

# Continuous positive airway pressure for obstructive sleep apnea in children

Jessie J. Wang Toshihiro Imamura MD James Lee MD FRCPC Marie Wright MBChB MRCPCH Ran D. Goldman MD FRCPC

## Abstracts

**Question** A 12-year-old child underwent adenotonsillectomy for treatment of obstructive sleep apnea (OSA) but continues to snore at night and struggles with attentiveness at school. The child's parent uses a continuous positive airway pressure (CPAP) machine at night and wonders whether the same therapy could be used in children.

**Answer** Unlike in adults, pediatric OSA is commonly related to adenotonsillar hypertrophy and is often amenable to treatment with adenotonsillectomy. As an alternative to surgery or in cases of postsurgical persistence of OSA, CPAP has shown effectiveness in improving both polysomnographic parameters and daytime neurobehavioural symptoms in children with OSA. Adherence to CPAP therapy is a challenge in children and requires parental education and special considerations such as a mask acclimatization period.

## La ventilation à pression positive continue pour l'apnée obstructive du sommeil chez l'enfant

### Résumé

**Question** Un enfant de 12 ans a subi une adéno-amygdalectomie pour traiter une apnée obstructive du sommeil (AOS), mais continue de ronfler la nuit et éprouve des problèmes d'attention à l'école. Un des parents de l'enfant utilise un appareil de ventilation à pression positive continue (CPAP) la nuit et se demande si la même thérapie peut aussi être utilisée chez les enfants.

**Réponse** Au contraire de l'AOS chez l'adulte, celle chez l'enfant est habituellement associée à une hypertrophie adénoamygdalienne qui répond souvent bien à un traitement par adénoamygdalectomie. Comme option de rechange à une opération chirurgicale ou dans les cas d'une persistance post-chirurgicale de l'AOS, il a été démontré que la CPAP est efficace pour améliorer les paramètres évalués par polysomnographie et les symptômes neurocomportementaux diurnes chez les enfants souffrant d'AOS. La conformité à une thérapie avec CPAP représente un défi chez les enfants; elle demande de bien renseigner les parents et de tenir compte d'exigences particulières, comme une période d'adaptation au masque.

Obstructive sleep apnea (OSA) is a partial or complete upper airway obstruction that disrupts normal alveolar ventilation and sleep structure. Nocturnal symptoms include snoring, mouth breathing, pauses in breathing, restlessness, enuresis, and sweating. Daytime consequences include sleepiness—which can be challenging to elicit from younger children when taking medical history—and poor academic performance in school-aged children. Hyperactivity and inattentiveness are characteristic symptoms seen in pediatric patients but not adults, and up to 30% of children with OSA have a concomitant diagnosis of attention deficit hyperactivity disorder.<sup>1,2</sup> However, clinical evaluation of a child with suspected OSA is not reliable, and the diagnosis is best confirmed by overnight polysomnography (PSG), during which multiple physiologic parameters are continuously monitored.

Reports of OSA prevalence differ depending on diagnostic method and threshold.<sup>3</sup> Using questionnaires

followed by PSG confirmation, with an apnea-hypopnea index (AHI; the average number of apneas and hypopneas per hour of sleep) threshold of 5, the prevalence of OSA in elementary school-aged children was 1.2% in a sample of 5740 children in the United States,<sup>4</sup> and 9.1% of boys and 5.7% of girls from a cohort of 6447 children in Hong Kong.<sup>5</sup>

The main pathogenesis of pediatric OSA is adenotonsillar hypertrophy.<sup>5,6</sup> There is also a strong association of OSA with body mass index.<sup>4,5</sup> Adolescents who are overweight or obese are predominantly at risk of having OSA, and the rising prevalence of pediatric OSA might be the result of increasing pervasiveness of childhood obesity. The presence of trisomy 21, craniofacial anomalies, neuromuscular disorders including cerebral palsy, premature birth, and African American ethnicity are other recognized risk factors for childhood OSA.<sup>3</sup>

## Managing OSA

The goals of OSA management in children are to improve sleep quality (which can be measured by polysomnographic parameters), improve daytime symptoms and quality of life, and enhance long-term cognitive potential and school performance.<sup>3</sup> A Cochrane review of 3 randomized controlled trials concluded that adenotonsillectomy improves quality of life, symptoms, and behaviour in children 5 to 9 years old with mild to moderate OSA.<sup>6</sup> One of the trials assigned 464 children to either an early adenotonsillectomy group or a watchful waiting group and found no statistically significant difference in attention or executive function measures between the 2 groups.<sup>7</sup> Thus, potential benefits of the procedure must be weighed against risks of surgery and general anesthesia, including bleeding, infection, and intraoperative respiratory compromise. Obstructive sleep apnea might persist after adenotonsillectomy—especially in children with obvious adenotonsillar hypertrophy on diagnosis—with an incidence ranging from 13% to 29% in children without additional risk factors.<sup>8,9</sup> There is a higher incidence of persistence in children with obesity, severe OSA at baseline, craniofacial anomalies, trisomy 21, neuromuscular disorders, and in those younger than 3 years or older than 7 years of age.<sup>3</sup>

Intranasal corticosteroids (specifically fluticasone and budesonide) and the leukotriene receptor antagonist montelukast have been shown to improve mild OSA and can be useful in those with contraindications to surgery or persistent disease after adenotonsillectomy.<sup>10</sup> Less well-supported treatments include rapid maxillary expansion, positional therapy, mechanical jaw positioning, and specific craniofacial procedures.<sup>3</sup> Although not well studied, weight loss should be included in the treatment plan of overweight and obese children with OSA.

## Continuous positive airway pressure

Continuous positive airway pressure (CPAP) therapy, which treats OSA by stenting the airway open, was first reported in 1986 as an alternative to tracheostomy in 10 children aged 3 to 11 years with OSA, all of whom had congenital anomalies or a developmental disorder.<sup>11</sup> Investigation of CPAP in children began in 1995 when the commercial availability of pediatric masks increased.<sup>12</sup> Based on questionnaires from the medical directors of 9 pediatric sleep disorder centres in the United States, Canada, and France, indications for CPAP included OSA associated with obesity, craniofacial anomalies, trisomy 21, and OSA persistence after adenotonsillectomy.<sup>12</sup> Most centres obtained baseline PSG before repeating overnight PSG for CPAP pressure titration. Most prospective trials used this approach,<sup>13-17</sup> with one group adding a 2-week mask acclimatization period before overnight titration to maximize children's ability to tolerate the mask.<sup>15-17</sup>

Continuous positive airway pressure therapy has consistently demonstrated efficacy in improving polysomnographic parameters, including respiratory disturbance index (defined as the number of apneas, hypopneas, and respiratory event-related arousals per hour of sleep), AHI, and oxygen saturation nadir,<sup>14-16,18,19</sup> as well as patient- or caregiver-reported daytime sleepiness.<sup>15,19</sup> Studies included infants younger than 1 year of age<sup>13,14</sup> or infants 2 years of age,<sup>15-17</sup> and found no difference in CPAP efficacy in children younger than 7 years (mean decrease in AHI=17, compared to 16 in older children;  $P>.05$ ).<sup>16</sup> Although CPAP is not approved by the Food and Drug Administration for use in children weighing less than 30 kg, a prospective trial of CPAP in 18 patients younger than 2 years of age who had medical disorders such as laryngomalacia, bronchopulmonary dysplasia, presence of trisomy 21, and congestive heart failure, reported significant improvement in polysomnographic parameters, with a reduction in mean apnea index from 12.8 to 4.5 ( $P<.0001$ ) and a reduction in longest apnea from 25.6 seconds to 8.2 seconds ( $P<.001$ ).<sup>20</sup>

## Barriers to success

Children face barriers to successful initiation of CPAP therapy, including limited mask size options<sup>15</sup> and limited titration capabilities in hospitals and sleep specialists with pediatric expertise.<sup>21</sup> Furthermore, long-term CPAP effectiveness is hampered by poor parent and child adherence.<sup>12,13,15-17,19</sup> One group suggested that parental motivation and perception of CPAP benefit were important determinants of adherence, and they identified poor adherence in children beyond infancy up to 5 years of age.<sup>13</sup> A double-blind randomized controlled trial of 29 children assigned to either CPAP treatment or bilevel pressure treatment using the same machines had a dropout rate of 24% at 6 months because of nonadherence. There was no difference in efficacy or adherence between the 2 ventilator modes, including or excluding dropouts.<sup>15</sup> Parental reports overestimated actual usage, as determined by the usage meter on the machine, by a mean of 1.8 hours per night, and 78% of parents acknowledged their child was not using the machine every night. Nevertheless, in a heterogeneous group of 52 children randomized to either CPAP therapy or bilevel pressure therapy, even with a mean nightly usage of only 3 hours, there were significant improvements after 3 months in both AHI (from an average of 18.1 to 2;  $P<.001$ ) and neurobehavioural assessments of attention deficits (from a median score of 9 to 4 on the Conners Abbreviated Symptom Questionnaire;  $P<.001$ ), sleepiness (from an average score of 14 to 5 on the Epworth Sleepiness Scale;  $P=.004$ ), and behaviour (from a median score of 58 to 52 on the Child Behavior Checklist;  $P<.001$ ).<sup>19</sup> In a prospective trial of 56 children aged 2 to 16 years, higher maternal education was associated with increased positive airway pressure use, both in terms of nights per month

and hours per night, suggesting the importance of parental understanding of the consequences of OSA and the requirement of treatment, although socioeconomic status was an unaccounted confounder.<sup>17</sup>

## Adverse effects

Marcus et al reported that the most common side effects of CPAP use include nasal symptoms (congestion, rhinorrhea, epistaxis), affecting 38% of children at 5 months of use.<sup>15</sup> Other common side effects include skin irritation and erythema from mask pressure, eye irritation from mask air leak, and airway dryness,<sup>12,13,15,16,20</sup> but the incidence of these was not reported. Prolonged CPAP use might also lead to impaired growth of the facial bones, resulting in midfacial hypoplasia.<sup>22</sup> Often, troubleshooting and changes to CPAP delivery can help improve adherence when CPAP is initially poorly tolerated. In 64 children receiving CPAP treatment, 26% were intolerant to initial therapy, and 37% of these eventually accepted CPAP after home mask acclimatization, change in mask size, skin cream use, and addition of passive humidification.<sup>13</sup> Once CPAP is initiated, regular follow-up assessments every 6 to 12 months is advised to optimize adherence, identify any necessary changes to CPAP delivery, and re-assess whether CPAP is still needed.<sup>13</sup> Studies report CPAP pressure requirements changing over time in 22% of 94 patients<sup>12</sup> and within 3 months in 56 children,<sup>16</sup> emphasizing the importance of regular follow-up assessments.

## Conclusion

Continuous positive airway pressure is safe and efficacious in children of all ages with OSA, but high-quality evidence is limited. While adenotonsillectomy is first-line therapy for most children with moderate to severe OSA (medical management should be used in children with mild symptoms), CPAP therapy should be considered in consultation with pediatricians and pediatric sleep specialists when OSA persists after adenotonsillectomy or when surgery is not a suitable option. 🌿

### Competing interests

None declared

### Correspondence

Dr Ran D. Goldman; e-mail [rgoldman@cw.bc.ca](mailto:rgoldman@cw.bc.ca)

### References

- Chervin RD, Ruzicka DL, Giordani BJ, Weatherly RA, Dillon JE, Hodges EK, et al. Sleep-disordered breathing, behavior, and cognition in children before and after adenotonsillectomy. *Pediatrics* 2006;117(4):e769-78.
- Wu J, Gu M, Chen S, Chen W, Ni K, Xu H, et al. Factors related to pediatric obstructive sleep apnea-hypopnea syndrome in children with attention deficit hyperactivity disorder in different age groups. *Medicine (Baltimore)* 2017;96(42):e8281.
- Marcus CL, Brooks LJ, Draper KA, Gozal D, Halbower AC, Jones J, et al. Diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics* 2012;130(3):576-84. Epub 2012 Aug 27.
- Bixler EO, Vgontzas AN, Lin HM, Liao D, Calhoun S, Vela-Bueno A, et al. Sleep disordered breathing in children in a general population sample: prevalence and risk factors. *Sleep* 2009;32(6):731-6.
- Li AM, So HK, Au CT, Ho C, Lau J, Ng SK, et al. Epidemiology of obstructive sleep apnea syndrome in Chinese children: a two-phase community study. *Thorax* 2010;65(11):991-7.
- Venekamp RP, Hearne BJ, Chandrasekharan D, Blackshaw H, Lim J, Schilder AG. Tonsillectomy or adenotonsillectomy versus non-surgical management for obstructive sleep-disordered breathing in children. *Cochrane Database Syst Rev* 2015;(10):CD011165.
- Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG, et al. A randomized trial of adenotonsillectomy for childhood sleep apnea. *N Engl J Med* 2013;368(25):2366-76. Epub 2013 May 21.
- Ye J, Liu H, Zhang GH, Li P, Yang QT, Liu X, et al. Outcome of adenotonsillectomy for obstructive sleep apnea syndrome in children. *Ann Otol Rhinol Laryngol* 2010;119(8):506-13.
- Mitchell RB. Adenotonsillectomy for obstructive sleep apnea in children: outcome evaluated by pre- and postoperative polysomnography. *Laryngoscope* 2007;117(10):1844-54.
- Friedman BC, Goldman RD. Anti-inflammatory therapy for obstructive sleep apnea in children. *Can Fam Physician* 2011;57:891-3.
- Guilleminault C, Nino-Murcia G, Heldt G, Baldwin R, Hutchinson D. Alternative treatment to tracheostomy in obstructive sleep apnea syndrome: nasal continuous positive airway pressure in young children. *Pediatrics* 1986;78(5):797-802.
- Marcus CL, Ward SL, Mallory GB, Rosen CL, Beckerman RC, Weese-Mayer DE, et al. Use of nasal continuous positive airway pressure as treatment of childhood obstructive sleep apnea. *J Pediatr* 1995;127(1):88-94.
- Massa F, Gonzalez S, Laverty A, Wallis C, Lane R. The use of nasal continuous positive airway pressure to treat obstructive sleep apnoea. *Arch Dis Child* 2002;87(5):438-43.
- Palombini L, Pelayo R, Guilleminault C. Efficacy of automated continuous positive airway pressure in children with sleep-related breathing disorders in an attended setting. *Pediatrics* 2004;113(5):e412-7.
- Marcus CL, Rosen G, Ward SL, Halbower AC, Sterni L, Lutz J, et al. Adherence to and effectiveness of positive airway pressure therapy in children with obstructive sleep apnea. *Pediatrics* 2006;117(3):e442-51.
- Marcus CL, Beck SE, Traylor J, Cornaglia MA, Meltzer LJ, DiFeo N, et al. Randomized, double-blind clinical trial of two different modes of positive airway pressure therapy on adherence and efficacy in children. *J Clin Sleep Med* 2012;8(1):37-42.
- DiFeo N, Meltzer LJ, Beck SE, Karamessinis LR, Cornaglia MA, Traylor J, et al. Predictors of positive airway pressure therapy adherence in children: a prospective study. *J Clin Sleep Med* 2012;8(3):279-86.
- Waters KA, Everrett FM, Bruderer JW, Sullivan CE. Obstructive sleep apnea: the use of nasal CPAP in 80 children. *Am J Respir Crit Care Med* 1995;152(2):780-5.
- Marcus CL, Radcliffe J, Konstantinopoulou S, Beck SE, Cornaglia MA, Traylor J, et al. Effects of positive airway pressure therapy on neurobehavioral outcomes in children with obstructive sleep apnea. *Am J Respir Crit Care Med* 2012;185(9):998-1003. Epub 2012 Feb 9.
- Downey R 3rd, Perkin RM, MacQuarrie J. Nasal continuous positive airway pressure use in children with obstructive sleep apnea younger than 2 years of age. *Chest* 2000;117(6):1608-12.
- Rulong G, Crisalli J, Dixon M, Corlette L, Mullen L, Dyke R, et al. 0889 Identifying barriers to CPAP adherence in the pediatric population. *Sleep* 2017;40(Suppl 1):A330-1.
- Li KK, Riley RW, Guilleminault C. An unreported risk in the use of home nasal continuous positive airway pressure and home nasal ventilation in children: mid-face hypoplasia. *Chest* 2000;117(3):916-8.

*Can Fam Physician* 2021;67:21-3. DOI: 10.46747/cfp.670121



Child Health Update is produced by the Pediatric Research in Emergency Therapeutics (PRETx) program ([www.pretx.org](http://www.pretx.org)) at the BC Children's Hospital in Vancouver, BC. Ms Wang and Drs Imamura, Lee, and Wright are members and Dr Goldman is Director of the PRETx program. The mission of the PRETx program is to promote child health through evidence-based research in therapeutics in pediatric emergency medicine.

Do you have questions about the effects of drugs, chemicals, radiation, or infections in children? We invite you to submit them to the PRETx program by fax at 604 875-2414; they will be addressed in future Child Health Updates. Published Child Health Updates are available on the Canadian Family Physician website ([www.cfp.ca](http://www.cfp.ca)).