

PEDIATRIC PAP TITRATION PROTOCOL

PURPOSE

In order to provide the highest quality care for our patients, our sleep disorders facility adheres to the *AASM Standards of Accreditation*. The accompanying policy and procedure on pediatric titrations follows the spirit of the *Clinical Guidelines for the Manual Titration of Positive Airway Pressure in Patients with Obstructive Sleep Apnea*. We recognize that the guidelines from this 2008 consensus paper are non-binding, and that there may be some minor deviations found in our policy.

POLICY

All individuals who record sleep studies must follow best practices for pediatric titrations in order to attain the ideal pressure setting for their patients. Too low of pressures may cause patients to either be sub-optimally treated or to wake up in a panic. Too much pressure may cause the patient to experience bloating or mask leakage. Determining the appropriate pressure setting for each patient will lead to improved adherence and outcome. Pediatric titrations are not an exact science, and it is understood that technologists may need to make minor changes for individual patients. The procedure below is meant as a guideline. PAP may be started in the sleep lab as a planned PAP titration study or emergently due to a severely abnormal sleep study if directed by the on call sleep specialist. The following protocol applies to those patients in whom PAP will be used in the sleep lab.

PROCEDURE

- 1.0 Review the patient's clinical notes for pertinent history.
- 2.0 Review the patient's previous sleep study or studies to assess the severity of sleep-disordered breathing, the type of respiratory events, and the position and stage at which the events were most severe. This will help to attain a better titration.
Example: If the patient's sleep-disordered breathing was worse in the supine position, make sure the patient stays in the supine position as much as possible; or, if it was worse during REM sleep, minimize sleep disruption so that the patient can achieve and maintain REM sleep.
- 3.0 Application of electrodes, montages, filters, sensitivities, and scoring will be performed according to *The AASM Scoring Manual*.
- 4.0 Each patient and parent should be shown the PAP device and nasal interface prior to starting PAP titration. Patient/parent questions about the device should be elicited and answered. The need for this treatment will likely already have been discussed with the patient, but additional explanation and encouragement may be needed on the night of the study.
- 5.0 The sleep laboratory VPAPtx unit will be used for all titration studies unless specified for particular patients by the ordering physician. These studies will be conducted in the CPAP mode, unless otherwise specified.
- 6.0 The patient should be fitted with an appropriate mask. This means ensuring that the mask does not extend down onto the lip (for nasal masks) and is not so wide as to leak around the bridge of the nose or put pressure on the inner canthus of the eye. The mask should be put in place firmly enough that it does not leak but not so firmly as to be uncomfortable. Nasal masks are preferred.

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- 7.0** Full face mask can be substituted for severe air leak at the mouth that interferes with therapy, patient comfort, or high pressures
- 8.0** Prior to “lights-out”, the parent and patient should be given a demonstration of the device to familiarize them with it. With the mask in place and the PAP set at 4 cmH₂O on the remote control software, turn on the blower unit. The patient should be informed that this is the starting pressure for the night and instructed to keep their mouth closed when using CPAP. It may take a few minutes to adapt to this, and encouragement may be needed at this time.
- 9.0** Begin the patient on a setting of four cm of water. If the patient is morbidly obese or unable to fall asleep on the setting of four cm of water, higher starting pressures may be needed. Bilevel titration should begin at 8/4 cm of water.
- 10.0** If apneas or frequent hypopneas are present, pressure settings should be increased by one cm of water (inspiratory and expiratory settings should be increased by one cm of water each if bilevel titration). If occasional hypopneas, snoring, or mask flow limitation (see below) are present, pressure settings should be increased by one half cm of water (inspiratory and expiratory settings should be increased by one half cm of water each if bilevel titration) and maintained for at least five minutes to determine if events improve or resolve. Pressure settings may need to be increased more quickly during REM sleep given the limited amount of REM during sleep and the need to treat events during this stage. Heated humidification should be used during all titrations to improve patient comfort. This can be stopped if uncomfortable for the patient.

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If a mask leak occurs, the tech should first fix the leakage before raising the pressure. Otherwise, the final pressure setting chosen for the patient may be too high. Once the mask leak has been fixed, decrease the pressure to the last setting where mouth breathing and/or mask leakage was not present, and then re-titrate as indicated. Make sure to document directly on the study the steps taken to resolve the leak, and the type of masks used. Pressure settings usually do not need to be set as high with a nasal mask than with a full-face mask.

- 1.0 The recoding technologist should document directly on the study at least every 30 minutes.
- 2.0 If the patient takes a break from wearing the mask, do not decrease the pressure on attempted return to sleep unless the patient remains awake for 15 minutes, or the patient specifically requests that the pressure be lowered.
- 3.0 Do not raise pressure settings for central apneas. If the patient develops central apneas, pressure setting may need to be lowered.

4.0 Ensure that supine sleep has been seen on the chosen setting. Going above the chosen setting the half or one cm of water to show range may be helpful to ensure that the correct pressure has been established

Snoring

5.0 The following rules should apply in all circumstances of PAP titration:

Age	Minimum EPAP	Minimum EPAP/IPAP	Max EPAP	Max IPAP
<12 years	4cmH2O	8/4cmH2O	15cmH2O	20cmH2O
≥12 years	4cmH2O	8/4cmH2O	20cmH2O	30cmH2O

5.1 Note: IPAP-EPAP difference should not be <4 cmH2O and not > 10 cmH2O

6.0 For patients who already are on CPAP or Bi-level PAP at home, they should start the titration study on their home settings unless otherwise specified by the ordering physician.

- Technician should document:
 - a) Mask make and model
 - b) Mask size.
 - c) Comments on fitment of mask and air leak during the study.
 - d) Comments on patient tolerance of PAP.
 - e) All changes made to any PAP parameter and oxygen saturation. This includes changes in the rate. All changes in IPAP, EPAP, and oxygen should be recorded in the variable parameters recorded by the polysomnography equipment/program. If there is no parameter in the polysomnography program to record the change, make sure to put the change noted in the comments section.
 - f) All other information required in the standard polysomnography policy and procedure

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7.0 Ensure that supine sleep has been seen on the chosen setting. Going above the chosen setting by one half or one cm of water to show range may be helpful to ensure that the correct pressure has been established.

8.0 If supine REM sleep for at least 15 minutes has not been obtained at the designated optimal setting during the study, the patient may be awakened and instructed to lie in the supine position (or parents may move their child into the supine position).

19.0 For Obstructive Sleep Apnea in patients without neuromuscular disease:

- Begin the study on CPAP mode at a pressure of 4 cmH₂O unless specifically ordered by the ordering physician (see Figures 1 and 2)
- After at least 5 minutes of continuous sleep, increase CPAP pressure by 1cmH₂O for any of the following reasons:

Age	Obstructive/ Mixed Apneas	Hypopneas	RERA's	Loud or Unambiguous Snoring
<12 years	≥1	≥1	≥3	≥1 minute
≥12 years	≥2	≥3	≥5	≥3 minutes

- Continue titrating in increments of 1-2 cmH₂O every 5 minutes according to the above criteria.
- Once respiratory events are stabilized, there should be at least 30 minutes without breathing events before and “Exploration” or “Down” titration should occur

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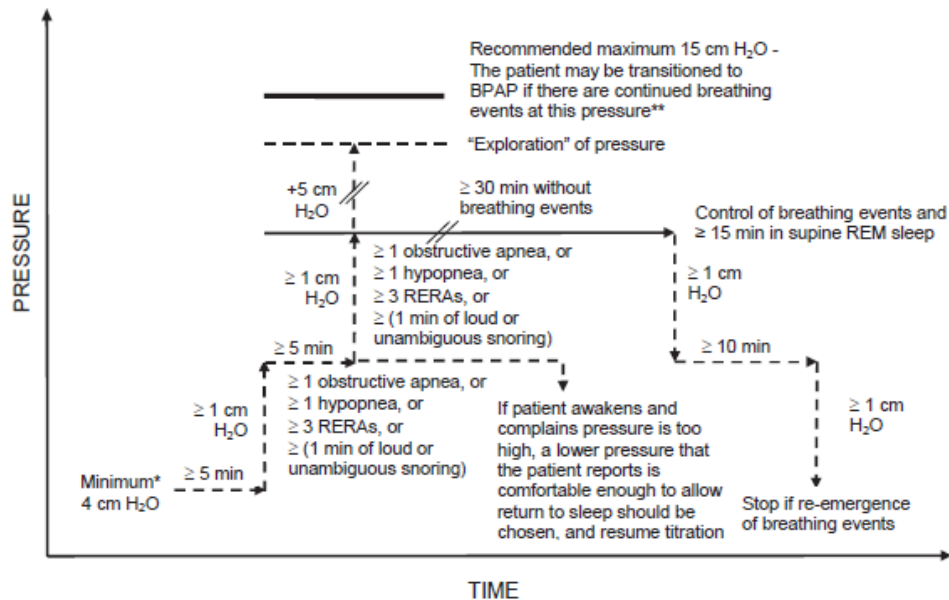


Figure 1—CPAP Titration Algorithm for Patients <12 years During Full- or Split-Night Titration Studies. Note: Upward titration at ≥ 1 -cm increments over ≥ 5 -min periods is continued according to the breathing events observed until ≥ 30 min without breathing events is achieved.

* A higher starting CPAP may be selected for patients with an elevated BMI and for retitration studies

** The patient should also be tried on BPAP if the patient is uncomfortable or intolerant of high CPAP

- Exploration of CPAP pressure at which control of abnormalities in respiratory parameters is achieved should not exceed 5 cmH₂O greater than the lowest optimal pressure.
- “Down” titration of pressure for CPAP/BPAP is not required but should be considered only after 30 minutes of continuous sleep, including 15 minutes of supine REM sleep, without any obstructive events or snoring. The CPAP or IPAP pressure can be decreased by 1-2 cmH₂O every ≥ 10 minutes of sleep until signs of obstructive events or snoring returns. If snoring or obstructive events occur, then return pressure to the lowest pressure at which obstructive events and snoring resolved. If this is inadequate, continue up titration according to Figures 1 and 2 and do not attempt down titration again. As noted above, the IPAP-EPAP difference should never be <4 or >10 cmH₂O.

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- For those patients who are already on CPAP/BPAP at home, they should be started on their home settings. “Down” titration of pressure for CPAP/BPAP should be considered only after 30 minutes of continuous sleep without any obstructive events or snoring, including 15 minutes of supine REM sleep. The CPAP or IPAP pressure can be decreased by 1-2 cmH₂O every ≥10 minutes of sleep until signs of obstructive events or snoring returns. If snoring or obstructive events occur, then return pressure to the lowest pressure at which obstructive events and snoring resolved. If this is inadequate, continue up titration according to Figures 1 and 2 and do not attempt down titration again. As noted above, the IPAP-EPAP difference should never be <4 or >10 cmH₂O.
- If the patient awakens and complains that the pressure is too high, the pressure should be restarted at a lower pressure, chosen as the one that allows the patient to return to sleep.

20.0 For Bi-level PAP Titration

- If the patient is unable to tolerate CPAP secondary to
 - 1) Persistent mouth breathing despite use of a full-face mask/chin strap
 - 2) Inability to exhale against higher expiratory pressures (typically around 15 cm of water in pediatric patients); or
 - 3) has frequent central apneas; the use of bilevel positive airway pressure may be indicated.Make sure to document directly on the study why the patient is being switched from CPAP to bilevel.
- If changing the patient to bi-level PAP during a CPAP titration, the EPAP minimum should be 4 cmH₂O or the highest CPAP level that was tolerated. The minimum IPAP to start with is the EPAP + 4 cmH₂O.
 - Example 1- Patient is currently using CPAP 8 cmH₂O and is tolerating this well but still has obstructive events. On increasing the CPAP to 10 cmH₂O, the patient does not tolerate this. You should then switch to BPAP with IPAP 12 cmH₂O and EPAP 8 cmH₂O (because the last tolerated CPAP level was 8 cmH₂O).
 - Example 2- Patient is tolerating CPAP 15 cmH₂O but still has obstructive events. You should then switch to BPAP with IPAP of 19 cmH₂O and EPAP 15 cmH₂O (because the patient was tolerating 15 cmH₂O before the switch).
- The inspiratory time chosen is based on the respiratory rate and patient condition.
 - The inspiratory time can be calculated as follows:
Time in seconds = (60seconds)/[(respiratory rate)(3)]
Example: If the respiratory rate is 15, then the inspiratory time is 1.3 seconds. If the respiratory rate is 20, then the inspiratory time is 1 second.

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- The inspiratory time can be shortened in the setting of significant obstructive lung disease.
- The maximum inspiratory time that should be set is 1.2 seconds
- For patients <12yo for each ≥ 5 minutes of sleep observation:
 - IPAP **and** EPAP should be increased by 1-2 cmH₂O if ≥ 1 obstructive **apnea** is observed
 - IPAP alone should be increased by 1-2 cmH₂O if ≥ 1 hypopnea, ≥ 3 RERAs, or ≥ 1 minute of loud or unambiguous snoring is observed
- For patients ≥ 12 yo:
 - IPAP **and** EPAP should be increased by 1-2 cmH₂O if ≥ 2 obstructive **apneas** are observed
 - IPAP alone should be increased by 1-2 cmH₂O if ≥ 3 hypopneas, ≥ 5 RERAs, or ≥ 3 minutes of loud or unambiguous snoring is observed
- Follow Figures 3 and 4 (on the next page) for titration algorithm for patients <12yo (Figure 3) and ≥ 12 yo (Figure 4).

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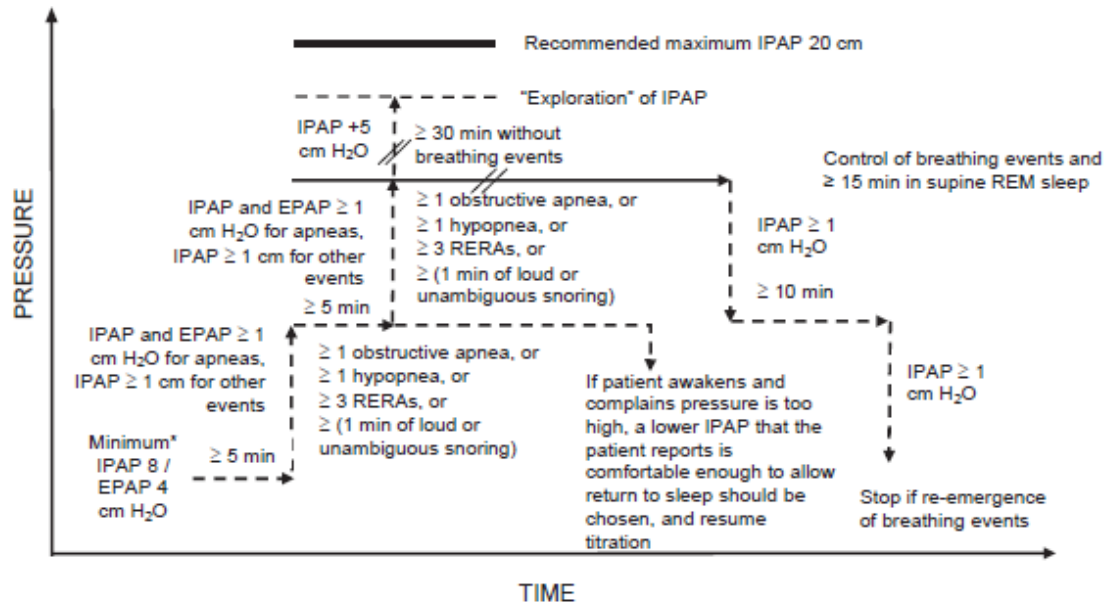


Figure 3—BPAP Titration Algorithm for Patients <12 years During Full- or Split-Night Titration Studies. Note: Upward titration of IPAP and EPAP ≥ 1 cm H₂O for apneas and IPAP ≥ 1 cm for other events over ≥ 5 -min periods is continued until ≥ 30 min without breathing events is achieved. A decrease in IPAP or setting BPAP in spontaneous-timed mode with backup rate may be helpful if treatment-emergent central apneas are observed.

* A higher starting IPAP and EPAP may be selected for patients with an elevated BMI and for retitration studies. When transitioning from CPAP to BPAP, the minimum starting EPAP should be set at 4 cm H₂O or the CPAP level at which obstructive apneas were eliminated. An optimal minimum IPAP-EPAP differential is 4 cm H₂O and an optimal maximum IPAP-EPAP differential is 10 cm H₂O.

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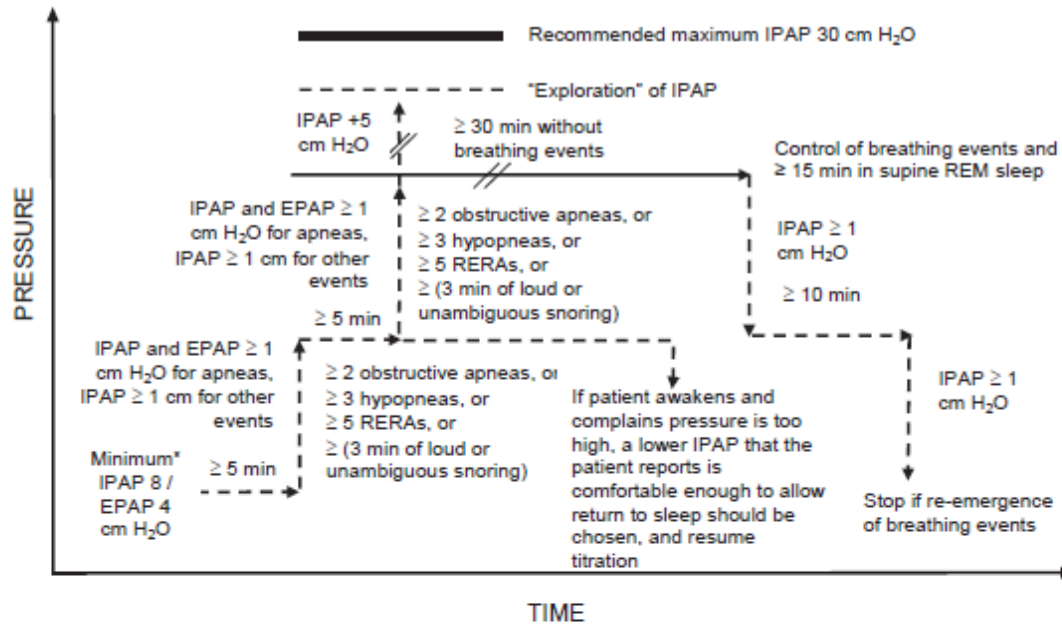


Figure 4—BPAP Titration Algorithm for Patients ≥ 12 years During Full- or Split-Night Titration Studies. Note: Upward titration of IPAP and EPAP ≥ 1 cm H₂O for apneas and IPAP ≥ 1 cm for other events over ≥ 5 -min periods is continued until ≥ 30 min without breathing events is achieved. A decrease in IPAP or setting BPAP in spontaneous-timed mode with backup rate may be helpful if treatment-emergent central apneas are observed.

* A higher starting IPAP and EPAP may be selected for patients with an elevated BMI and for retitration studies. When transitioning from CPAP to BPAP, the minimum starting EPAP should be set at 4 cm H₂O or the CPAP level at which obstructive apneas were eliminated. An optimal minimum IPAP-EPAP differential is 4 cm H₂O and an optimal maximum IPAP-EPAP differential is 10 cm H₂O.

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- Exploration of IPAP pressure at which control of abnormalities in respiratory parameters is achieved should not exceed 5 cmH₂O greater than the lowest optimal pressure.
- If the patient awakens and complains that the pressure is too high, the IPAP should be restarted at a lower pressure, chosen as the one that allows the patient to return to sleep.
- If the patient begins to have central apneas during the titration, these may be due to the patient's response to positive pressure. In this case, decrease the IPAP by 1-2 cmH₂O until central apneas resolve every 10 minutes unless obstructive episodes or snoring is present or returns during the down titration.
- If the maneuver in section 8 is ineffective, return to therapeutic positive pressures and increase backup rate by 2 bpm until adequate ventilation during central apneas is achieved.
- For hypoventilation management, see the policy and procedure manual section on BPAP for hypoventilation.

21.0 For addition of oxygen:

- Add oxygen during PAP titration after obstructive events have been resolved and oxygen saturation is <90% for >2 minutes.
- Connect oxygen at the port farthest from the patient interface device.
- Start oxygen at 1 LPM and increase by 0.5 LPM increments every 5minutes.
- Goal oxygen saturations for titration should be ≥95% for <18yo and ≥ 92% for ≥18yo unless otherwise specified by the ordering physician.

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22.0 For Obstructive Sleep Apnea in patients with neuromuscular disease:

- Follow the above protocol for titration of CPAP or Bi-level PAP.
- Highly consider initiation of BPAP for patients with neuromuscular weakness as they are at risk for sleep related hypoventilation.
- If there is significant asynchrony with Bi-level PAP or patient discomfort with Bi-level PAP, consider changing to Timed Mode with an increased backup rate (set to the spontaneous respiratory rate at sleep)

Reference for Figures in Policy: