnographic Technologists (BRPT), American Board of Sleep Medicine (ABSM), or the National Board for Respiratory Care (NBRC), sleep technologists assist sleep specialists in the clinical assessment, physiological monitoring and testing, diagnosis, management, and prevention of sleep related disorders with the use of various diagnostic and therapeutic tools, providing care to patients of all ages. These tools include, but are not limited to polysomnograms, positive airway pressure devices and accessory equipment, and home sleep apnea testing (HSAT) devices. 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), with the goal of eliminating obstructive apneas, hypopneas, respiratory effort related arousals (RERAs), and snoring. A continuous positive airway pressure (CPAP) titration allows the technologist to increase positive airway pressure throughout the polysomnographic recording to determine the single fixed pressure that will eliminate respiratory disturbances. 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 or requires ventilatory support. BPAP allows the sleep technologist to separately adjust inspiratory and/or expiratory pressures during the polysomnogram to maintain the patency of the airway and provide ventilatory support. A servoventilation device (SV) uses a servocontroller (a computer-controlled valve) to adjust airway pressure on a breath-by-breath basis to maintain ventilation. This modality may be beneficial for patients with periodic breathing abnormalities such as Cheyne Stokes respiration and central apnea seen in heart failure patients or those 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 for patients with obstructive sleep apnea. PAP therapy 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. This guideline will provide recommendations for the manual titration of PAP in patients with obstructive sleep apnea.

KEY DEFINITIONS

Apnea is the cessation of airflow (≥90% reduction from pre-event baseline airflow) for a duration defined by the current AASM Scoring Manual for adults and pediatric patients.

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.

Hypopnea is a reduction in airflow with a minimum amplitude and duration specified in the scoring criterion of the current AASM Scoring Manual for adults and pediatric patients.

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) refers to the number of apneas, hypopneas and RERAS per hour of sleep.

Respiratory event index (REI) defined for use with home sleep apnea testing (HSAT) refers to the total number of events scored per hour of monitoring time.

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 Board of Registered Polysomnographic Technologists (BRPT) examination and are identified by the Registered Polysomnographic Technologist

(RPSGT) credential, the American Board of Sleep Medicine (ABSM) examination and are identified by the Registered Sleep Technologist (RST) credential or the 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 a microphone applied to the neck, unfiltered airflow or mask pressure tracings, or the detection of vibration using a piezoelectric transducer.

Type I device/study is a comprehensive attended polysomnography.

Type II device/study is a comprehensive unattended polysomnography.

Type III device/study is an unattended home sleep apnea test (HSAT) that does not record the signals needed to determine sleep stages or sleep disruption.

1.0 SCOPE

This guideline addresses PAP use and titration and is based on the 2008 Clinical Guidelines for PAP titration (1) and the 3rd edition *International Classification of Sleep Disorders*, diagnostic criteria (2). 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 a sleep-specific accredited facility that meets minimum accreditation standards by a credentialed 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.

The use of pediatric or adult titration procedures should be determined on an individual basis. Factors, such as the onset of puberty, should be considered. Assigning arbitrary age limits to determine pediatric vs. adult care should be discouraged (3).

1.1 Indications for Positive Airway Pressure

Obstructive Sleep Apnea (OSA) Syndrome is diagnosed based on AASM *International Classification of Sleep Disorders*, third edition (ICSD-3) criteria.

Adult OSA is diagnosed in patients with one or more of the following:

- Complaints of sleepiness, non-restorative sleep, fatigue, or insomnia symptoms
- Waking with breath holding, gasping, or choking
- A bed partner or others report habitual snoring, breathing interruptions or both during the patient's sleep
- The patient has a diagnosis of hypertension, a mood disorder, cognitive dysfunction, coronary artery disease, stroke, congestive heart failure, atrial fibrillation, or type 2 diabetes.

AND

- PSG or HSAT demonstrates ≥ 5 obstructive respiratory events per hour of sleep

OR

PSG or HSAT demonstrates ≥ 15 predominantly obstructive respiratory events per hour of sleep

	Mild	Moderate	Severe
Adult ≥ 12 years	RDI 5 to < 15	RDI 15 to 30	RDI > 30
Children < 12 years	RDI 1 to < 5	RDI 5 to < 10	RDI > 10

1.2 Patient Referral

A PAP titration is performed following a clinical evaluation and review of a PSG or HSAT (adult) that meets diagnostic criteria for OSA per ICSD-3 criteria and AASM titration guidelines.

2.0 RECORDING TECHNIQUES

PAP (full-night or split-night) titration should be performed using Type 1 attended polysomnography in a sleep-specific accredited 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 (4). 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 (5). 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 KΩ or less. The alternate/backup electrode EEG derivation is F3-M2, C3-M2, and O1-M2 also recorded at a minimum sampling rate of 200 Hz with impedances of 5 KΩ or less. The recommended sampling rate is 500 Hz. Filter settings for this parameter are Low Frequency Filter (LFF) 0.3 Hz and High Frequency Filter (HFF) 35 Hz.

EOG electrodes should be placed at E1 and E2 according to *The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications* standards (4). The recommended EOG derivation is E1-M2, E2-M2 recorded at a minimum sampling rate of 200 Hz with impedances of 5 KΩ 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 (4). 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 uncalibrated respiratory inductance plethysmography (RIP). The minimum acceptable sampling rate for the collection of respiratory data, including end-tidal CO2, 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 and HFF 15 Hz.

The recommended blood oxygen sensor is a pulse oximeter with a maximum acceptable signal averaging time of ≤ 3 seconds at a heart rate of 80 beats per minute. Finger probe placement is recommended. For detection of hypoventilation, use transcutaneous PCO2 or end tidal PCO2. The minimum recommended sampling rate is 10Hz. The preferred sampling rate is 25 Hz, which improves the ability to recognize artifacts.

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

A pulse rate is generally obtained from the pulse oximeter. It may also be obtained from the electrocardiogram (ECG) on certain systems. The minimum acceptable sampling rate is 10 Hz. The preferred sampling rate is 25 Hz, which improves the ability to recognize artifacts. 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 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) and HFF 70 Hz.

The minimum acceptable sampling rate for the collection of snoring sound or vibration data is 200 Hz, using a snore microphone or snore sensor. The preferred sampling rate is 500 Hz, which improves waveform definition. Filter settings are LFF 10 Hz and HFF 100 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

	Minimum CPAP	Maximum CPAP
≥ 12 years old	**4** cm H_2O	**20** cm H_2O
< 12 years old	**4** cm H_2O	**15** cm H_2O

Increase pressure by a minimum of 1 cm H_2O with an interval of no less than 5 minutes when any one of the following is observed:

≥ 12 years old	**2** obstructive apneas	**3** hypopneas	**5** RERAs	**3** minutes of loud or unambiguous snoring
< 12 years old	**1** obstructive apnea	**1** hypopnea	**3** RERAs	**1** minute of loud or unambiguous snoring

An optimal titration is achieved when all of the following are observed:

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.

A good titration is achieved when all of the following are observed:

1. The Respiratory Disturbance Index (RDI) is ≤ 10 per hour (or is reduced by 50% if the baseline RDI is < 15 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.

An adequate titration is achieved when all of the following are observed:

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 inadequate titration does not meet any of the above grades. A repeat titration should be considered.

2.2.2 Bilevel Positive Airway Pressure

Titration guidelines for when and how to switch to Bilevel (BPAP) Therapy:

1. Consider bilevel therapy when the patient complains that he/she is uncomfortable or is intolerant of high CPAP pressures. (Document this on the record.)
2. Consider bilevel therapy when CPAP level is 15 cm H_2O or greater and respiratory disturbances continue. (Document this on the record.)

Begin BPAP at EPAP 4 cm H_2O or the CPAP level at which obstructive apnea was eliminated; set IPAP 4 cm H_2O higher.

	Minimum IPAP	Minimum EPAP	Maximum IPAP	Minimum I/E Difference	Maximum I/E Difference
≥ 12 years old	**8** cm H_2O	**4** cm H_2O	**30** cm H_2O	**4** cm H_2O	**10** cm H_2O
< 12 years old	**8** cm H_2O	**4** cm H_2O	**20** cm H_2O	**4** cm H_2O	**10** cm H_2O

Increase both IPAP and EPAP pressures by a minimum of 1 cm H_2O with an interval of no less than 5 minutes when you see any of the following:

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

Increase IPAP pressure by a minimum of 1 cm H_2O with an interval of no less than 5 minutes when you see any of the following:

≥ 12 years old	**3** hypopneas	**5** RERAs	**3** minutes of loud or unambiguous snoring
< 12 years old	**1** hypopnea	**3** RERAs	**1** minute of loud or unambiguous snoring

An optimal titration is achieved when all of the following is observed:

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.

A good titration is achieved when all of the following is observed:

1. The Respiratory Disturbance Index (RDI) is $\leq$ 10 per hour (or is reduced by 50% if the baseline RDI was <15 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.

An adequate titration is achieved when all of the following is observed:

1. The Respiratory Disturbance Index (RDI) is NOT $\leq$ 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 inadequate titration does not meet any of the above grades. A 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 (1) 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. Advanced pressure relief technologies may be implemented to improve patient comfort, including various pressure relief settings. Bilevel PAP therapy may be utilized for patients who are intolerant of high CPAP pressures. Determining optimal pressure is made difficult when pressure leaks exist. Therefore, mask and mouth leaks should be promptly addressed.

AASM PAP Titration guidelines recommend increasing pressure in response to obstructive respiratory events as indicated previously. Techniques such as "exploration" titration can be utilized to assist in the determination of the optimum pressure settings during CPAP and BPAP titration. EPAP or IPAP pressure may be increased exploratively by 2 to 5 cm H_2O above the setting where respiratory events are controlled in order to eliminate upper airway resistance and repetitive arousals.

Down titration may be utilized to confirm therapeutic pressure. If utilized, down titration should follow a minimum of 30 minutes of sleep time where obstructive events have been eliminated. Reduce EPAP or IPAP pressure by a minimum of 1 cm H_2O, with an interval of no less than 10 minutes, until obstructive events reappear, then increase pressure by a minimum of 1 cm H_2O, with an interval of no less than 5 minutes, until obstructive events are eliminated.

In most patients, obstructive respiratory events are most likely to occur in supine REM. In addition, treatment-emergent central sleep apnea is more likely to occur in NREM. Therefore, optimal therapeutic pressure should ideally be confirmed **both** in NREM sleep as well as in supine REM for at least 15 minutes.

2.2.4 Supplemental Oxygen

Supplemental oxygen should be administered based on physician order or established 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 (1) 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 (time does not have to be consecutive) after the respiratory events have been resolved. Supplemental oxygen should be introduced into the PAP device at the device tubing connection using a T connector, not at the PAP mask directly. 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. Maximum oxygen administration levels should be determined by your facility medical director and policy and procedure manual.

2.2.5 Split-Night Studies

The treatment of OSA with PAP therapy should be based on diagnostic criteria established during objective sleep testing. A split night study (SNS) includes an initial diagnostic testing portion followed by a period of initiation and titration with PAP therapy. During a SNS, PAP therapy should be initiated if a moderate to severe degree of obstructive sleep apnea (AHI $\geq$ 15) is observed over a minimum of two (2) hours of sleep time within the diagnostic period (6). Lower AHIs may be considered diagnostic if clinically appropriate as deemed by the medical director. In addition, it is recommended that at least three (3) hours remain available for the titration procedure. If the diagnostic portion of a SNS is inconclusive, a full PSG is recommended. If the titration portion of the SNS is inconclusive, a full titration study is recommended. Patients undergoing SNS should receive similar instruction and preparations as those undergoing a full PAP titration, including PAP education, mask fitting, and pressure acclimatization. Split-night studies must be performed using titration algorithms identical to those used for full-night PAP titration, and optimal titration definitions are similarly applicable. 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, facilities may adopt modified titration protocols that remain compliant with recommendations.

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. Patients who have experienced new symptoms such as the resurgence of severe snoring or dramatic changes in weight may be candidates for repeat titrations, however repeat testing should only be ordered as medically necessary by a board-certified sleep specialist.

3.0 DOCUMENTATION

As per the PSG protocol, the sleep technologist is responsible for ensuring that all required documentation such as history, physical exam, previous PSG test results, referral/order, insurance information, pre sleep questionnaires, prescription, medication list, etc. is available prior to the PAP or SNS 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. At a minimum, technical information should include pressures throughout the study, mode of therapy (CPAP, BPAP, etc.) reasons for pressure changes, leak, tidal volume, etc. Documentation frequency is determined by sleep lab protocol.

The sleep technologist records the following information during titration for physician review:

a. Beginning and ending pressures
b. Pressure or delivery mode changes and rationale (apneas, hypopneas, APAP, BPAP, etc.)
c. Body position throughout the night
d. Sleep stages
e. Patient behavior (restless, complaints)
f. Snoring
g. SpO2
h. The reason for changing from one mask or device mode to another
i. Leak
j. Tidal volume
k. Respiratory rate
l. Heart rate

3.1.1 Recording Summary

The scoring technologist is responsible for reviewing and analyzing the raw data of the PAP titration record, and generating a preliminary findings report for the board-certified sleep physician to review. The report is a synopsis of the record for the interpreting board certified physician prior to her/his own review and should include key points of the titration. Using the current AASM Scoring Guidelines, the scoring technologist stages the epochs, scores arousals, respiratory events, and limb movements and documents potential cardiac arrhythmias. In addition, the video should also be reviewed in order to verify the positional changes or major body movements made by the patient throughout the titration.

Following the record being scored, the record summary should include the following parameter categories as detailed in the AASM Scoring Manual (4) for the interpreting physician to review:

a. General Parameters of Monitoring the PAP titration
b. Sleep Scoring Data
c. Arousal Events
d. Cardiac Events
e. Movement Events
f. Respiratory Events
g. Summary Statements
h. Titration Summary

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 PSG recording instruments. The sleep technologist educates and instructs patients and caregivers in the use of PAP equipment and addresses potential challenges that may hinder PAP compliance. 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 (7).

5.2 Sleep Facility Organization and Record Keeping

For organization and record keeping purposes, sleep facilities must have departmental policies and procedures for Sleep Technologists performing PSG/PAP titration to follow. Policies must incorporate HIPAA guidelines for maintaining confidentiality and documentation requirements. In addition, records and recordings must be securely stored in accordance with state guidelines and kept available for the length of time designated by the statutes (generally a seven-year minimum). Patient charts, whether in print or electronic format, should be organized and available for use when needed in the sleep facility. Equipment and sensor use, cleaning and maintenance must be documented and meet manufacturer standards.

5.3 Equipment Safety

All electronic equipment used for diagnostic and therapeutic sleep testing must be inspected and maintained, and these actions must be documented annually, at minimum, by a trained biomedical technician.

5.3 Infection Control

An infection control program is extremely important for maintenance of patient safety and to provide quality care. 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. Additional protective equipment should be utilized as necessary with regard to both individual patient circumstance and broader public health requirements. Refer to the CDC's Guide to Infection Prevention for Outpatient Settings: Minimum Expectations for Safe Care for general recommendations (8), and the AAST's COVID-19 Sleep Lab Guideline for specific infection control guidance during the public health emergency (9).

It is essential to follow the manufacturer's recommendations for cleaning and disinfecting equipment, as well as comply with facility policies and procedures. 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. This is particularly relevant for all reusable PAP therapy equipment, including masks or interfaces, tubing, humidifiers, and headgear, as well as all testing sensors. Single use supplies are highly recommended and must be discarded after use.

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