2nd INTERNATIONAL PEDIATRIC NONINVASIVE VENTILATION CONFERENCE

November 3rd & 4th 2016

CPAP for OSAS in children

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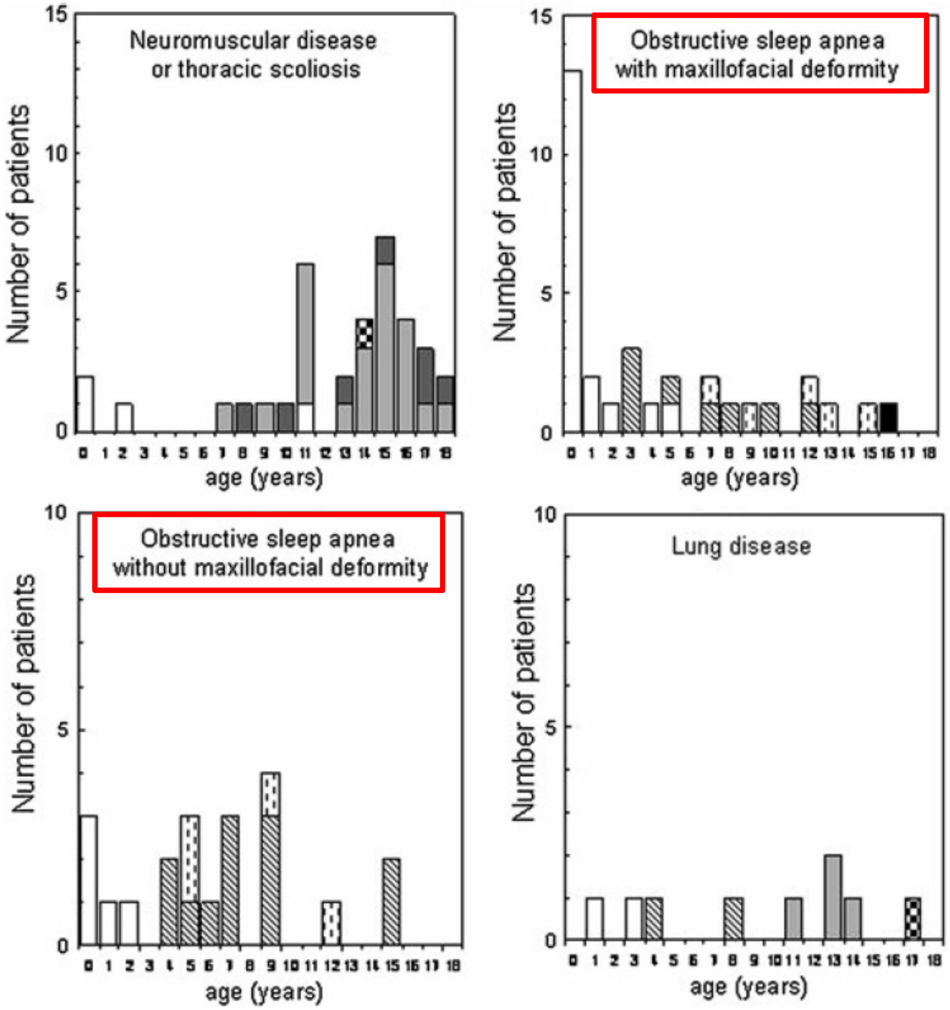
CPAP for OSAS in children

- For which patients ?
- When to start ?
- Which CPAP mode & setting ?
- Which equipment ?
- How to monitor ?
- When to stop ?
- Conclusion

Patients started on home CPAP



Ramirez *et al.* Intensive Care Med 2012;38:655

Polygraphic respiratory events during sleep in children treated with home continuous positive airway pressure: description and clinical consequences

Alessandro Amaddeo [a,b], Valeria Caldarelli [c], Marta Fernandez-Bolanos [a], Johan Moreau [a,d,e], Adriana Ramirez [a,f], Sonia Khirani [a,g], Brigitte Fauroux [a,h,i,*]

Female to male ratio (F/M)	6/20	
Age, years (mean ± SD)	7.8 ± 6.2	
Time of follow-up, months (mean ± SD)	10.6 ± 14.4	
Predisposing conditions	- Down syndrome	3
	- Treacher Collins syndrome	3
	- Polymalformative syndrome	3
	- Idiopathic OSAS	3
	- Achondroplasia	2
	- CATCH-22 syndrome	2
	- Neurofibromatosis type 1 with subglottic neurofibroma	1
	- Bronchopulmonary dysplasia	1
	- Turner syndrome	1
	- Menkes syndrome	1
	- Cherubism	1
	- Beckwith–Wiedemann syndrome	1
	- Pycnodysostosis	1
	- Niemann–Pick disease type A	1
	- Post-intubation laryngeal paralysis	1
	- Prader–Willi syndrome	1

Sleep Medicine 16 (2015) 107–112

Rev Port Pneumol. 2014;20(3):146–151

revista portuguesa de
PNEUMOLOGIA
portuguese journal of pulmonology
www.revportpneumol.org

ORIGINAL ARTICLE

Non-invasive ventilation in complex obstructive sleep apnea – A 15-year experience of a pediatric tertiary center

I.C. Girbal*, C. Gonçalves, T. Nunes, R. Ferreira, L. Pereira, A. Saianda, T. Bandeira

Table 1 Distribution of patients according to primary diagnosis, presence of associated hypoventilation and age at NIV start.

Nosologic group	Patients ($N = 68$) n (%)[b]	OSA plus hypoventilation syndrome n (%)[b]	Age at NIV start in months Median (IQR)
Congenital malformations/genetic disorders	34 (50)	7 (10)	42.5 (5–144)
Prader–Willi syndrome	6	2	176 (158–187)
Pierre–Robin syndrome	5	0	1 (0–2)
Trisomy 21	5	2	120 (46–180)
Craniofacial malformation[a]	10	0	40 (7–45)
Airway malacia	5	0	13 (2–15)
Other	3	3	60 (40–96)
Cerebral palsy	9 (13)	2 (3)	168 (89–173)
Central nervous system tumor	8 (12)	1 (1.5)	171 (94–180)
Inborn errors of metabolism	6 (9)	2 (3)	59 (20–135)
Mucopolysaccharidosis	5	2	59 (46–156)
Gaucher disease	1	0	2
Adenoid/tonsil hypertrophy	3 (4)	0	15 (12–31)
Obesity	3 (4)	0	166 (154–194)
Others	5 (8)	0	106 (85–110)

Obstructive sleep disordered breathing in 2- to 18-year-old children: diagnosis and management

EUROPEAN RESPIRATORY SOCIETY

Athanasios G. Kaditis[1], Maria Luz Alonso Alvarez[2], An Boudewyns[3], Emmanouel I. Alexopoulos[4], Refika Ersu[5], Koen Joosten[6], Helena Larramona[7], Silvia Miano[8], Indra Narang[9], Ha Trang[10], Marina Tsaoussoglou[1], Nele Vandenbussche[11], Maria Pia Villa[12], Dick Van Waardenburg[13], Silke Weber[14] and Stijn Verhulst[15]

5.3. Are there conditions predisposing to upper airway obstruction which make treatment of obstructive SDB a priority?

Summary

a) Major craniofacial abnormalities

b) Neuromuscular disorders

c) Achondroplasia

d) Chiari malformation

e) Down syndrome

f) Mucopolysaccharidoses

g) Prader–Willi syndrome

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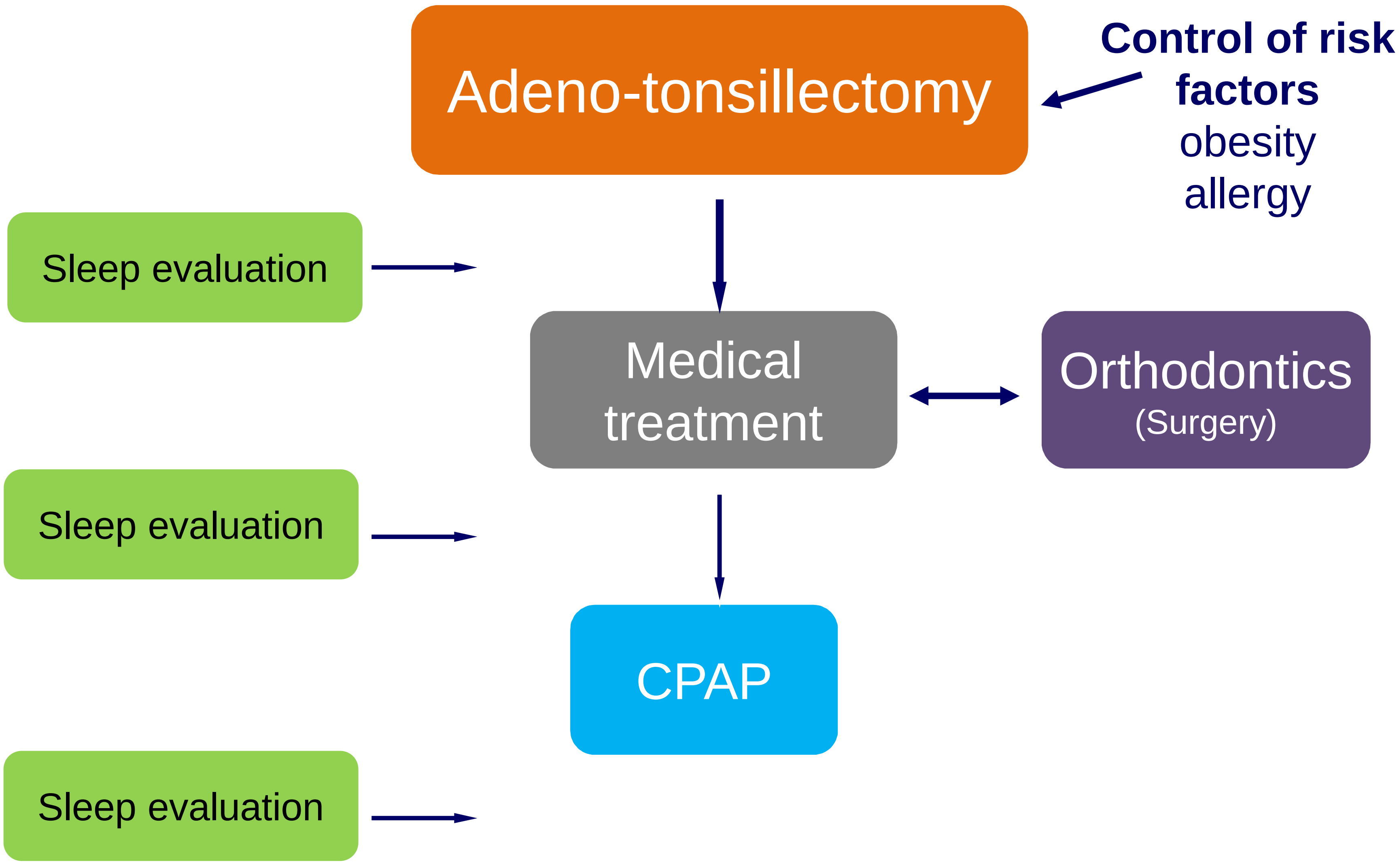
When to start CPAP ?



When to start CPAP ?

- No validated criteria: lack of validated markers of OSA-end-organ morbidity in children
- Recommendations:

TASK FORCE REPORT
ERS STATEMENT

EUROPEAN RESPIRATORY SOCIETY

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6.7. What are the indications, efficacy and potential complications of CPAP or NPPV in children with obstructive SDB?

Summary

a) Usual indications for CPAP are: residual OSAS after adenotonsillectomy (AHI >5 episodes·h^{-1}) and OSAS related to obesity, craniofacial abnormalities or neuromuscular disorders. If nocturnal hypoventilation occurs (*e.g.* end-tidal carbon dioxide tension (P_{CO_2}) >50 mmHg for >25% of total sleep time or peak end-tidal P_{CO_2} ⩾55 mmHg) NPPV is preferred.

Long Term Continuous Positive Airway Pressure (CPAP) and Noninvasive Ventilation (NIV) in Children: Initiation Criteria in Real Life

A. Amaddeo, MD,[1,2,3] J. Moreau, MD,[1,4] A. Frapin, MSN,[1] S. Khirani, PhD,[1,5] O. Felix, MD,[1,6]
M. Fernandez-Bolanos, MSc,[1] A. Ramirez, MSc,[1,7] and B. Fauroux, MD, PhD[1,2,3]*

TABLE 2—Respiratory Variables Used for Continuous Positive Pressure or Noninvasive Ventilation Initiation

1.	Minimum SpO_2 <90%
2.	Maximal $PtcCO_2$ >50 mmHg
3.	Time spent with a SpO_2 <90% ≥2% of recording time
4.	Time spent with a $PtcCO_2$ >50 mmHg ≥2% of recording time
5.	Oxygen desaturation index >1.4 events/hr
6.	AHI >10 events/hr

Pediatric Pulmonology 51:968–974 (2016)

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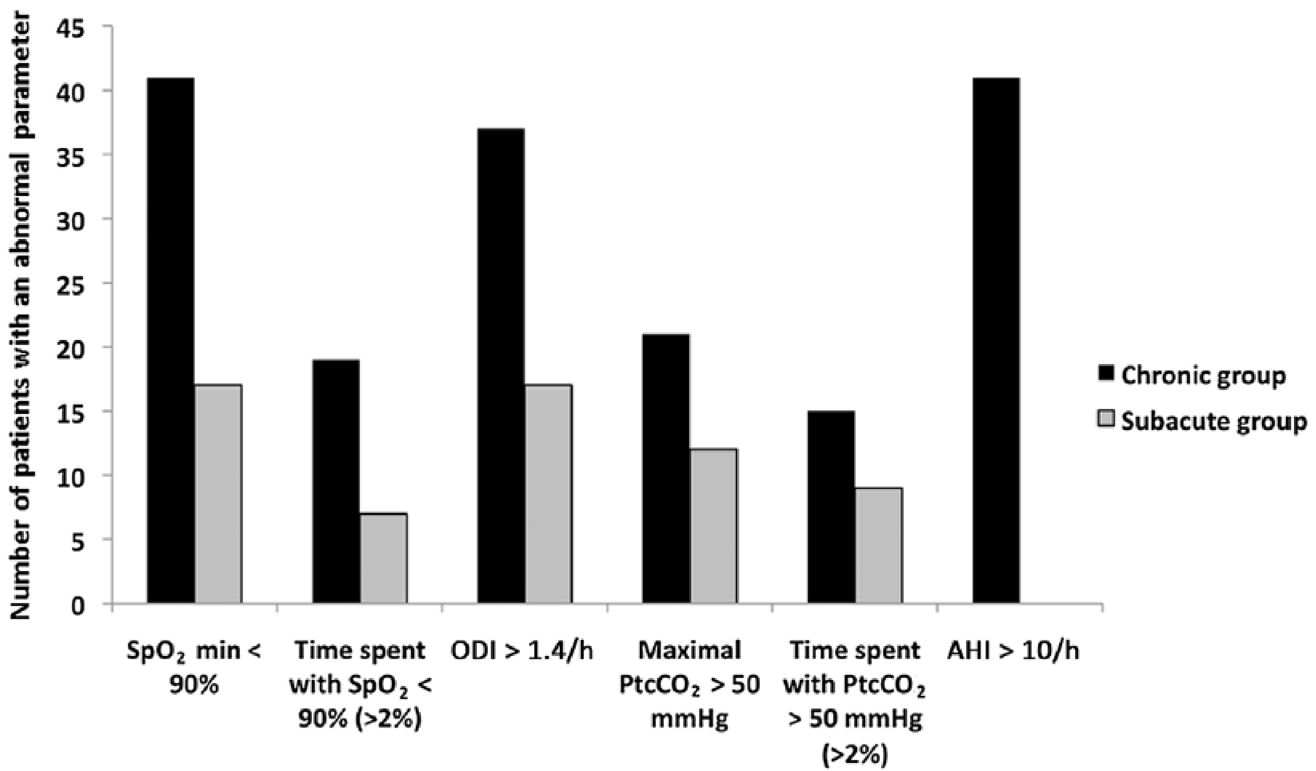

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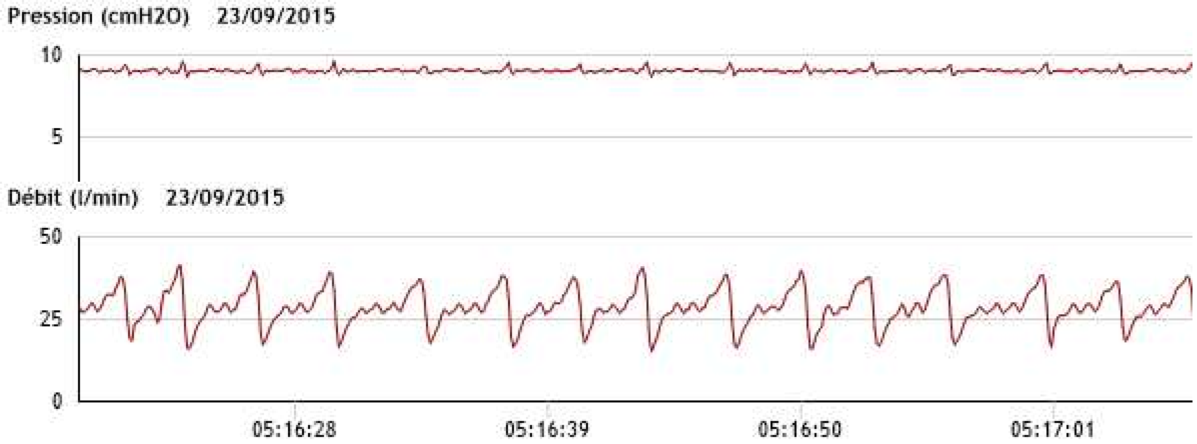
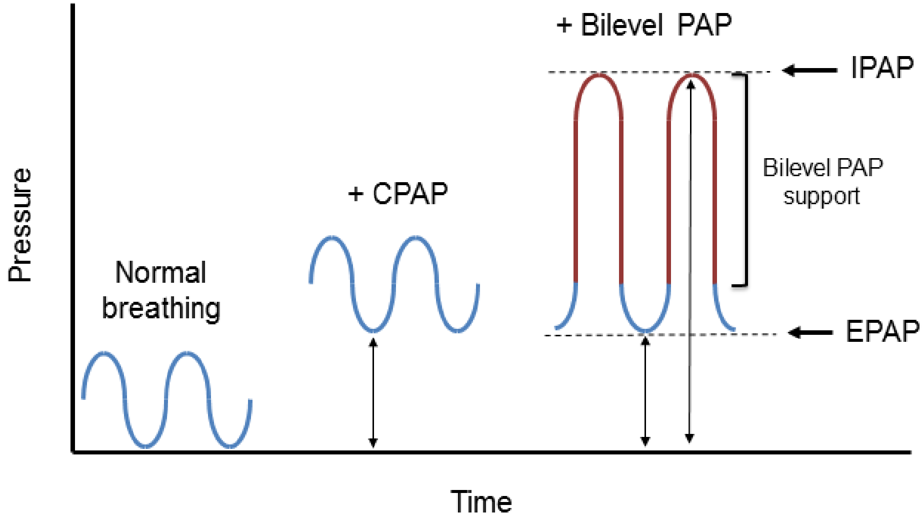
CPAP modes - 1

Constant CPAP

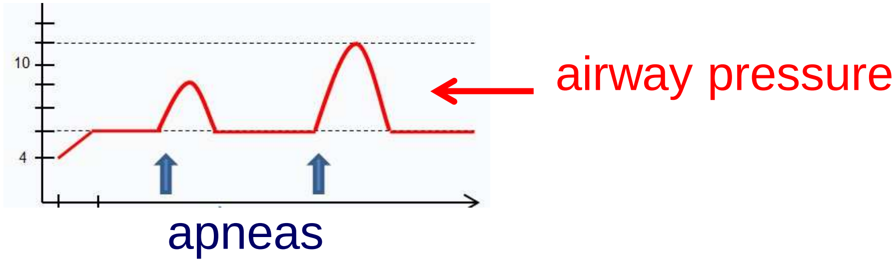


Bilevel positive airway pressure (BiPAP)

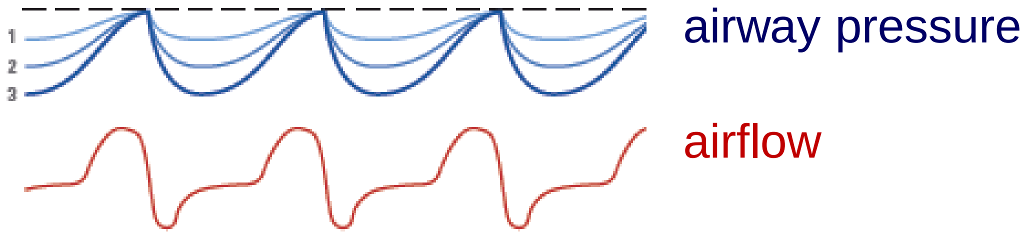


CPAP modes - 2

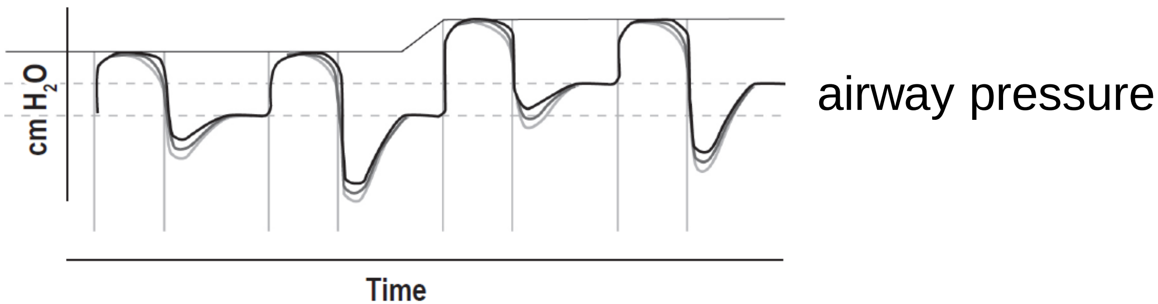
Auto-CPAP



C-Flex



Bi-Flex



JCSM
Journal of Clinical Sleep Medicine

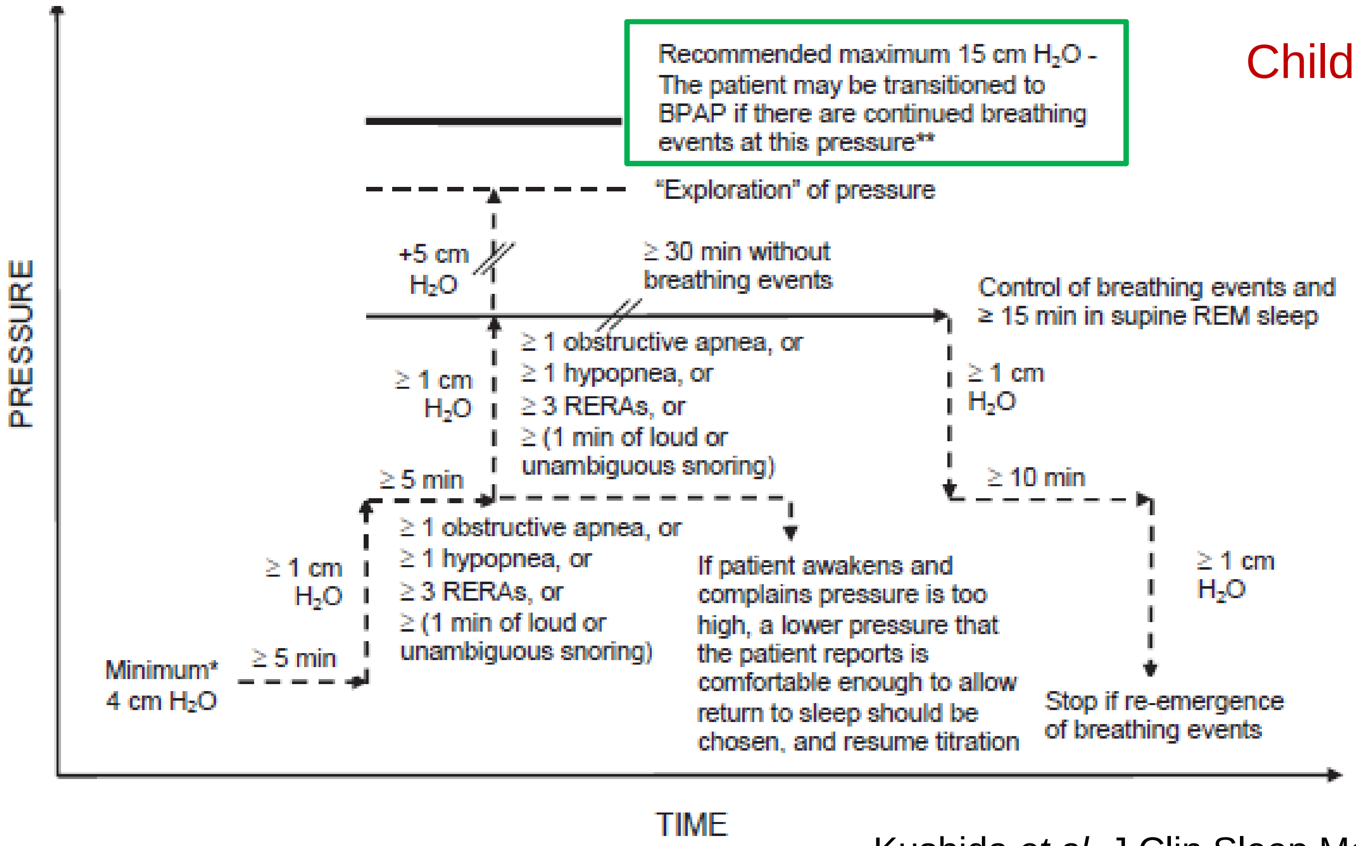
SPECIAL ARTICLE

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

Positive Airway Pressure Titration Task Force of the American Academy of Sleep Medicine

Task Force Members: Clete A. Kushida, M.D., Ph.D., RPSGT (Chair)[1]; Alejandro Chediak, M.D. (Vice-Chair)[2]; Richard B. Berry, M.D.[3]; Lee K. Brown, M.D.[4]; David Gozal, M.D.[5]; Conrad Iber, M.D.[6]; Sairam Parthasarathy, M.D.[7]; Stuart F. Quan, M.D.[8]; James A. Rowley, M.D.[9]

Child < 12 years



Kushida *et al*. J Clin Sleep Med;2008:4:157

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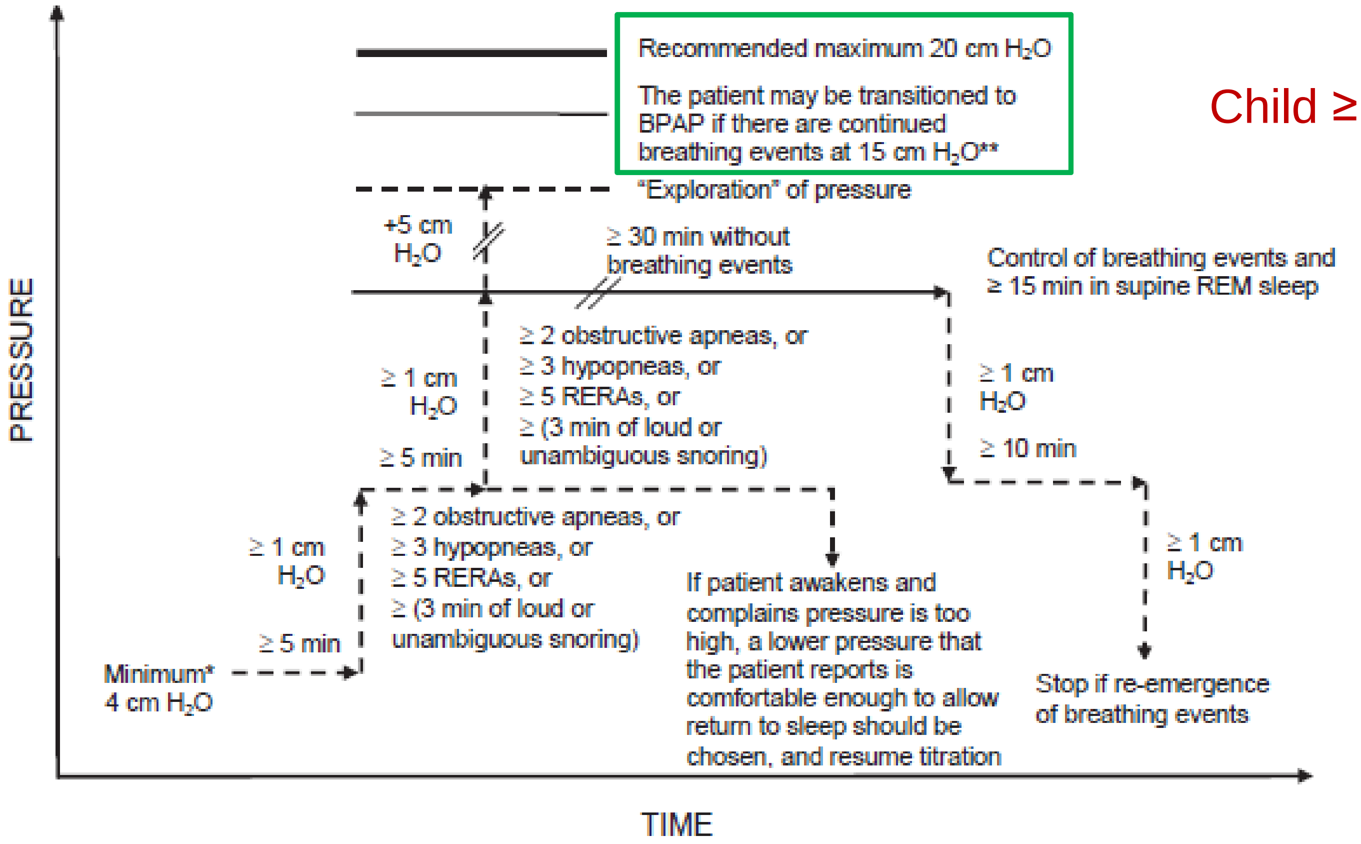


Child ≥ 12 years

Kushida *et al*. J Clin Sleep Med;2008:4:157

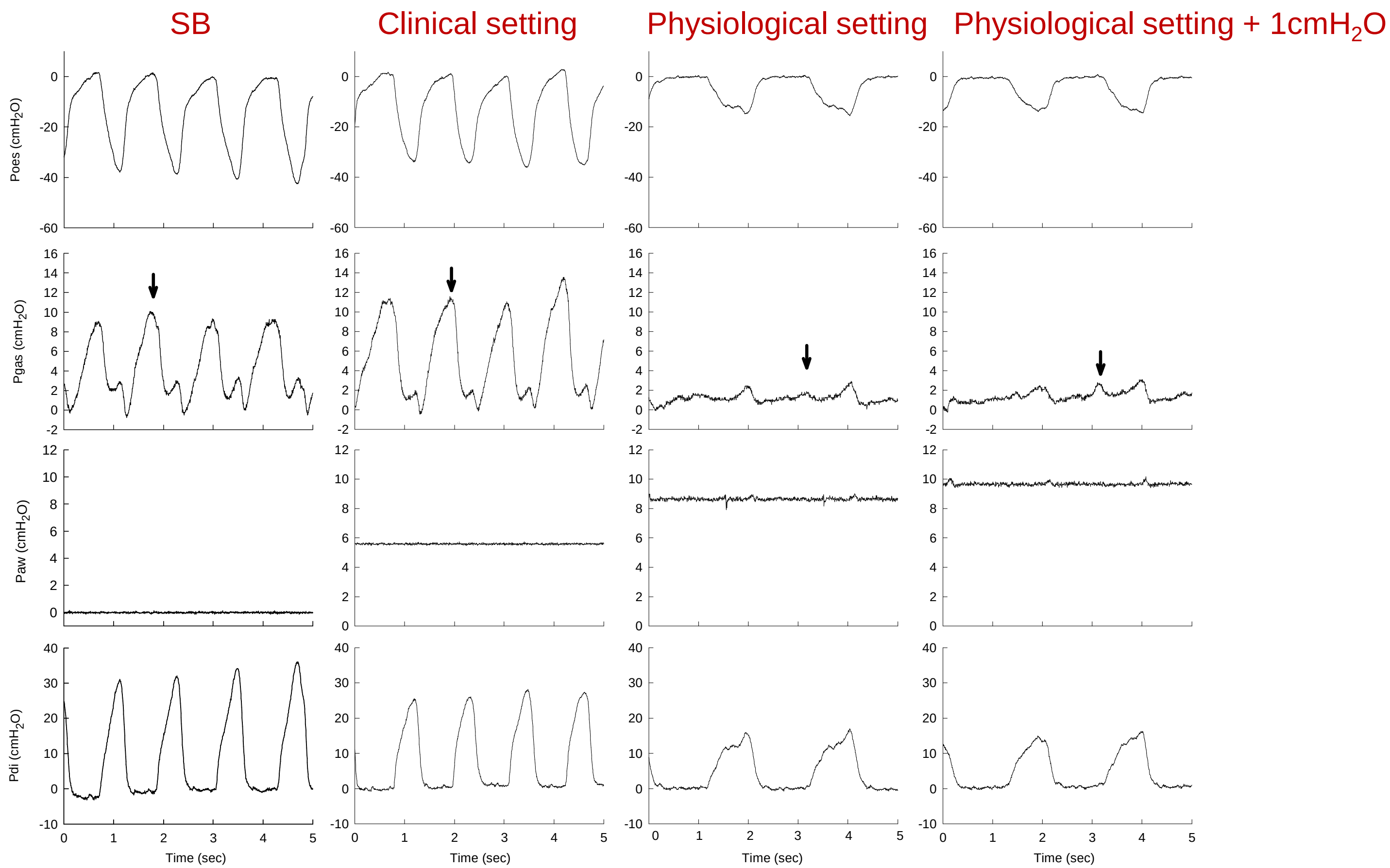
Khirani *et al. Critical Care* 2013, **17**:R167
http://ccforum.com/content/17/4/R167

CRITICAL CARE

RESEARCH Open Access

Continuous positive airway pressure titration in infants with severe upper airway obstruction or bronchopulmonary dysplasia

Sonia Khirani[1,2], Adriana Ramirez[2,3], Sabrina Aloui[2], Nicolas Leboulanger[4,5,6], Arnaud Picard[5,7] and Brigitte Fauroux[2,5,6*]



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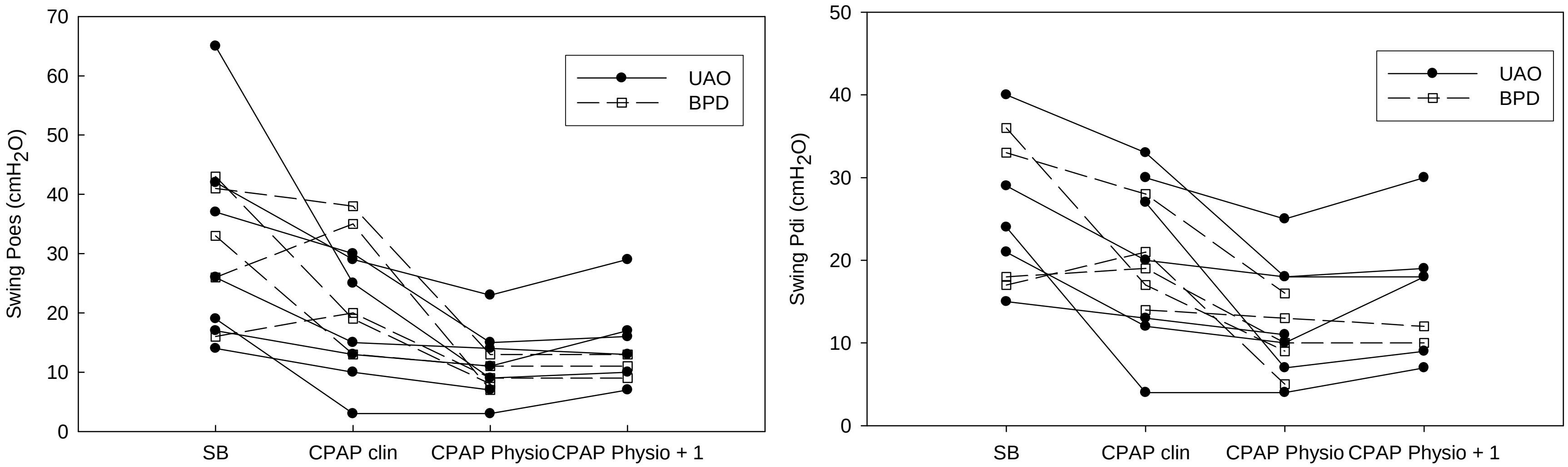

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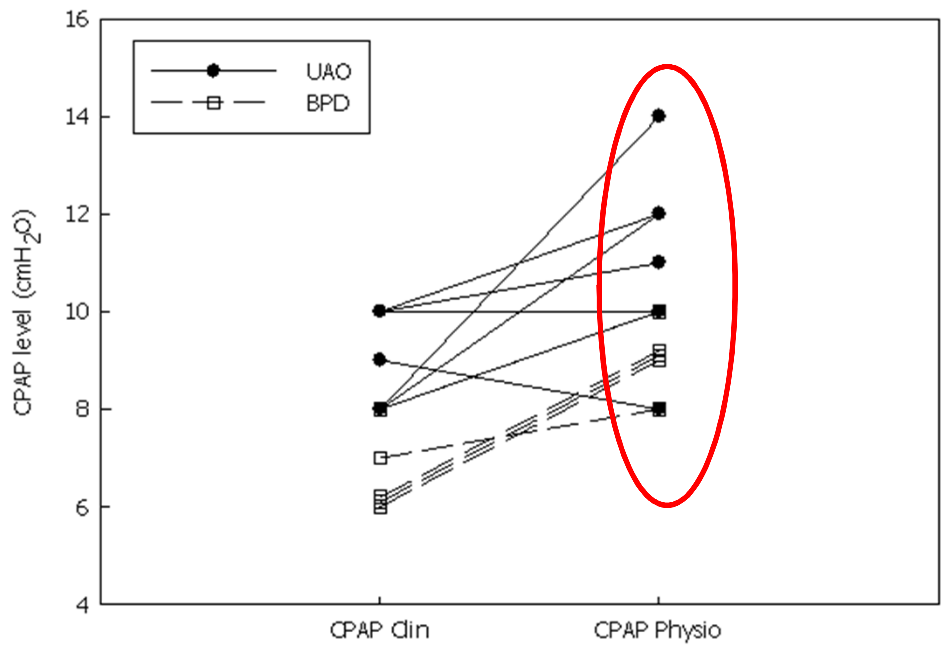
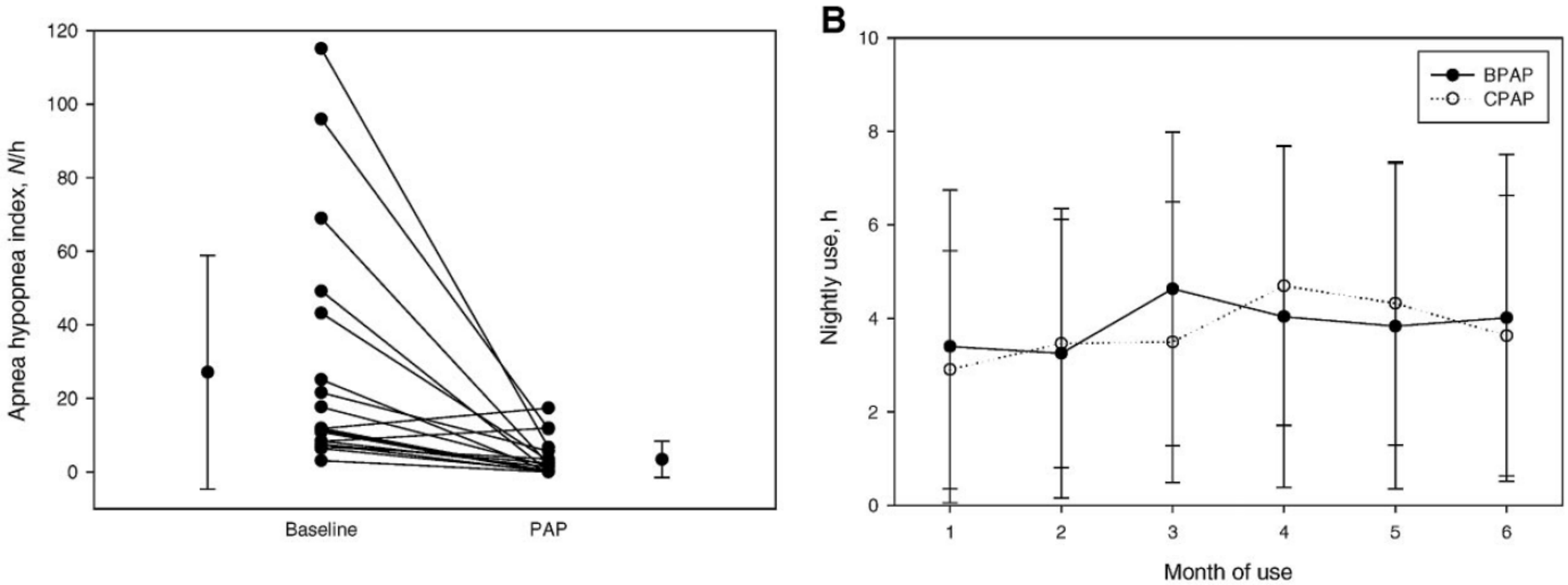


Khirani *et al.* Crit Care 2013;17:R167

No difference between CPAP and BiPAP

29 children with OSAS: CPAP or Bilevel PAP

1/3 not compliant at 6 months, mean use/night: 5.3 ± 2.5 hours



Marcus *et al.* Pediatrics 2006;117:e442

Efficacy of Automated Continuous Positive Airway Pressure in Children With Sleep-Related Breathing Disorders in an Attended Setting

Luciana Palombini, MD; Rafael Pelayo, MD; and Christian Guilleminault, MD

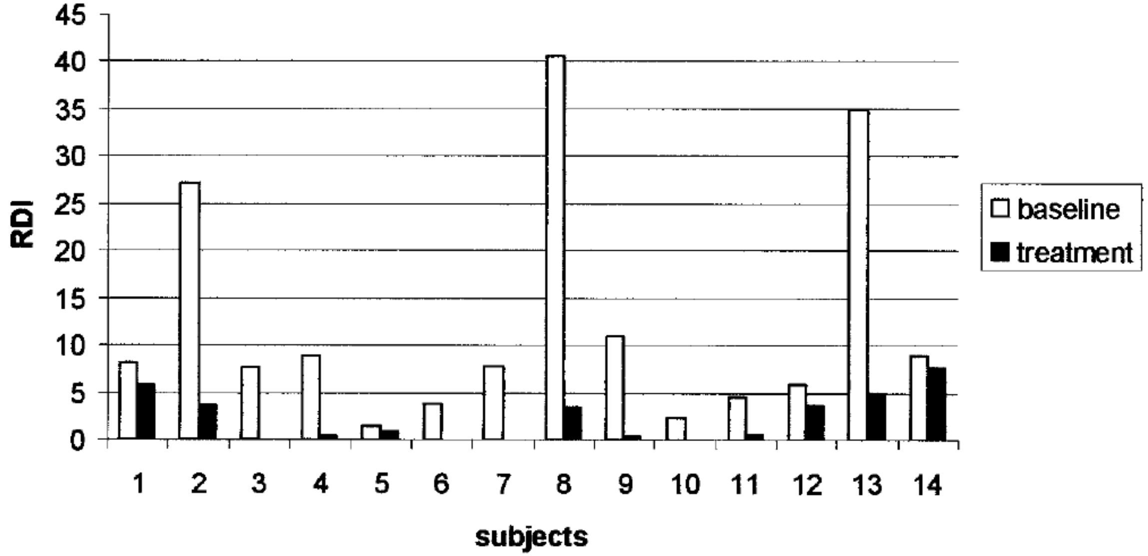


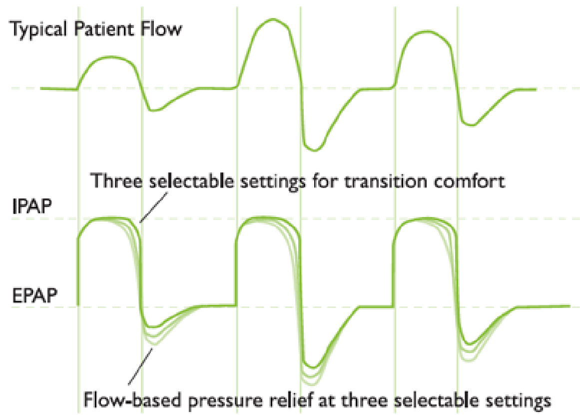
TABLE 3. Polysomnographic Results

	Baseline, Mean (SD)	AutoSet T (Manually Reviewed)
RDI baseline, events/h	12.4 (12.4)	2.3 (2.6)*
Lowest O_2 saturation, %	86 (10.8)	93.6 (3.9)*
Sleep efficiency, %	84.8 (7.2)	86.8 (7)
Sleep latency, min	10.4 (13)	6.7 (7.5)

PEDIATRICS Vol. 113 No. 5 May 2004

No difference between CPAP and A-Flex

Randomized double blind trial: CPAP vs Bi-Flex
PSG before and after 3 months
Objective compliance at 1 and 3 months



56 children and adolescents	CPAP	A-Flex	p
Mean use (nights/month) at M1	24 ± 6	22 ± 9	NS
Mean use (min/night) at M1	201 ± 135	185 ± 165	NS
AHI/h at baseline	22 ± 21	24 ± 6	NS
IAH/h at M1	2 ± 3	2 ± 2	NS
Epworth Sleepiness Scale at baseline	8 ± 5	10 ± 6	NS
Epworth Sleepiness Scale at M1	6 ± 3	5 ± 5	NS

Marcus *et al.* J Clin Sleep Med 2012;8:37

In practice

- No CPAP mode has proven to be superior to constant CPAP
- Titration
  - in-hospital overnight titration = gold standard
  - alternatively
    - start with auto-CPAP
    - switch to constant CPAP after one week (in-built software)
    - infant: set (progressively) to the highest tolerated level

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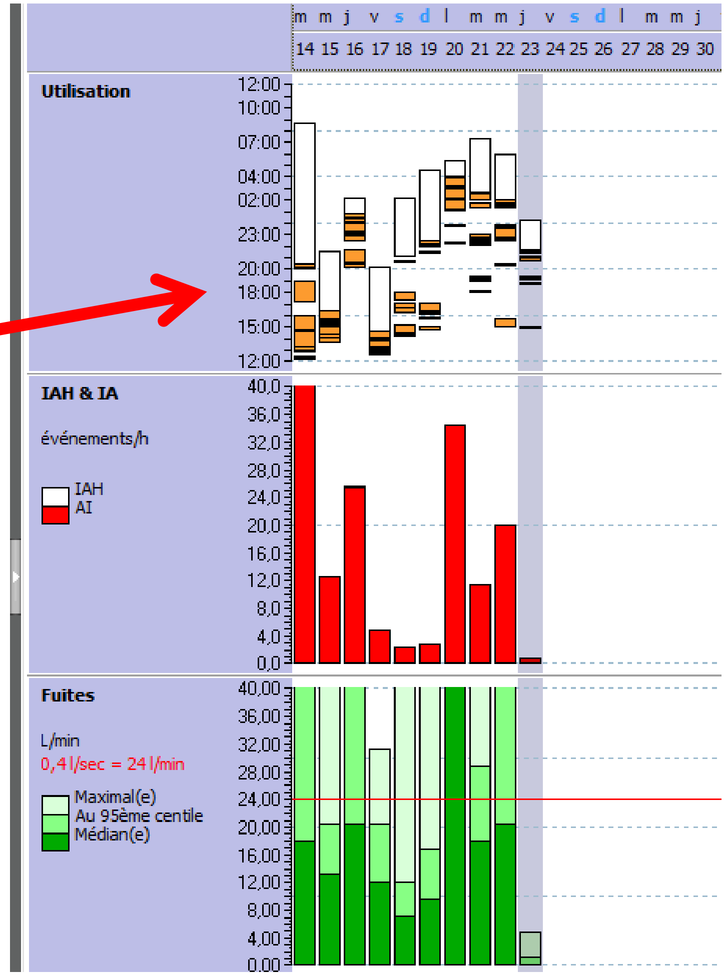
Devices able to deliver CPAP

Devices able to deliver CPAP

Devices	CPAP	Auto CPAP	Bilevel PAP	Adjustable trigger	Volume guarantee	Minimal weight	Minimal flow detection
S10 VPAP ST	yes	no	yes	yes	no	13kg	50ml
S10 Autoset	yes	yes	no	no	no	30kg	100ml
BIPAP A30	yes	no	yes	no	200ml	10kg mode ST 20kg AVAPS	Autotrack
BIPAP A40	yes	no	yes	yes	200ml	10kg mode ST 20kg AVAPS	Autotrack or airflow
PR1 REMstar	yes	yes	no	no	no	30kg	Autotrack
PR1 BIPAP ST	yes	no	yes	no	no	18kg	Autotrack
PR1 BIPAP ST AVAPS	yes	no	yes	no	200ml	18kg mode ST 20kg AVAPS	Autotrack
Trilogy	yes	no	yes	yes	50ml	5kg	Autotrack or airflow

Choice of the CPAP device

- Characteristics of the patient
  - battery ? alarms ? (humidification)
  - necessity to use the in-built software ?
- In practice
  - simplicity
  - ergonomy
  - humification



Interfaces for children

Long-term non-invasive ventilation in children

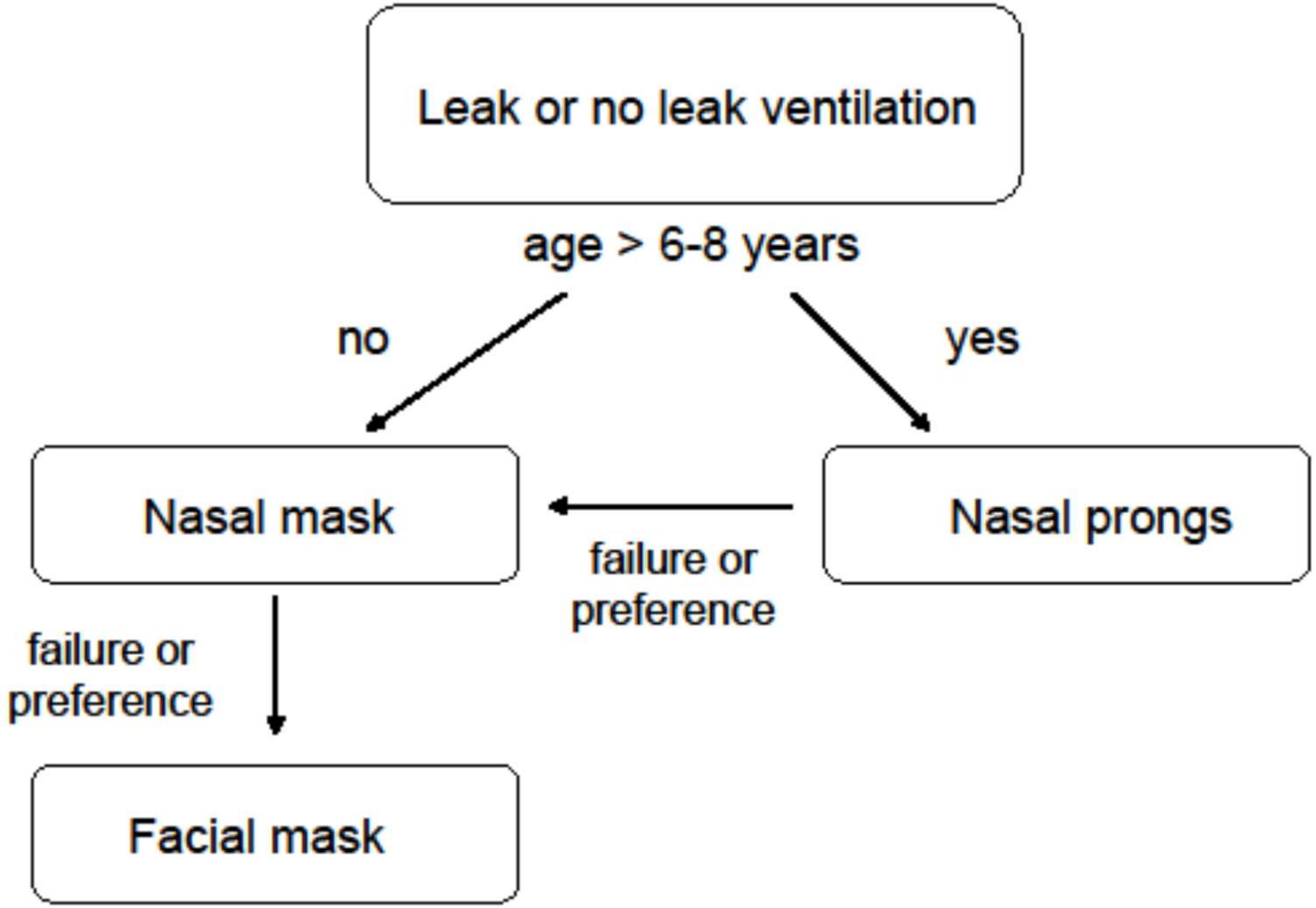
Alessandro Amaddeo, Annick Frapin, Brigitte Fauroux

	Advantages	Disadvantages	Side-effects
Nasal mask	Small internal volume; large choice of different industrial models	Not usable in case of mouth leaks	Pressure sores, eye irritation if leaks, facial deformity
Nasobuccal mask	Prevents mouth leaks	Large volume; risk of inhalation of gastric content in case of gastro-oesophageal reflux; impairs communication and vocalisation; increased aerophagia	Pressure sores, eye irritation if leaks, facial deformity
Total face mask	Prevents mouth leaks	Larger volume than nasobuccal mask; risk of inhalation of gastric content in case of gastro-oesophageal reflux; impairs communication and vocalisation; increased aerophagia	Pressure sores, facial deformity
Nasal pillows	Small and light; no pressure sores	Not usable in case of mouth leaks	Nasal irritation
Mouthpiece	Small and light; no pressure sores; can be used intermittantly	Not useable during sleep	None

Table: Advantages, disadvantages, and side-effects of interfaces for children

www.thelancet.com/respiratory **Published online July 13, 2016 http://dx.doi.org/10.1016/S2213-2600(16)30151-5**

Choice of the interface



Nasal interfaces for infants

Interfaces for older children

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Polygraphy duration (h:min)	7:10 ± 1:30
Mean CPAP level (cmH_2O)	7.7 ± 1.5
Nocturnal gas exchange	
Mean SpO_2 (%)	97 ± 1
Minimal SpO_2 (%)	89 ± 6
Time spent with SpO_2 <90% (%)	0.2 ± 0.5
Oxygen Desaturation Index (number/h)	3.8 ± 5.2
Mean $PtcCO_2$ (mmHg)	40 ± 4
Maximal $PtcCO_2$ (mmHg)	46 ± 7
Time spent with $PtcCO_2$ >50 mmHg (%)	1.7 ± 6.0
Objective CPAP adherence over the last month (n = 20)	
Average use per night (h:min)	7:40 ± 2:10
Average use per month (nights/month)	28 ± 2

Occurrence of SomnoNIV respiratory events during CPAP ($n = 29$).

	Unintentional leaks	Partial or total UAO without decrease in ventilatory drive	Partial or total UAO with decrease in ventilatory drive	Decrease in ventilatory drive	Mixed events
Number of polygraphies with the event, *n* (percentage)	12 (41%)	19 (65%)	13 (45%)	12 (41%)	3 (10%)
Event index/h, median (range)	0.0 (0.0–3.1)	0.4 (0.0–7.9)	0.0 (0.0–4.8)	0.0 (0.0–25.2)	0.0 (0.0–2.0)
Percentage of time spent with each event, median (range)	0.0 (0.0–42.4)	0.7 (0.0–13.7)	0.0 (0.0–7.4)	0.0 (0.0–5.3)	0.0 (0.0–4.0)

Sleep Medicine 16 (2015) 107–112

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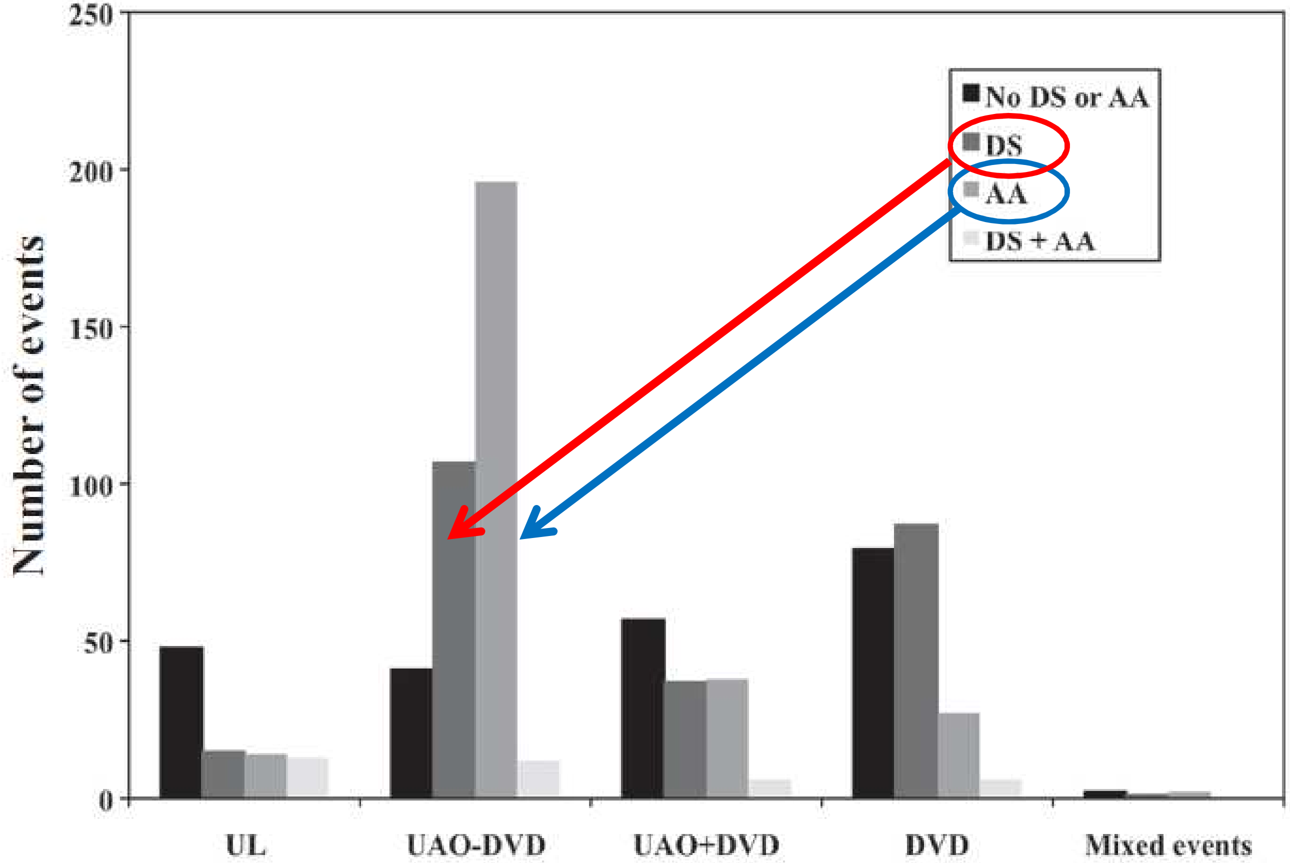
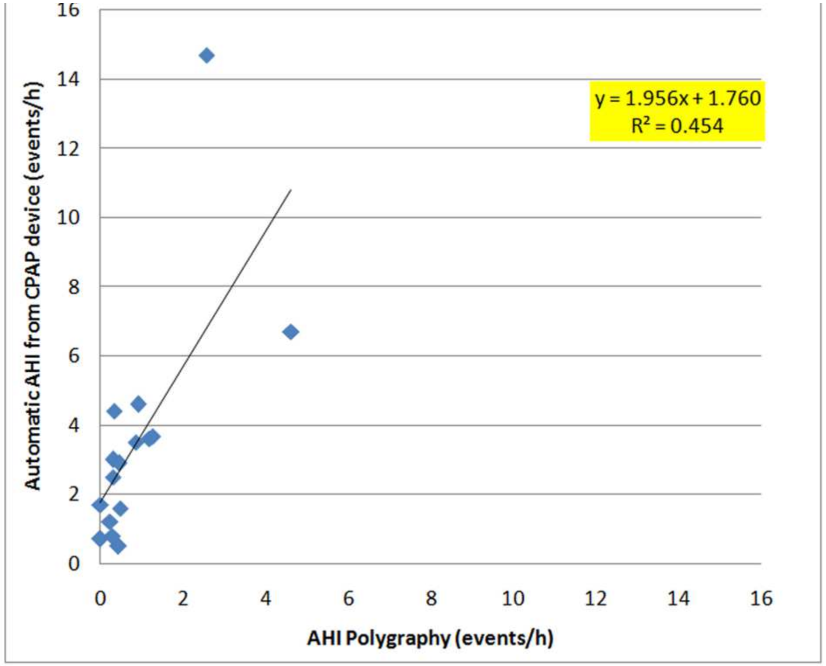


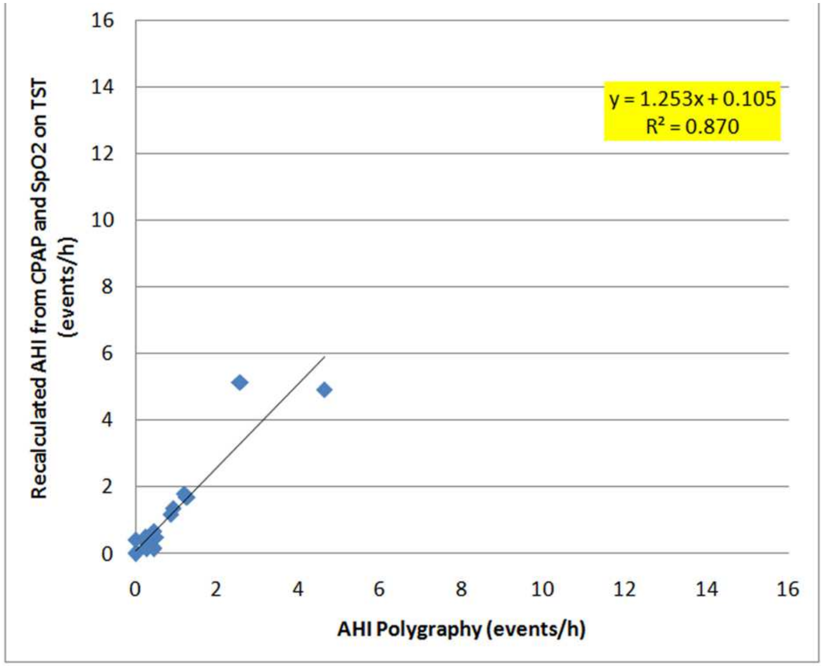
Sleep Medicine 16 (2015) 107–112

Value of the analysis of the in-built software

Comparison of the data from the in-built software (Rescan) + SpO_2 and a PG



Automatic analysis



Analysis of the in-built software tracings as a PG

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Weaning of CPAP

- Lack of guidelines
- Determinants
  - underlying disease and natural history (PRS)
  - growth, weight loss
  - interventions: orthodontics, surgery…
- Long lasting effect of CPAP
  - importance long term follow up with of regular assessments
- Criteria: normal sleep without CPAP

Noninvasive positive-pressure ventilation avoids recannulation and facilitates early weaning from tracheotomy in children*

Brigitte Fauroux, MD, PhD; Nicolas Leboulanger, MD; Gilles Roger, MD; Françoise Denoyelle, MD, PhD; Arnaud Picard, MD, PhD; Erea-Noel Garabedian, MD; Guillaume Aubertin, MD; Annick Clément, MD, PhD

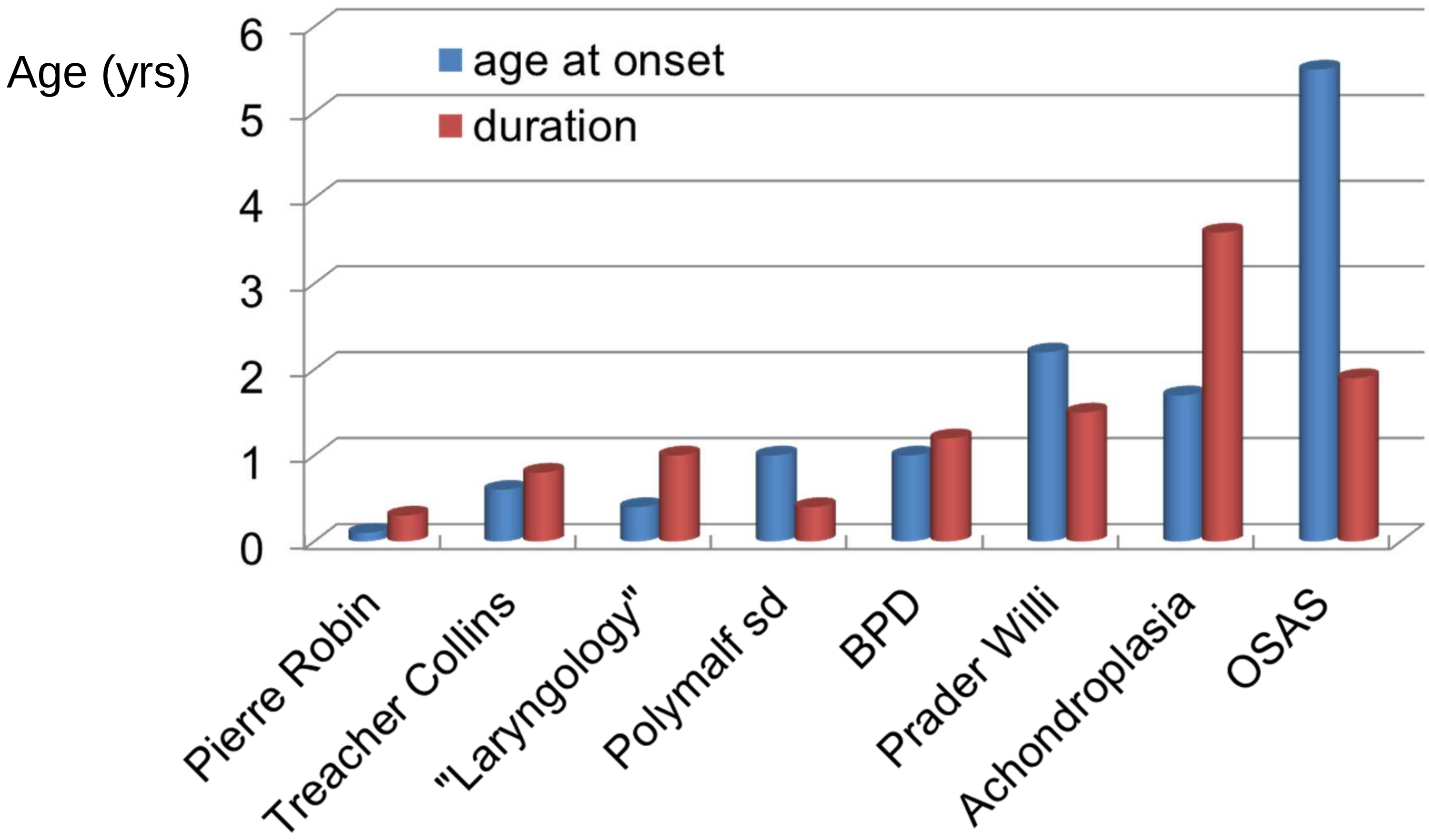
Patient	Gender	Diagnosis	Age at Tracheotomy	Age at Detubation (yrs)	NPPV Delay (mos)	Outcome
Delayed NPPV group						
1	female	Treacher-Collins syndrome	1 mo	2.5	6	on NPPV since 1 mo
2	female	Vocal cord paralysis + tracheomalacia	1 mo	2.5	4	successful NPPV withdrawal at age 5, now 7.5 yrs old
3	male	Vocal cord paralysis + polymalformation	3 mos	11	48	still on NPPV at age 18
4	male	Congenital diaphragmatic hypoplasia #	3 mos	5.7	12	still on NPPV at age 12
5	female	Cystic lymphangioma	6 mos	2	1	successful NPPV withdrawal at age 4, now 11 yrs old
6	male	Vocal cord paralysis + BPD #	6 mos	2	1	still on NPPV at age 4
7	male	Vocal cord paralysis + multiple congenital anomalies	6 mos	10	6	still on NPPV at age 11
8	male	Laryngeal cleft	1 yr	3	6	successful NPPV withdrawal at age 12, now 13 yrs old
9	female	Vocal cord paralysis + cerebral tumor	6.5 yrs	10.5	9	still on NPPV at age 12

Pediatr Crit Care Med 2010 Vol. 11, No. 1

Weaning of CPAP/NIV
59 patients (25%) / 27 mois

Age at CPAP/NIV initiation (median), yrs	1.4
CPAP / NIV	51 (86%) / 8 (14%)
Duration of CPAP / NIV (median), yrs	1 / 4
Diagnosis	Laryngeal disease 8 Prader Willi sd 6 Bronchopulmonary dysplasia 6 Treacher Collins 6 Pierre Robin sd 5 Polymalformative sd 5 Idiopathic OSA 5 Achondroplasia 3 Crouzon, Apert 2 Pycnodysostosis 2 Mucoplysaccharidosis 2 Goldenhar sd 1 Other 6
Reason of withdrawal	**Improvement 75%:** spontaneous 2/3, after surgery 1/3 Non compliant, poor tolerance: 25%

Age at onset of CPAP/NIV and duration of treatment



CPAP for OSAS in children

- For which patients ?
- When to start ?
- Which CPAP mode & setting ?
- Which equipment ?
- How to monitor ?
- When to stop ?
- Conclusion

Conclusion

Areas for future research

- Validation of initiation & weaning criteria
- Improvements of the flow detection (in-built software) of CPAP devices (infant)
- Nasal prongs and naso-buccal interfaces for infants
- Teletransmission of inbuilt software data + gas exchange (SpO_2 + $PtcCO_2$)