

Airways Clearance Techniques



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The role of a Chest Physiotherapist

1. Inhalation therapy:

- choice of appropriate inhalation device(s)
- training of the patient/family in its optimal use
- handling, cleaning and need for servicing and replacement of the device

2. Airway Clearance therapy (ACT):

- choice of technique(s)
- training of the patient and caregivers in its optimal use.

3. Physical education and exercise

- providing the patient and family with appropriate and stimulating physical education and exercise programs.
- Musculoskeletal issues, including posture, bone density, urinary incontinence, and pain

4. Education:

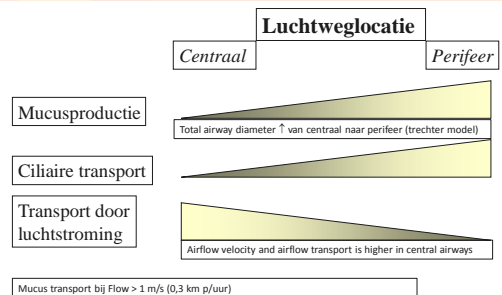
- improving and up-dating patients', families' and locally involved physiotherapists' knowledge of pathophysiology and its treatment.

Introductie

- 10.000 liter lucht per / dag
- Mucus productie in de bronchiale boom (globet cells, clara cells en type II alveolaire cellen)
- Mucus dat de trachea bereikt ~ 10 – 20 ml/dag
- Mucus (mechanische barriere voor organismen; chemische screen met anti-oxident eigenschappen; biologische barriere)
- Mucus transport: [1] ciliary beating (8 - 15 herz) en [2] airflow (PCF 160 – 180 L/min).

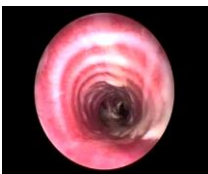


Principes Airway clearance



Airway Clearance Therapie (ACT) Indicatie

- (Chronisch) gestoorde sputumevacuatie
- Onderste luchtwegen



Airway clearance afhankelijk van:

- Airway clearance gestoord
 - Kwantiteit van mucus
 - Viscositeit van mucus
 - Trilhaarfrequentie
- Veranderde eigenschappen luchtwegen
- Open zijn van de luchtwegen
 - Weerstand
 - Airflow
 - Functie Glottis



Three Phases of Cough (PCF)

- Vitale capaciteit (IC)
- Pi-max
- Luchtweg weerstand

Inspiration

↓

Compression

↓

Expiration

↓

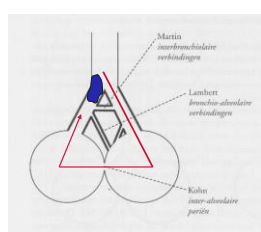
PCF > 500 L/min

- Elastische eigenschappen long
- Mobiliteit Thorax
- Uitademingsdruk (Pe-max)

- Stabiliteit bronchus wand
- Goede glottis functie
- Expiratory Flow (Pe-max)

Airway clearance


- Via collaterale ventilatie
 - Lucht achter mucusplug



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Principes van mucusklaring

- Lucht achter mucus
- Trilling / vibratie
- Expiratoire luchtstroomsnelheid
- Houding



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Algemene behandeltechnieken bij sputummobilisatie

Inspirator volume	Oscillaties	Expiratoire flow	Houding
ACBT Houding Airstacken Cough Assist Inspanning	Flutter, IPV, High Frequency Chest Wall Oscillators, Inspanning	Hoesten/Huffen PEP Autogene drainage Comprimeren Airstacken Cough Assist Inspanning	Houdings-drainage

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AIRWAY-CLEARANCE THERAPY GUIDELINES AND IMPLEMENTATION

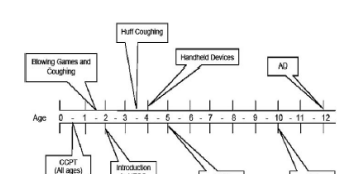


Fig. 1. Not all airway-clearance modalities are appropriate for all ages. We have a strategy of introducing airway-clearance techniques to all patients at our center. We introduce the various airway-clearance techniques based upon the patient's age and ability to perform the therapy. This timeline approximates the appropriate age the therapy can be introduced. AD = autogenic drainage, CCPT = conventional chest physiotherapy, HFCC = high-frequency chest compression, ACBT = active cycle breathing technique, IPV = intrapulmonary percussive ventilation.

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The Physiology of Cough

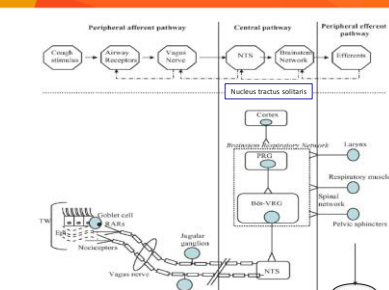
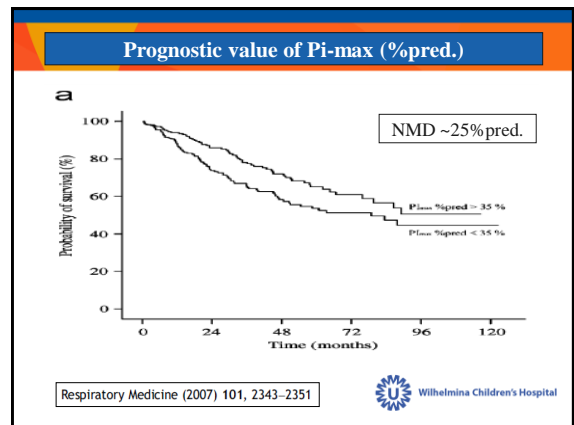
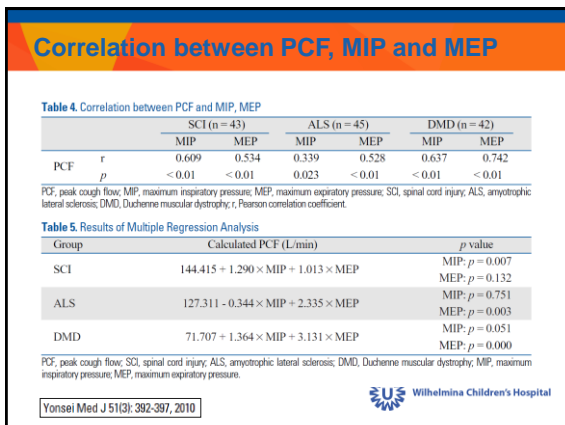
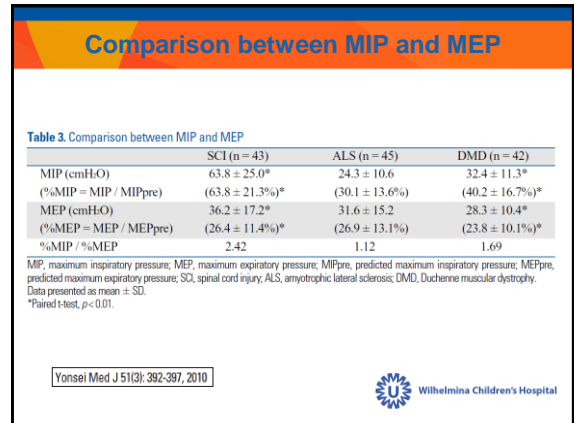
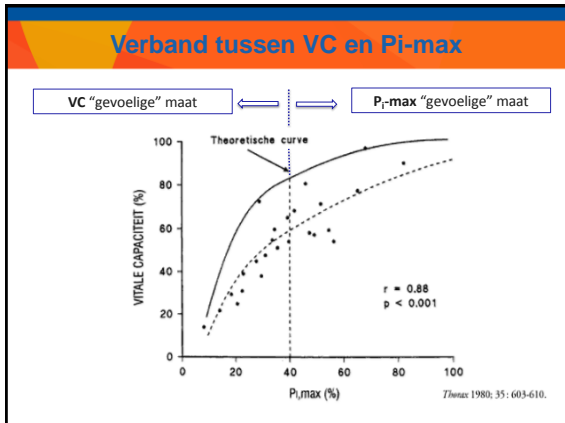
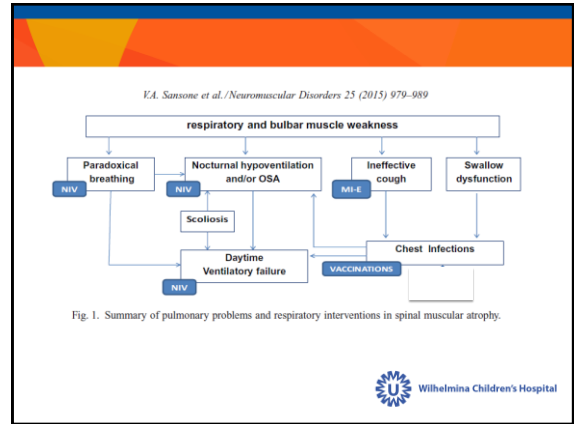
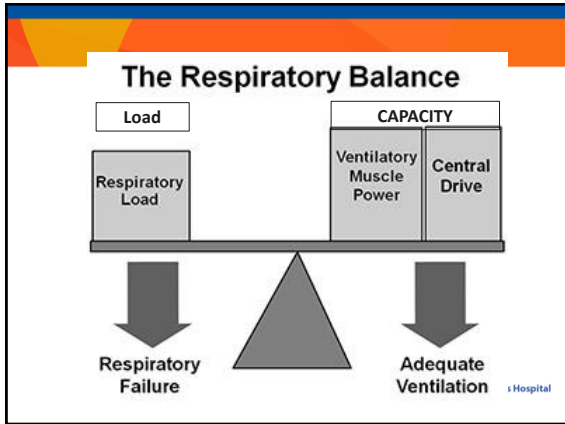
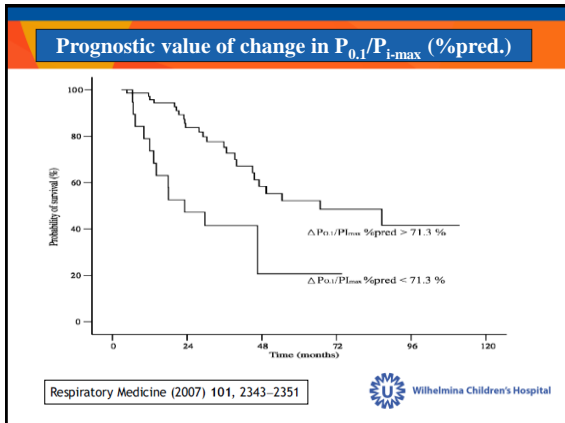
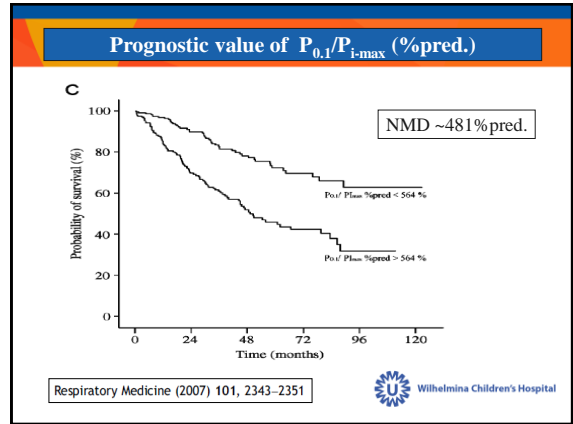
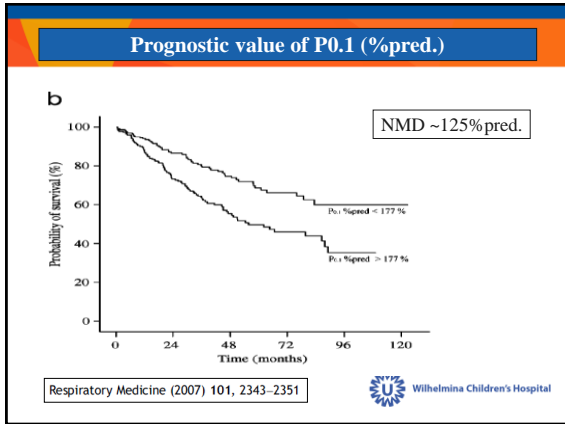


Figure 1 Concepts adapted from review articles^{1,2,3,38,41} grossly simplified into a schematic view. BOI-VRG, Bötzinger, pre-Bötzinger and ventral respiratory group; Epi, epithelium; PRG, pontine respiratory group; RAR, rapid adapting receptor; TM, tracheal wall.

PEDIATRIC RESPIRATORY REVIEWS (2006) 7, 3-8





Ineffective Airway clearance

- IVC < 1,1 L (SE= 91%; SP= 71%: chest infections)
 - (VC < 20 ml/kg) → Airstacken → Coughlator
- Vocal Cord dysfunction
- P_{e-max} < 45 cm H₂O (SE= 86%; SP= 47%: chest infections)
 - (P_{e-max} < 30 cmH₂O) → Compression → RMT
- Peak flow < 160 L/min (SE= 75%; SP= 79%: chest infections) (PCF: normal 360 – 1200 L/min)
 - PCF < 160 L/min → Airstacken → Compression → Coughlator

Developmental Medicine & Child Neurology, 2009

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Conclusions

Category 1:
Patients with MEP > 34 cmH₂O and / or VC > 1,9 L → no MAC

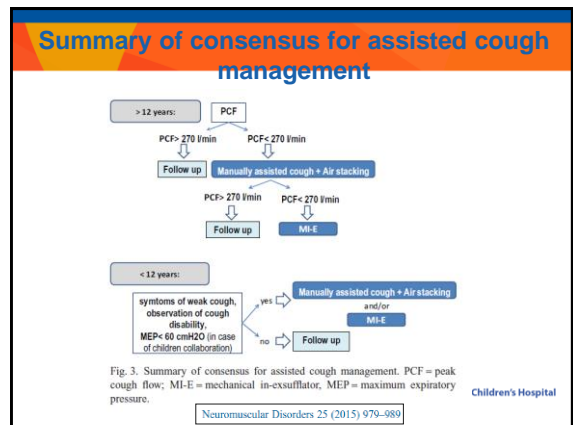
Category 2:
Patients with VC of 0.34 L - 1.9 L and / or MEP 14 – 34 cmH₂O → Breath-stacking plus MAC

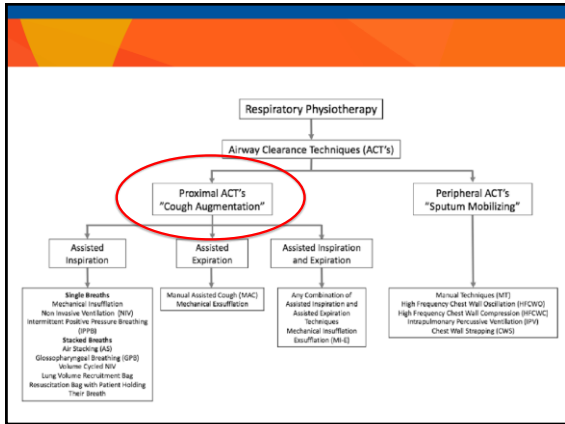
Category 3:
Patients with VC < 0,34 L → In-exsufflation device.

Respiratory Medicine (2007) 101, 2343-2351

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[Respir Care 2009;54(3):359-366. © 2009 Daedalus Enterprises]





Geassisteerde inspiratie

- Enkelvoudig**
 - maximale inademing zonder stapeling
 - Indicatief voor glottis dysfunctie
- Stapelen**
 - Maximale inspiratoire capaciteit
 - Kikkeren ('glossopharyngeal breathing')
 - 6-9 ademhalingen van 40-200mL*
 - MIC = 5x VC (patient report)
 - Airstacking
 - 2-5 insufflaties, 3-5 sec vasthouden, 3-5 series
 - Alveolaire ventilatie, respiratoire compliance, hoestkracht
 - MIC > IC, mits intacte glottisfunctie



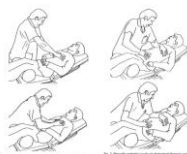
*Dall et al. JAMA 1955



Geassisteerde expiratie

Manuele compressie (MAC)

- Toename van expiratoire flow
- Compressie in de richting van de expiratoire thoraxbeweging
- Coöperatieve patiënt en bekwame hulpverlener/familieid
- CAVE osteoporose



M. Tansveld, L.J. Bonten, V. Galbo, M. Steen, F. Savelle. Limits of effective cough-augmentation techniques in patients with neuromuscular disease. Respir Care 54 (2) (2009) 359-366.


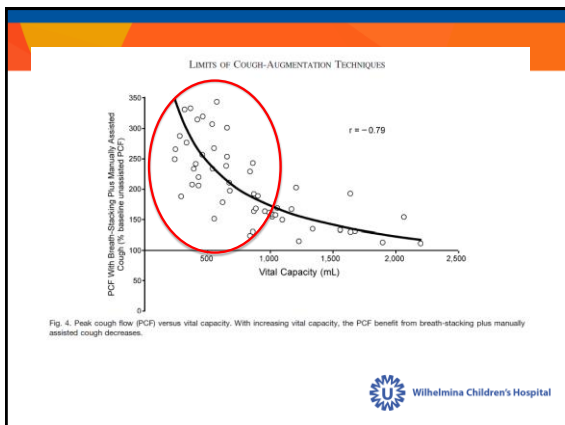
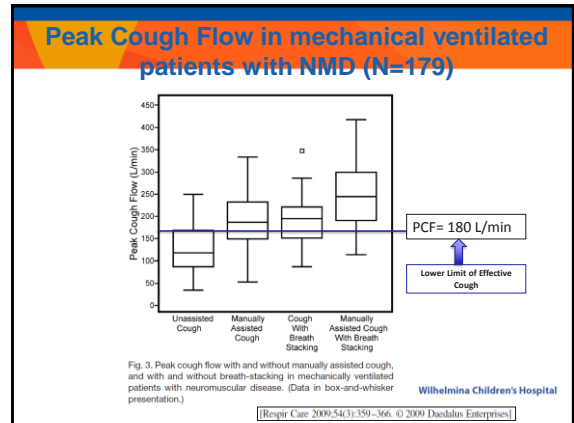




Table 4. Range of Respiratory Muscle Capacity for Effective Assisted Cough

	MAC	Cough With Breath-Stacking	Cough With Breath-Stacking Plus MAC
VC (mL)	1,030*–1,910	558–no limit	340*–no limit
MEP (cm H ₂ O)	14–34*	11–no limit	14–no limit
Unassisted PCF (L/min)	140–178	110*–no limit	90–no limit

* Best receiver operating characteristic (ROC) predictor of the limit of cough effectiveness among vital capacity (VC), maximum expiratory pressure (MEP), and unassisted peak cough flow (PCF).
No limit = no limit identified with ROC analysis
MAC = manually assisted cough



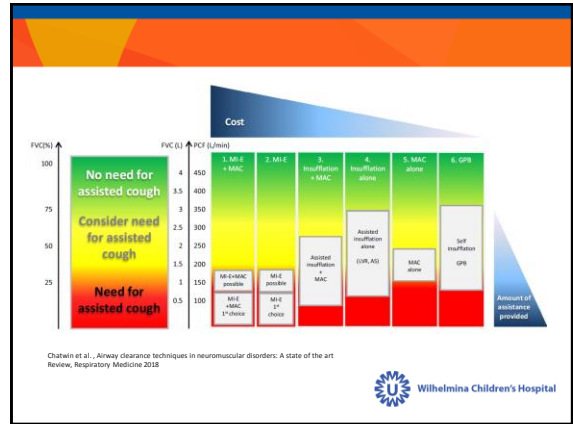
Geassisteerde inspiratie en expiratie

- Insufflatie/Airstacking + Manuele compressie
- Mechanische insufflatie-exsufflatie (MI-E)

Recommendations For The Use Of Mechanical Insufflation-Exsufflation (MI-E).

- MI-E is the **treatment of choice for the weaker group of patients with NMD**
- Face masks should be used when using MI-E in patients without an artificial airway
- **Inspiratory and expiratory timing pressures should be individualized with progressive build-up of pressure until efficiency is achieved**
- Higher expiratory than inspiratory pressures are advisable
- Patients with ALS are likely to benefit from lower pressures, triggered insufflation and longer insufflation time
- MI-E is possible through tracheostomy tubes, with higher pressures for smaller tube diameters
- **Complete the session with an insufflation** to leave an appropriate functional residual capacity in weaker patients or children
- In ICU, MI-E may be as a useful technique to prevent re-intubation
- MI-E may be considered in the weaker children with bulbar insufficiency, and those who cannot cooperate with MAC or AS or in whom these methods are not effective

Charlwin et al., Airway clearance techniques in neuromuscular disorders: A state of the art Review, Respiratory Medicine 2018



sputumevacuerende voorwaarden

- 1) Hoestkracht**
 - Voldoende expiratoire kracht: **41** (≥ 35 cm H₂O)
 - Onvoldoende inspiratoire capaciteit **0.8** (≥ 1.1 liter)
 - Onvoldoende air flow: **160** (≥ 270 L/min)
- 2) Adequaat gebruik hulpmiddelen**
 - Airstackballon: **170 L/min**
- 3) Personalised medicine**
 - → MAC + airstacking/ Cough-assist

Personalized medicine

Individuele benadering essentieel!

- Beschikbaarheid
- Effectiviteit
- Comfort
- Haalbaarheid
- Voorkeur
- Leeftijd

