

A close-up photograph of a baby sleeping peacefully. The baby is wearing a light blue, textured hat and is covered by a blue and white patterned blanket. The baby's mouth is slightly open, and their hands are clasped together. The background is a soft, textured blue surface.

NASAL CONTINUOUS POSITIVE AIRWAY PRESSURE FOR OBSTRUCTIVE SLEEP APNEA IN CHILDREN

Dr. Nguyễn Quỳnh Anh
Department of Respiration 1

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PREFACE

- Recent data from the USA and Europe: 14 - 49% of middle-aged men have clinically significant OSA
- 2 - 3% of all children from the newborn age to adolescence
- Equally in boys and girls
- A peak incidence in 2 and 8 years

DEFINITION

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- Obstructive sleep apnea (OSA) is defined as ≥ 5 episodes of apnea (nonbreathing) lasting ≥ 10 per hour of sleep
- Characterised by intermittent partial and/or complete upper airway obstruction during sleep that may impair normal ventilation and sleep pattern

ETIOLOGY

TABLE 2. Risk Factors for OSA in Children

Anatomic	<ul style="list-style-type: none">• Adenotonsillar hypertrophy• Nasal polyps• Nasal tumors• Allergic rhinitis• Anomalies of craniofacial bones<ul style="list-style-type: none">• Retrognathia – Pierre-Robin sequence• Micrognathia – Pierre-Robin• Midface hypoplasia – Down syndrome• Cleft palate• Macroglossia• Obesity
Functional	<ul style="list-style-type: none">• Generalized hypotonia in neuromuscular diseases <i>e.g., muscular dystrophies</i>• Effect of sedative hypnotics• Achondroplasia• Spina bifida – myelomeningocele• Mucopolysaccharidosis• Prematurity• Family history of OSA

SYMPTOMS

TABLE 3. Symptoms of OSA in Children

Nighttime symptoms	<ul style="list-style-type: none">• Snoring• Sleeping in unusual positions• Nocturnal sweating• Enuresis
Daytime symptoms	<ul style="list-style-type: none">• Daytime somnolence – rare in children• Aggressiveness• Anxiety• Hyperactivity• Inattentiveness• Learning difficulties• Deterioration in academic performance• Morning headaches• Mouth breathing• History of recurrent infectious illness

COMPLICATIONS

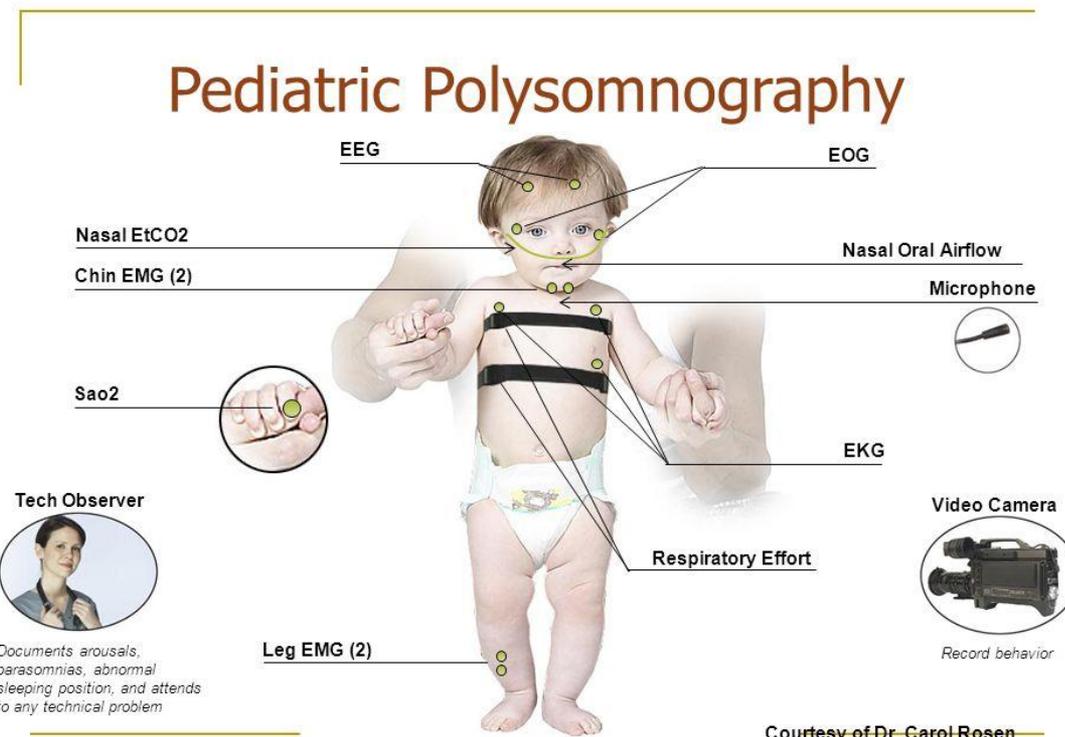
TABLE 4. Complications of OSA in Children

Behavioral	<ul style="list-style-type: none">• Aggression• Hyperactivity• Anxiety• Depressed mood• Psychosocial difficulties• Nocturnal enuresis
Cognitive	<ul style="list-style-type: none">• Inattentiveness• Impaired executive functioning• Impaired memory• Impaired scholastic function
Cardiopulmonary	<ul style="list-style-type: none">• Systemic hypertension• Impaired right ventricular function–rare• Cor pulmonale – rare
Growth and metabolism	<ul style="list-style-type: none">• Failure to thrive• Delayed physical growth

DIAGNOSTIC

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- Polysomnography remains the gold standard of pediatric OSA



DIAGNOSTIC

- Apnea-hypopnea index (AHI) is the total number of apneas and hypopneas that occur divided by the total duration of sleep in hours
 - < 1 : normal
 - 1 - 5: very mildly increased
 - 5 – 10: mildly increased
 - 10 – 20: moderately increased
 - > 20 : severely abnormal

TREATMENT

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- Indications:
 - AHI > 5, irrespective to the presence of morbidity
 - AHI 1 – 5, with OSA-related morbidity
 - Increasing body mass index percentile and male gender are risk factor for persistent OSA
 - Subjects with neuromuscular disorders and craniofacial anomalies

TREATMENT

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- Administration of anti-inflammatory medications
- Adenotonsillectomy
- Weight loss
- Use of orthodontic appliance
- Nasal continuous airway pressure (NCPAP)
- Tracheostomy

NCPAP

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- NCPAP is delivered by a flow generator to the patient via nasal mask or modified nasal prongs
- The device provides a “pneumatic splint” of the upper airway, preventing excessively high negative inspiratory pressures which cause closure of this airway segment

NCPAP

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- Indications:
 - ▣ Children who are not eligible for adenoidectomy and tonsillectomy (T & A)
 - ▣ Children whose sleep-breathing disorder persisted despite T & A



clinical investigations

Obstructive Sleep Apnea in Infants and Its Management With Nasal Continuous Positive Airway Pressure*

Frances McNamara, PhD; and Colin E. Sullivan, MBBS, PhD

NCPAP

Table 2—Average Respiratory and Sleep Variables for Diagnostic and CPAP Studies*

Variables	Diagnostic Study	CPAP Study
Total sleep time, min	488.6 ± 14.6	445.1 ± 14.7
Mean length NREM episodes, min	15.9 ± 1.0	21.6 ± 1.4†
Mean length REM episodes, min	6.3 ± 0.6	13.2 ± 0.8†
% REM sleep	16.0 ± 1.2	28.8 ± 0.9†
% SWS	34.2 ± 1.9	37.5 ± 2.5
% stage I/II NREM	49.8 ± 1.6	33.7 ± 1.9†
NREM		
Total apnea index, apneas/h	44.4 ± 9.3	9.5 ± 1.2‡
Central apnea index, apneas/h	29.8 ± 7.6	9.4 ± 1.2‡
Obstructive apnea index, apneas/h	14.6 ± 3.9	0.1 ± 0.1‡
Desaturation index, desaturations/h	37.8 ± 8.9	4.1 ± 0.9‡
REM		
Total apnea index, apneas/h	68.6 ± 8.9	22.7 ± 2.3‡
Central apnea index, apneas/h	25.0 ± 4.3	22.3 ± 2.2
Obstructive apnea index, apneas/h	43.6 ± 8.3	0.4 ± 0.1‡
Desaturation index, desaturations/h	63.4 ± 8.5	9.8 ± 1.4‡

*Data represent mean ± SEM for the diagnostic and CPAP polysomnographic studies of 18 infants.

†Significant difference from diagnostic study is denoted by *t* test ($p < 0.05$).

‡Significant difference from diagnostic study is denoted by rank-sum test ($p < 0.05$).

Nasal Continuous Positive Airway Pressure Use In Children With Obstructive Sleep Apnea Younger Than 2 Years of Age*

Ralph Downey III, PhD; Ronald M. Perkin, MD, MA; and Joanne MacQuarrie, RRT, RPSGT

NCPAP

Table 3—Significant Polysomnographic Variables That Changed From Baseline Polysomnogram to CPAP Polysomnogram in Children With OSA (n = 18)*

Variable	PSG		t Test (df)
	Baseline	CPAP	
No. of awakenings > 15 s†	13.5 ± 14.8	5.5 ± 5.2	0.9 (15)‡
Apnea index	12.8 ± 20.0	4.5 ± 13.4	4.4 (16)§
Obstructive apnea index	4.7 ± 13.4	2.0 ± 7.3	3.8 (16)§
Hypopnea apnea index	6.7 ± 12.7	2.0 ± 5.7	8.7 (16)‡
Longest apnea, s	25.6 ± 17.4	8.2 ± 7.3	3.9 (17)
Minimum SaO ₂ , %	74.8 ± 20.1	87.3 ± 9.5	2.3 (17)‡
SaO ₂ < 90%, min	22.2 ± 25.5	6.4 ± 14.9	2.3 (15)‡

*Values given as mean ± SD. df = degrees of freedom; SaO₂ = arterial oxygen saturation. See Table 1 for other abbreviation.

†For the entire sleep period.

‡p < 0.05.

§p < 0.0001.

||p < 0.001.

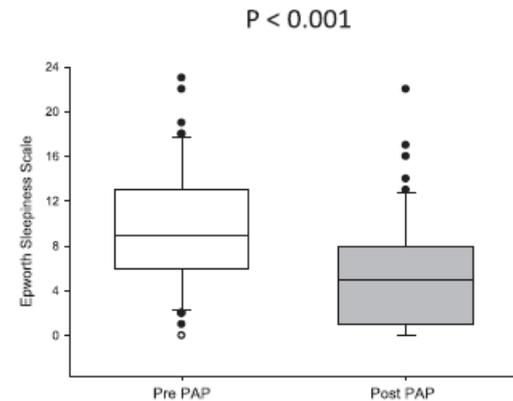
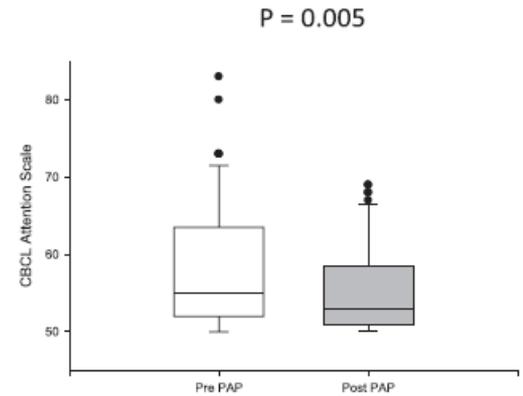
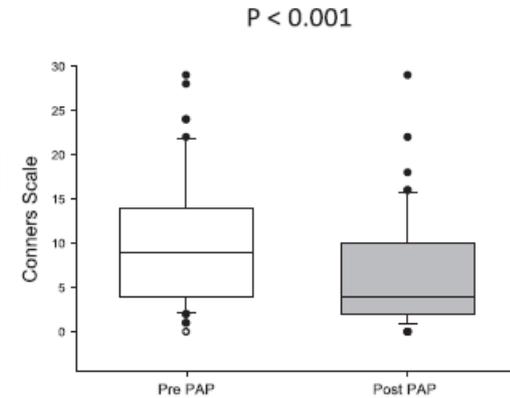
Effects of Positive Airway Pressure Therapy on Neurobehavioral Outcomes in Children with Obstructive Sleep Apnea

Carole L. Marcus¹, Jerilynn Radcliffe², Sofia Konstantinopoulou¹, Suzanne E. Beck¹, Mary Anne Cornaglia¹, Joel Traylor¹, Natalie DiFeo¹, Laurie R. Karamessinis¹, Paul R. Gallagher², and Lisa J. Meltzer³

NCPAP

TABLE 3. FREQUENCY OF CHILDREN FALLING IN THE CLINICALLY ABNORMAL RANGE ON NEUROBEHAVIORAL MEASURES AT BASELINE AND AFTER PAP THERAPY

Measure	Baseline	On PAP	P Value
Conners Abbreviated Symptom Questionnaire*	10 (19.2)	6 (11.5)	0.289
Modified Epworth Sleepiness Scale	14 (26.9)	5 (9.6)	0.004
Child Behavior Checklist			
Attention problems	13 (25)	8 (15.4)	0.18
Internalizing	13 (25)	9 (17.3)	0.34
Externalizing	8 (15.4)	6 (11.5)	0.73
Total	17 (32.7)	12 (23.1)	0.063
OSAS-18			
Moderate impairment	28 (53.8)	5 (9.6)	<0.001
Large impairment	9 (17.3)	2 (3.8)	0.039
PedsQL			
Impairment (caregiver report)	27 (51.9)	16 (30.8)	0.013
Impairment (child report) [†]	26 (61.9)	13 (31)	0.002



Use of nasal continuous positive airway pressure as treatment of childhood obstructive sleep apnea

Carole L. Marcus, MBBCh, Sally L. Davidson Ward, MD,
George B. Mallory, MD, Carol L. Rosen, MD,
Robert C. Beckerman, MD, Debra E. Weese-Mayer, MD,
Robert T. Brouillette, MD, Ha T. Trang, MD, PhD, and
Lee J. Brooks, MD

ORIGINAL ARTICLE

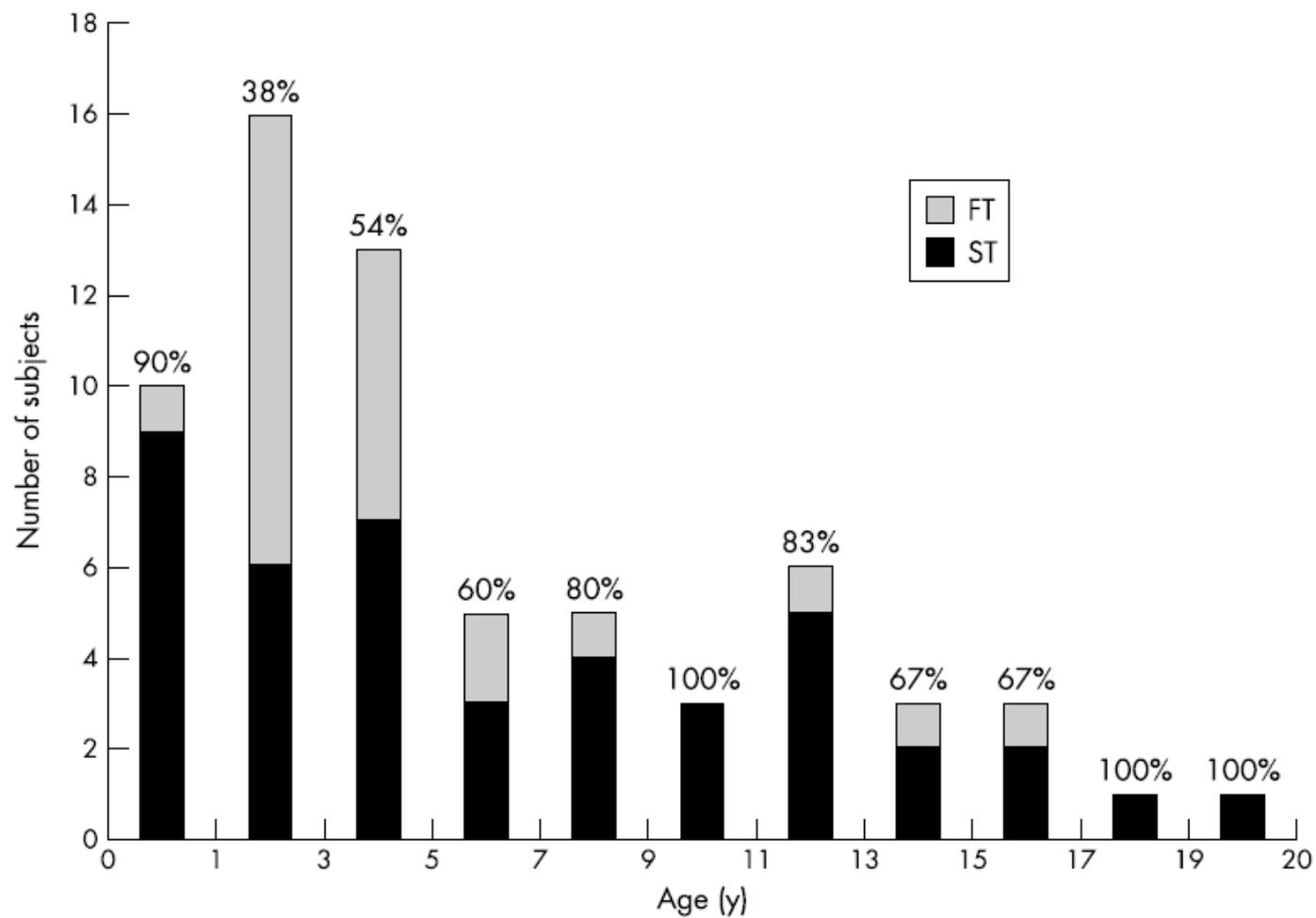
The use of nasal continuous positive airway pressure to treat obstructive sleep apnoea

F Massa, S Gonzalez, A Lavery, C Wallis, R Lane

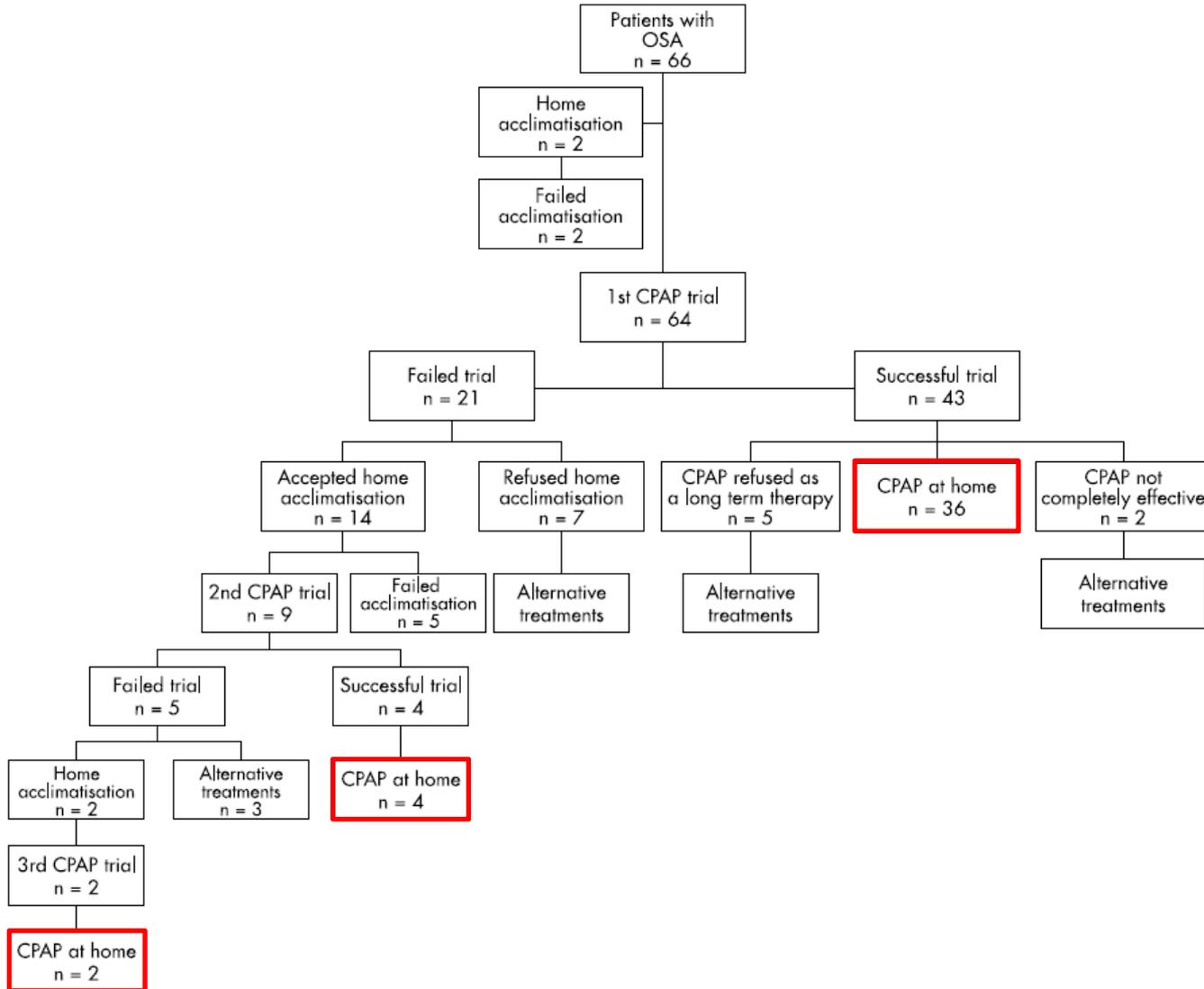
Arch Dis Child 2002;**87**:438–443

NCPAP

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NCPAP



NCPAP

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PEDIATRICS

Compliance Rates in Children Using Noninvasive Continuous Positive Airway Pressure

Anne R. O'Donnell, FRACP, PhD¹; Candice L. Bjornson, MD, MSc¹; Shelly G. Bohn, BSc, RPSGT; Valerie G. Kirk, MD¹

University of Calgary, Alberta Children's Hospital, Calgary, Canada

NCPAP

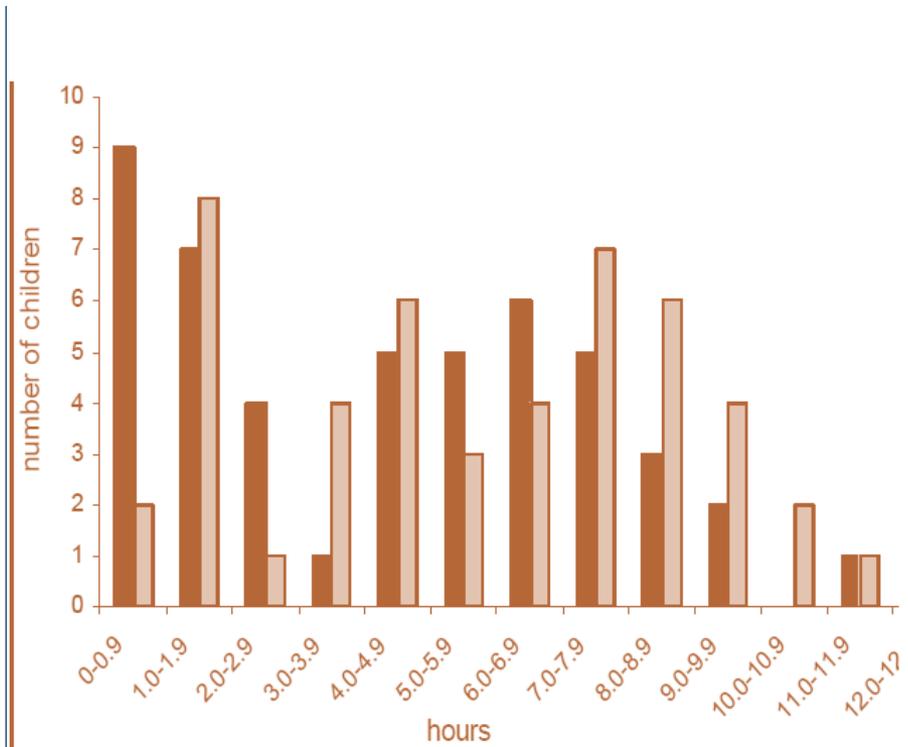
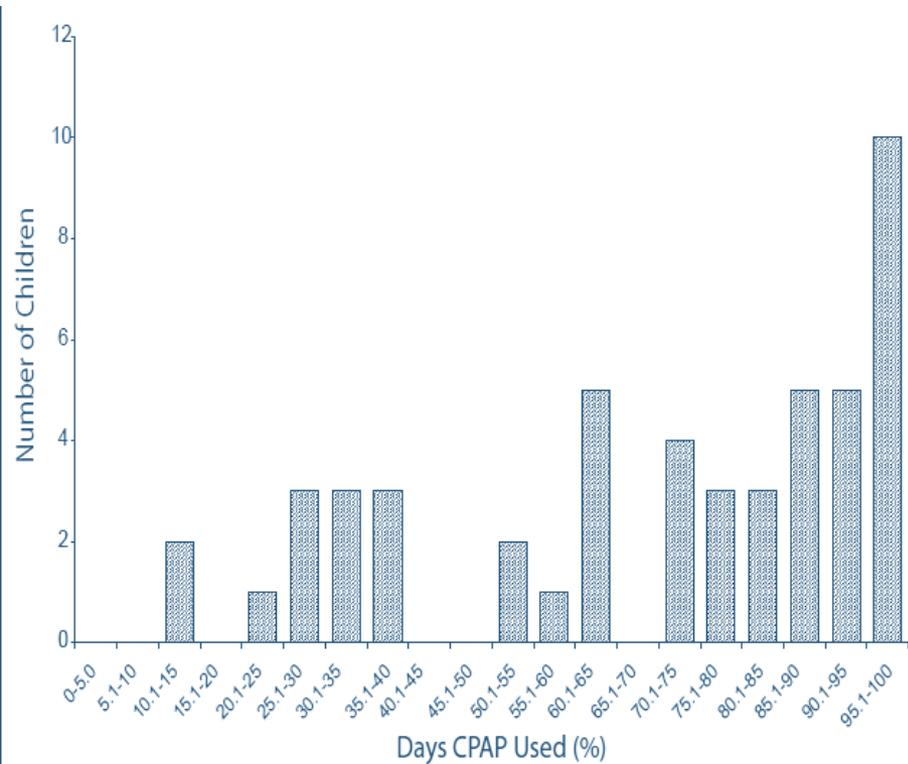


Figure 3—Compliance with nasal continuous positive airway pressure (nCPAP) (n = 50). Dark bars represent mean daily use, in hours; shaded bars represent mean nCPAP daily use on days nCPAP used, in hours.

Figure 2—Distribution of days nasal continuous positive airway pressure (nCPAP) used (n = 50). Most children used nCPAP at least half of the nights.

NCPAP

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Improving Positive Airway Pressure Adherence in Children

Michelle S. King, MD, Melissa S. Xanthopoulos, PhD, and Carole L. Marcus, MBBCh*

Sleep Center, The Children's Hospital of Philadelphia, Perelman School of Medicine, University of Pennsylvania, 34th and Civic Center Boulevard, Philadelphia, PA 19104, USA

NCPAP

Authors, Ref. Year	Population	Age	OSAS Characteristics	Associated Conditions	Measure of Adherence	Findings
DiFeo et al, ⁴³ 2012	N = 56 children and their parents 68% male 59% African American 36% Caucasian	2–16 y	AHI 19 ± 16/h Naïve to CPAP	71% obese 23% with neurodevelopmental disabilities 20% with genetic syndromes	Usage data from machine (at 1 and 3 mo)	Average use 3 ± 3 h per night after first month, 2.8 ± 2.7 h on third month Greatest predictor of use was maternal education Older, typically developing African American youth with low social support had poor adherence
Simon et al, ⁴⁴ 2012	N = 51 children and their parents 51% male 51% non-Hispanic Caucasian 37% African American 64% had Medicaid	8–17 y	Average AHI 17/h Average CPAP use of 22.9 mo	73.5% overweight/ obese	Usage data from machine	Poor adherence with average use of 3.35 h per night Questionnaire developed was able to identify specific barriers to CPAP
Marcus et al, ⁴¹ 2006	N = 29 children 72% male 51% African American	2–16 y	Newly diagnosed OSAS	65% obese 10% craniofacial abnormalities 34% systolic hypertension	Parental report and usage data from machine for 6 mo	Average use 3.8 ± 3.3 h per night 9 dropouts Parental report overestimated actual use No difference in adherence between CPAP and BPAP
O'Donnell et al, ³⁷ 2006	N = 50 children	Mean 10 ± 5.1 y 66% male	Median AHI = 11.3	78% with comorbidity	Usage data from machine	Average use 6.3 h per night
Koontz et al, ³⁵ 2003	N = 20 children 55% African American 30% Caucasian	1–17 y	Nonadherent children referred by physicians	45% with some degree of developmental delay	Usage data from machine	3 groups: 1 Consultation (usage 8.58 h/night) 2 Consultation with behavior therapy (usage 5.88 h/night) 3 No consultation/behavior therapy (usage 0.67 h/night)
Massa et al, ³⁶ 2002	N = 66 children 59% male	Infant to 19 y	All moderate to severe OSAS (AHI >5 per hour)	35% craniosynostosis syndromes 9.1% isolated facial defects 6.1% obese 3% trisomy 21 3% cerebral palsy	Parental report	67.7% report good adherence (uses every night and all night long) CPAP tolerated by 86%
Marcus et al, ¹⁷ 1994	N = 94 children 64% male	2 wk to 19 y	—	27% obese 25% craniofacial abnormalities 13% trisomy 21	Parental report	12.7% with inadequate adherence

NCPAP

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□ Case 1



NCPAP

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□ Case 2



SUMMARY

- NCPAP therapy has been shown to be effective in the management of OSA in infants
- Complications are minor
- The vast majority of children are able to be established on NCPAP, with most children wearing NCPAP for a substantial part of the night

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THANKS FOR YOUR ATTENTION !

