NIV - perioperative management
non-invasive ventilation
history

- use of NIV in restrictive lung disease in poliomyelitis
  - negative pressure ventilation ("iron lung")

- today
  - majority of children using NIV due to neuromuscular disorders

- more to come
  - obstructive sleep apnea syndrome
obstructive sleep apnea syndrome

- increasingly recognised disorder in children
  - adenoid, tonsillar hyperplasia
  - craniofacial abnormalities
  - neurological problems

  - Down‘s Syndrome
  - Pierre-Robin Sequence
  - cerebral palsy
  - severe tracheomalacia
suspected sleep-related breathing disorder

- sleep history
  - symptoms during sleep (snoring, pauses in respiration, gasping, cyanosis, arousal, enuresis, restlessness, sweating, mouth breathing)
  - awake symptoms (morning headache, somnolence, attentional or behavioral problems, hyperkinesis)
  - evolution of symptoms over time, change with intercurrent infections or allergies
  - sleep schedule, environment

- general medical history
  - ENT-problems, cardiopulmonary disease, growth & development, family history of sleep-disordered breathing
suspected sleep-related breathing disorder

- physical examination
  - vital signs; height, weight, BMI, RR, growth velocity
  - oropharynx; tonsils, palate, posterior airway space, tongue, occlusion
  - craniofacial; jaw size & position, bony dysplasia, adenoid facies, high & narrow hard palate
  - neck; thyroid, masses
  - chest; heart & breath sounds, split Sc2
  - breathing; mouth breathing, nasal speech, noisy air change
  - neurologic; focal deficits, brief developmental assessment
nocturnal ventilation failure

postoperative similar situation

REM-Sleep

- atony of muscles
  - weakness of diaphragm is exposed
  - upper airway muscles

- mixed sleep-disordered breathing problems
  - central
  - obstructive sleep apnea

- hypercarbia, hypoxemia

Initiating noninvasive management of respiratory insufficiency in neuromuscular disease; JO Benditt, Pediatrics 2009
NIV in obstructive sleep apnea

- improvement of memory
- reduction of pulmonary hypertension
- decrease of hypertension
- reduction of other cardiovascular risk factors
NIV in neuromuscular disease

- most important patient group
- various respiratory problems
NMD _ respiratory problems

- inability to ventilate
  - inspiratory muscle weakness

- aspiration risk
  - upper airway muscle weakness

- inability to cough
  - expiratory muscle weakness
  - upper airway muscle weakness
  - inspiratory muscle weakness

pneumonia, atelectasis, respiratory failure

Initiating noninvasive management of respiratory insufficiency in neuromuscular disease; JO Benditt, Pediatrics 2009
NMD, chest wall dis – pulmonary morbidity

- pulmonary morbidity is the commonest cause of
  - hospital admission
  - death

- pulmonary function
  - FVC is best measurement of respiratory capacity
  - if unable to perform measurement
    - frequent chest infections
    - poor feeding
    - symptoms of reflux & dysphagia
    - evidence of weak cough and increased respiratory efforts
  - SpO2 < 94%

Respiratory support for the severely handicapped child with NMD: ethics & practicability; Sem in Resp & Crit Care Med 2007; Simonds et al
clinical evaluation

- accurate assessment
- regular clinical review by a multidisciplinary team
- understanding the etiology of respiratory complications and prognostic implications
- measurement of respiratory function (day / night)
- anticipation of problems
nocturnal hypoventilation - monitoring

- review sleep quality & symptoms
- annual evaluation for sleep-disordered breathing
  - ideally annual polysomnography with continuous CO2 monitoring
- overnight pulse oxymetry with continuous CO2 monitoring

Initiating noninvasive management of respiratory insufficiency in neuromuscular disease; JO Benditt, Pediatrics 2009; Respiratory care of the patient with Duchenne muscular dystrophy; ATS Conscensus Statement; AJRCCM 2004; Respiratory support for the severely handicapped child with NMD: ethics & practicability; Sem in Resp & Crit Care Med 2007; Simonds et al
sleep studies

- pulse-oxymetry
  - SpO2, heart rate

- "TOSCA"
  - SpO2, PCO2, Heart rate

- OCR
  - SpO2, respiratory movements, heart rate

- PSG
  - EEG, EMG (eyes, legs), ECG, airflow nasal / oral, chest / abdominal, movements, SpO2, CO2
criteria for nocturnal ventilatory support

- symptoms of sleep-disordered breathing

+ 1 of the following:

- PaCO2 ≥ 45mmHg (daytime)
- nocturnal oximetry demonstrating oxygen saturation ≤ 88% for 5 consecutive minutes
- maximal inspiratory pressure < 60cmH2O
- FVC < 50% pred
criteria for diurnal ventilatory support

- NMD are progressive diseases; daytime respiratory insufficiency WILL develop

- waking PCO2 > 50mmHg; diurnal hypercarbia
- SpO2 < 92% (awake)
- daytime dyspnea
- increasing infections despite adequate cough therapy

Initiating noninvasive management of respiratory insufficiency in neuromuscular disease; JO Benditt, Pediatrics 2009, Respiratory Care of the Patient with Duchenne Muscular Dystrophy. ATS Consensus Statement; AJRCCM 2004
NIV in children

- proven useful
- compliance often difficult

NIPPV in the intensive care unit, Crit Care Med 2005, Caples et al
NIV in children

- proven useful
- compliance often difficult

- maximized by
  - adequate education
  - careful choice of suitable interface
  - humidifiers

NIPPV in the intensive care unit, Crit Care Med 2005, Caples et al
NIV in children

- predictors of success
  - younger age
  - unimpaired consciousness
  - moderate rather than severe hypercarbia
  - prompt physiologic improvement in heart & respiratory rates and gas exchange

NIPPV in the intensive care unit, Crit Care Med 2005, Caples et al
complications of NIV

- middle face hypoplasia
- eye irritation, conjunctivitis
- skin ulceration
- gastric distention
- emesis into full face mask
- mask displacement can lead to severe hypoxemia and hypercarbia
typical settings

- scoliosis surgery
- gastrostomy placement
NIV to shorten mechanical ventilation

- NIV
  - shortens duration of mechanical ventilation, facilitate weaning
    - acute-on-chronic respiratory failure
  - prevent re-intubation
    - effective when used immediately after extubation in patients at high risk for extubation failure
  - planned after extubation

NIV to shorten the duration of mechanical ventilation, Resp Care 2009, Scott
NIV in high risk scoliosis surgery

- potential of NIV as alternative to prolonged ETT

- 5 children with scoliosis secondary to DMD or SMA, FVC < 40%
- NIPPV preoperatively trained, postoperatively weaned to NIPPV

- 21 patients with restrictive lung disease (VC <45% pred (18-43%))
- extubation on first postop to NIPPV
extubation to NIV

- use of NIV can
  - aid the weaning process
  - prevent the need for postoperative ventilation
- children should be trained with NIV before surgery

Immediate extubation to NIV can reduce postoperative morbidity and need for PICU in children with NMD, Ped Anesthesia 2009, Plant
planning of operations

- preoperative evaluation at least 2 month before surgery
- postoperative care
  - airway clearance
  - respiratory support
- other problems?

Respiratory Care of the Patient with Duchenne Muscular Dystrophy, ATS Consensus Statement; AJRCCM 2004
process

1-3 months

evaluation
- signs and / or symptoms of sleep-disordered breathing

diagnosis
- sleep-study
- SpO2 - PSG

initiation of NIV
- mask fitting
- mask training

installation of NIV
- hospital (2-5 nights)

first check
- after 1-2 months

operation
- NIV in perioperative management
take home messages

- NIV can help in perioperative management
- be aware of the patients at risk
- installation of NIV takes time
- interdisciplinary management
danke