antadir
INDÉPENDANCE ET EXPERTISE POUR LE PROGRÈS DE LA SANTÉ À DOMICILE

3rd INTERNATIONAL PEDIATRIC
NONINVASIVE VENTILATION CONFERENCE

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Necker ENFANTS MALADES HÔPITAL UNIVERSITAIRE

Swallowing and speaking with NIV

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End:icap

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As already emphasized, NIV is preferred over invasive ventilation, especially for patients with neuromuscular or skeletal disorders who require noncontinuous ventilation because of ease of administration, preservation of upper airway function, enhanced quality of life, and lower cost. Even patients with severely weakened or paralyzed respiratory muscles whose time off the ventilator is negligible may be treated with NIV.[70] However, invasive ventilation should be considered in patients who have persistent symptomatic hypoventilation despite repeated trials of NIV. Further, patients with more rapidly progressive neuromuscular syndromes that impair upper airway function, such as the Guillain-Barré syndrome, are usually treated with invasive ventilation when ventilatory support is indicated. For all patients, the decision to switch from noninvasive to invasive ventilation should be individualized and take patient and pra… as environmental resources i…

Make *Chest* 2008

L'apparition d'un déficit ventilatoire chronique justifie la mise en place d'une ventilation mécanique au long cours destinée à suppléer partiellement ou totalement les muscles respiratoires défaillants. La méthode proposée en première intention est une ventilation non invasive (VNI). Ce type de ventilation est à distinguer des hyperinsufflations périodiques ou IPPB (*intermittent positive pressure breathing*), parfois proposées dans le cadre de la rééducation respiratoire [1].

Les indications de la VNI chez les patients atteints de MNM sont basées sur des critères établis lors de conférences de consensus et/ou sur des avis d'experts. Le critère majeur d'initiation d'une VNI est l'existence d'une hypercapnie diurne, même modérée ($PaCO_2 > 45$ mmHg). D'autres critères, plus précoces, ont été proposés, et comportent les symptômes d'hypoventilation alvéolaire nocturne (céphalées …

=> NON INVASIVE VENTILATION

= 1st-line ventilatoin treatment

ACCP 1998

Finder AJRCCM 2004

…nce de consensus - Chest 1999

Conférence de consensus – Rev Mal Respir 2006

…Recommandations HAS – 2006

Make Chest 2008

BTS – 2015

Recommendation

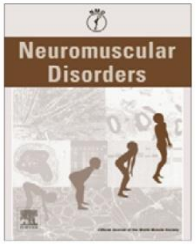
- NIV is the primary … thoracic disease patients with CRF.
- The most important criteria for the advent of long-term NIV are hypercapnia in combination with the typical symptoms of ventilatory insufficiency, and the reduction in quality of life.
- For symptoms of hypoventilation in the absence of hypercapnia, a somnological examination should take place.
- Patients with severe, restrictive ventilatory dysfunction in the absence of manifest hypercapnia must be closely monitored.

Windisch *Pneumologie 2010*

Assisted ventilation

- Children with NMW resulting in symptomatic nocturnal hypoventilation or daytime hypercapnia should be supported with NIV. [C]
- A non-invasive approach should be considered in children needing daytime ventilation. [D]
- Clinical teams caring for children using home ventilators should become familiar with a small number of machines. For most children pressure-targeted machines work well and are simple to use. [√]

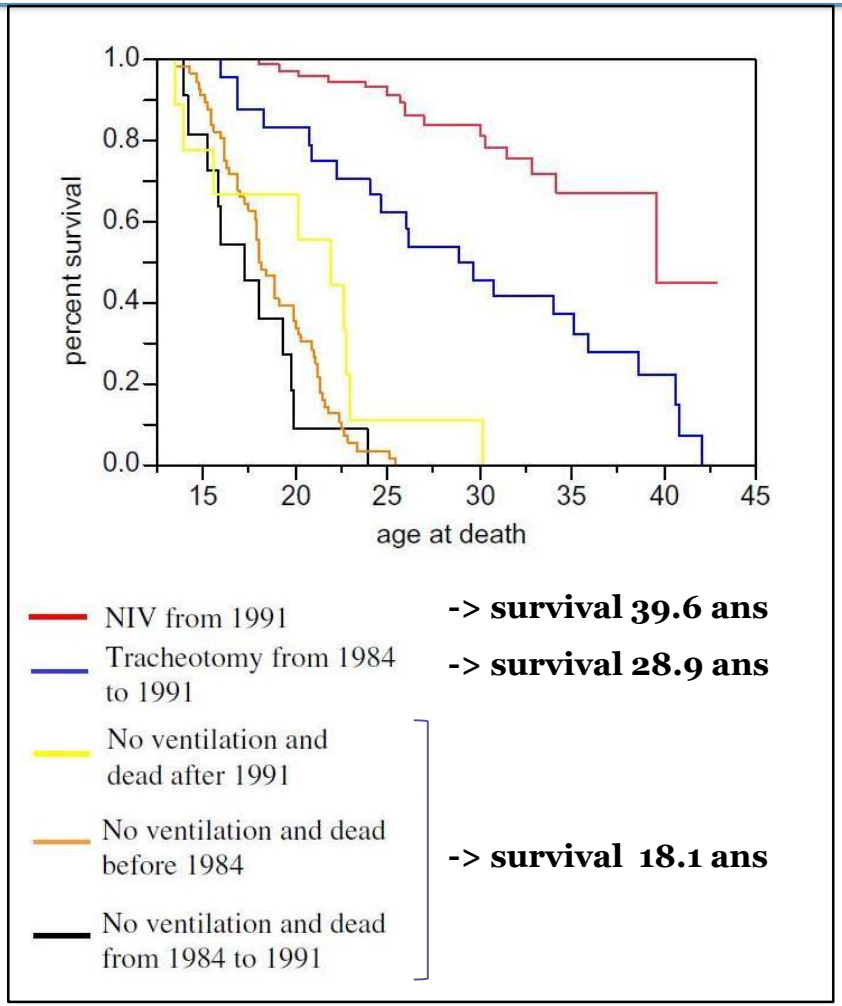
BTS 2015



Duchenne muscular dystrophy: Survival by cardio-respiratory interventions

Yuka Ishikawa, Toshihiko Miura, Yukitoshi Ishikawa, Tomoyuki Aoyagi, Hitoko Ogata, Satoshi Hamada, Ryoji Minami

Neuromuscular Disorders 21 (2011) 47–51



Prolonged NIV use

Interactions with
- **Swallowing ?**
- **Speaking ?**

Breathing and Swallowing Interaction

Normal Subject

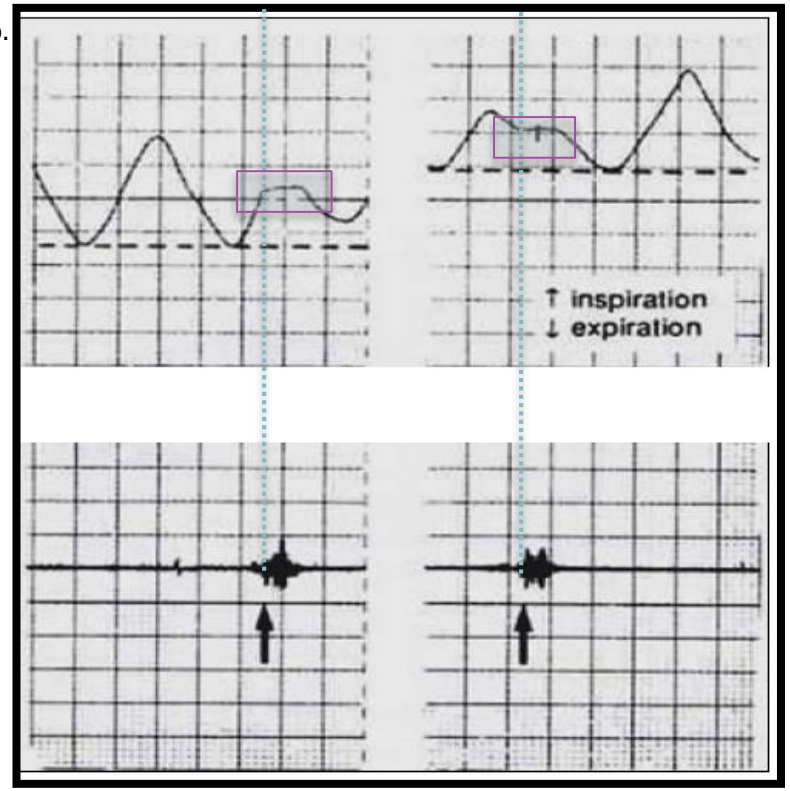
Several successive phases with a critical and complex neurological control (cortex and TC)

⇒ Critical phase: Oro-pharyngeal

Both voluntary and reflex event with modifications of the respiratory cycle

Breathing and swallowing Interaction

Normal Subject



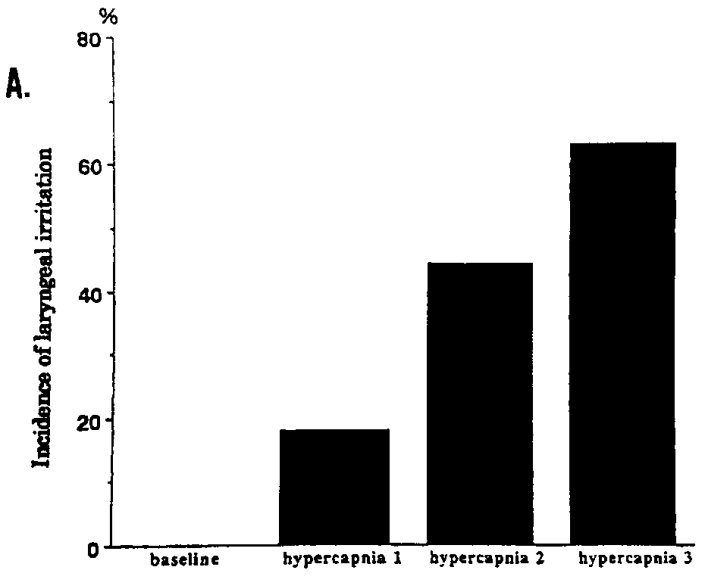
Interruption of respiratory cycle

=> Swallowing apnea

Breathing resumes at the end of inspiration **or** during expiration

Swallowing and respiratory failure

- Hypercapnia increases laryngeal inspiration



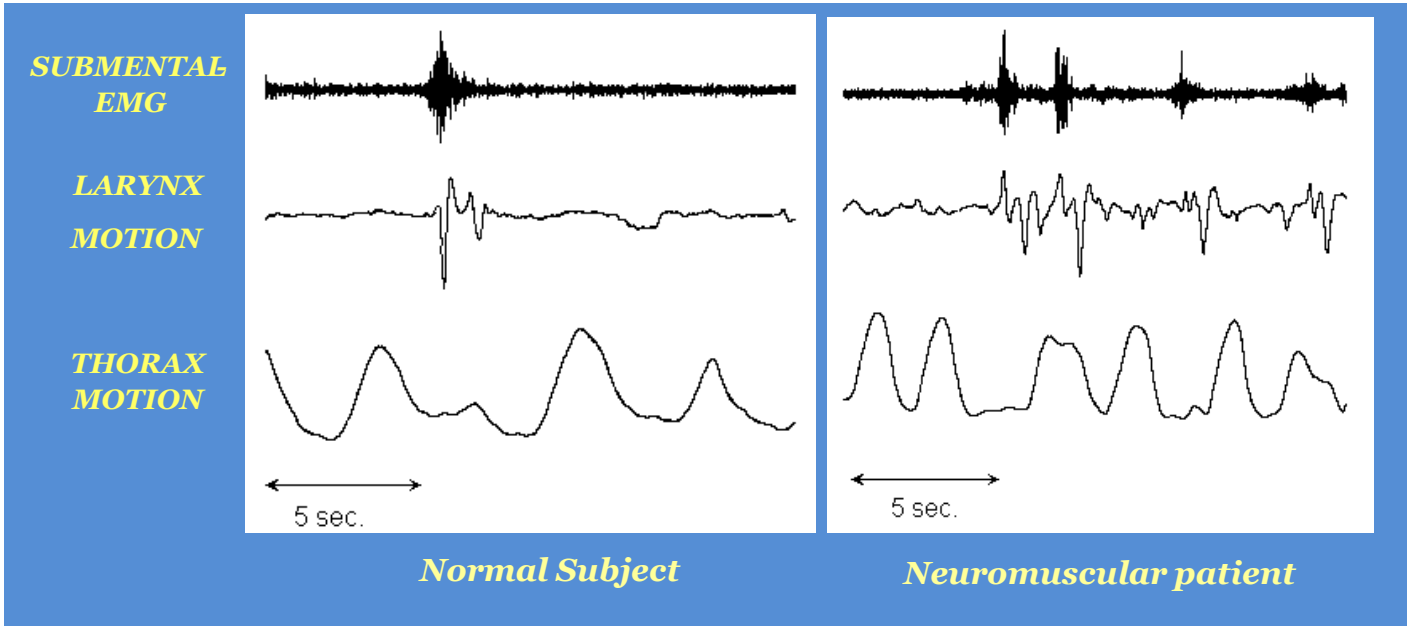
Nishino, AJRCCM,1998

Swallowing and respiratory failure

- Respiratory failure in NM disorders and in COPD may be associated with swallowing disorders and breathing swallowing interactions dysfunction

Shaker et al, American Journal of Physiol 1992
Terzi et al, AJRCCM 2007
Gross et al, AJRCCM 2009
Terzi et al , Neuromuscul Disord 2010

- In NM disorders



Terzi et al, AJRCCM 2007

Swallowing and respiratory failure

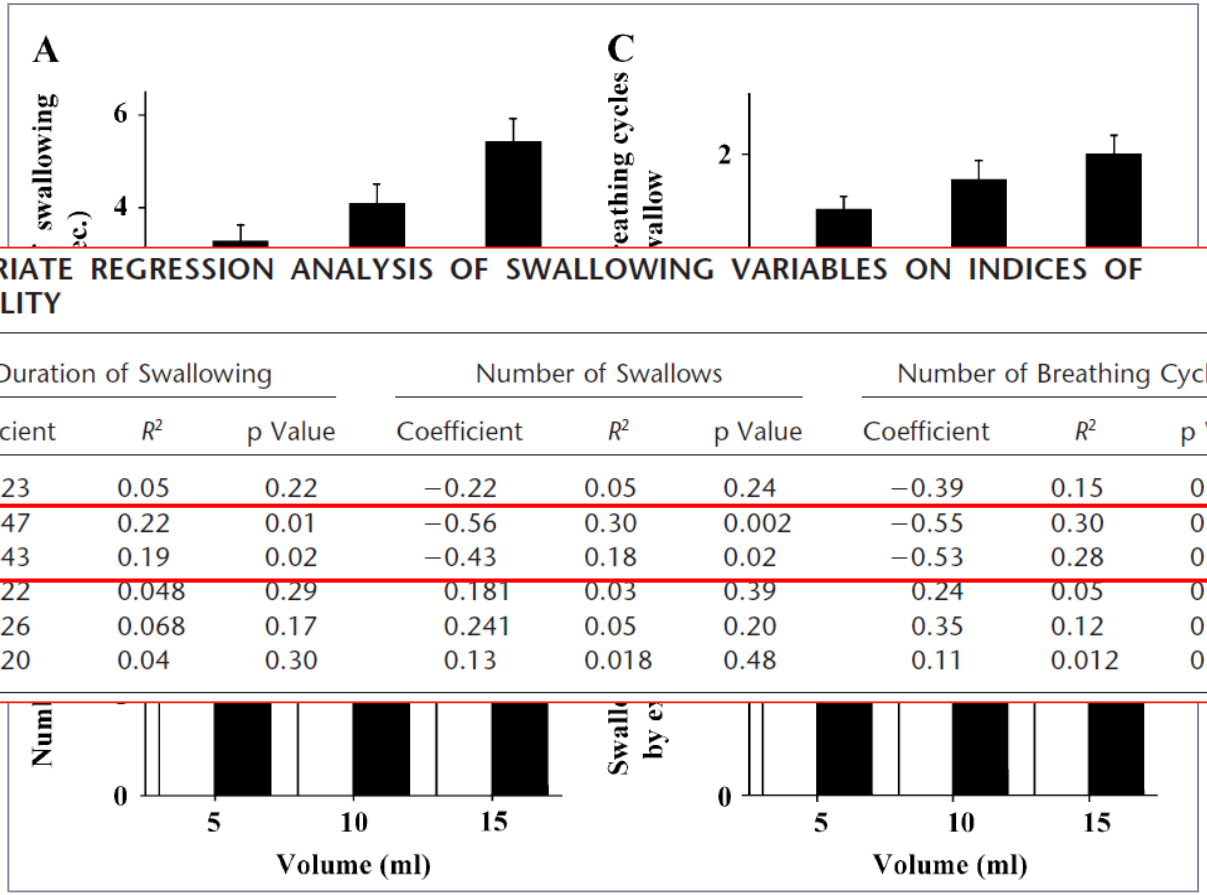


TABLE 3. UNIVARIATE REGRESSION ANALYSIS OF SWALLOWING VARIABLES ON INDICES OF LEVEL OF DISABILITY

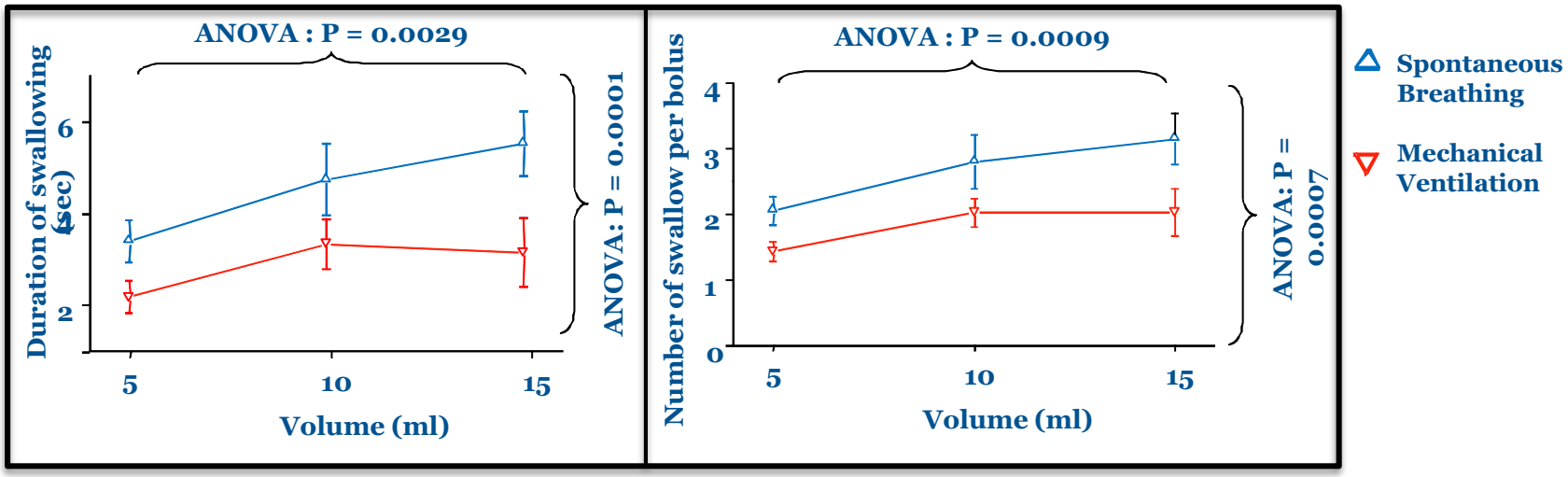
	Duration of Swallowing			Number of Swallows			Number of Breathing Cycles		
	Coefficient	R^2	p Value	Coefficient	R^2	p Value	Coefficient	R^2	p Value
VC	−0.23	0.05	0.22	−0.22	0.05	0.24	−0.39	0.15	0.03
MIP	−0.47	0.22	0.01	−0.56	0.30	0.002	−0.55	0.30	0.002
MEP	−0.43	0.19	0.02	−0.43	0.18	0.02	−0.53	0.28	0.004
Pa_{CO_2}	0.22	0.048	0.29	0.181	0.03	0.39	0.24	0.05	0.25
AI	0.26	0.068	0.17	0.241	0.05	0.20	0.35	0.12	0.06
Dysphagia	0.20	0.04	0.30	0.13	0.018	0.48	0.11	0.012	0.56

Comparing Normal Subjets - NMD

Terzi et al, AJRCCM 2007

Swallowing and respiratory failure and ventilation

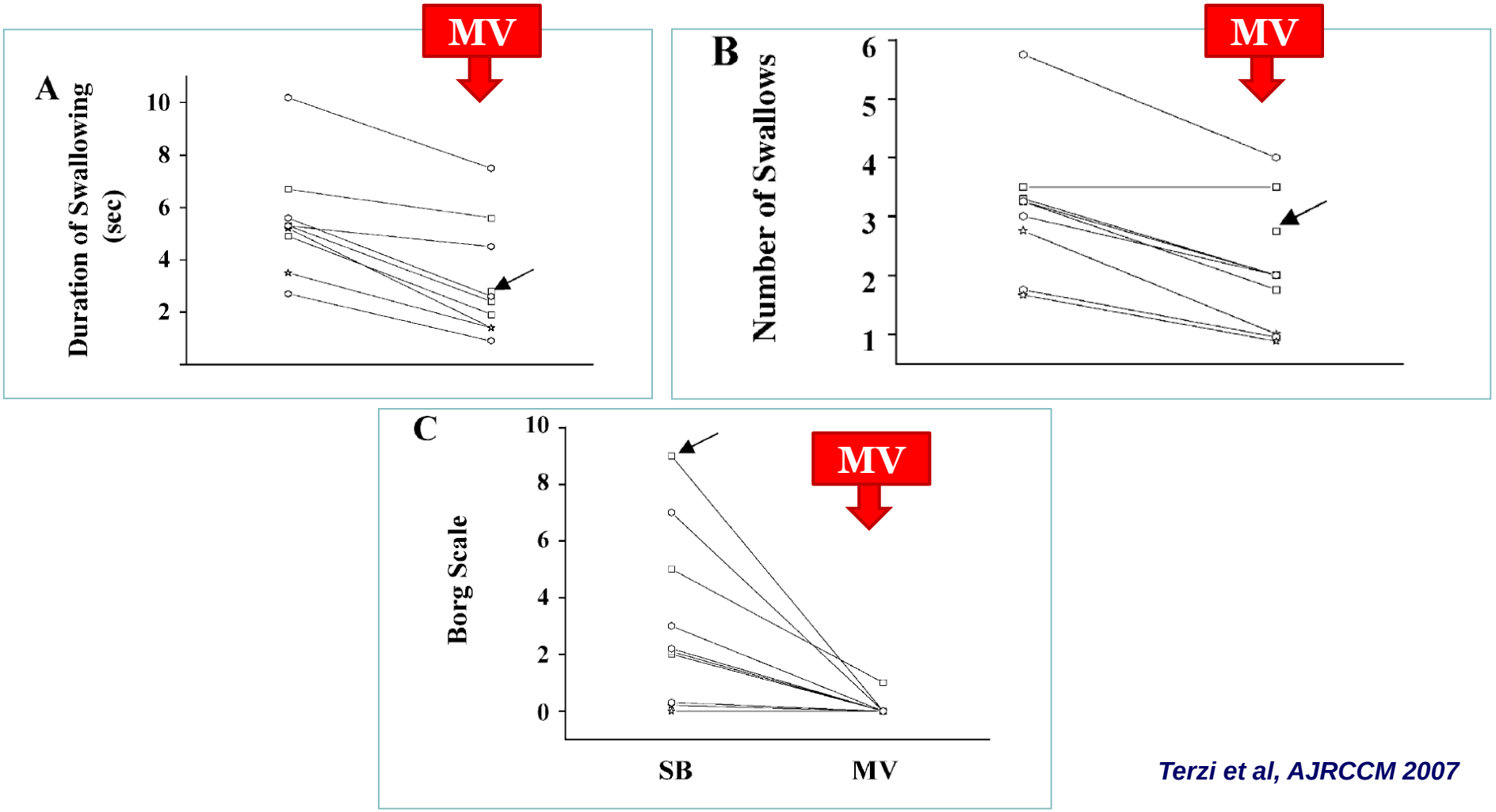
- Tracheostomized NM patients improve their swallowing parameters improve when swallowing **while ventilated**



Terzi et al, AJRCCM 2007

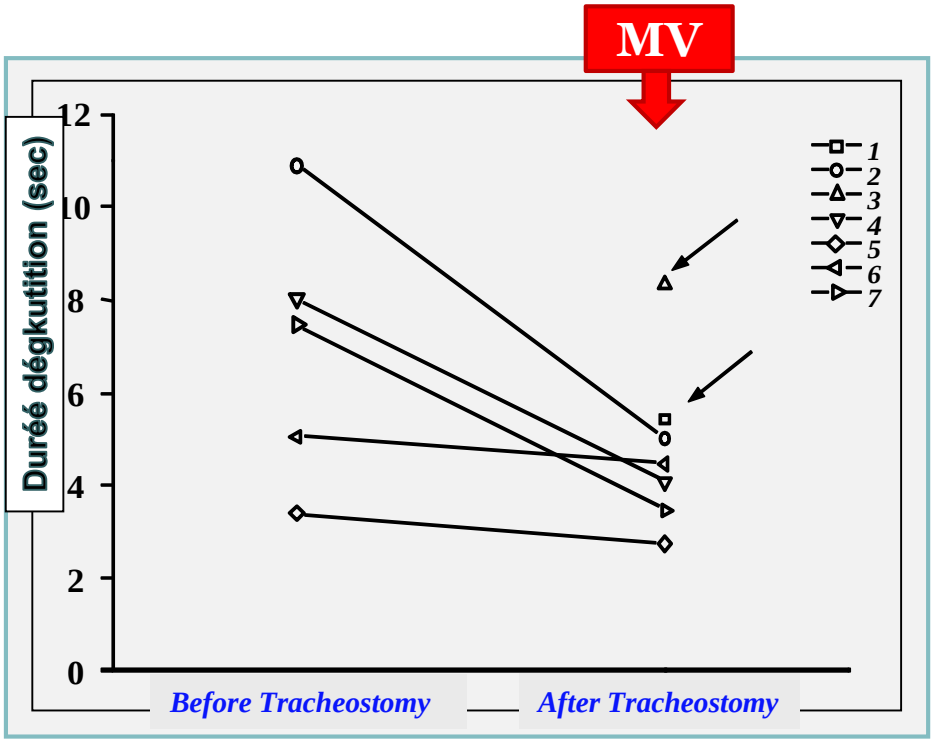
Swallowing and respiratory failure and ventilation

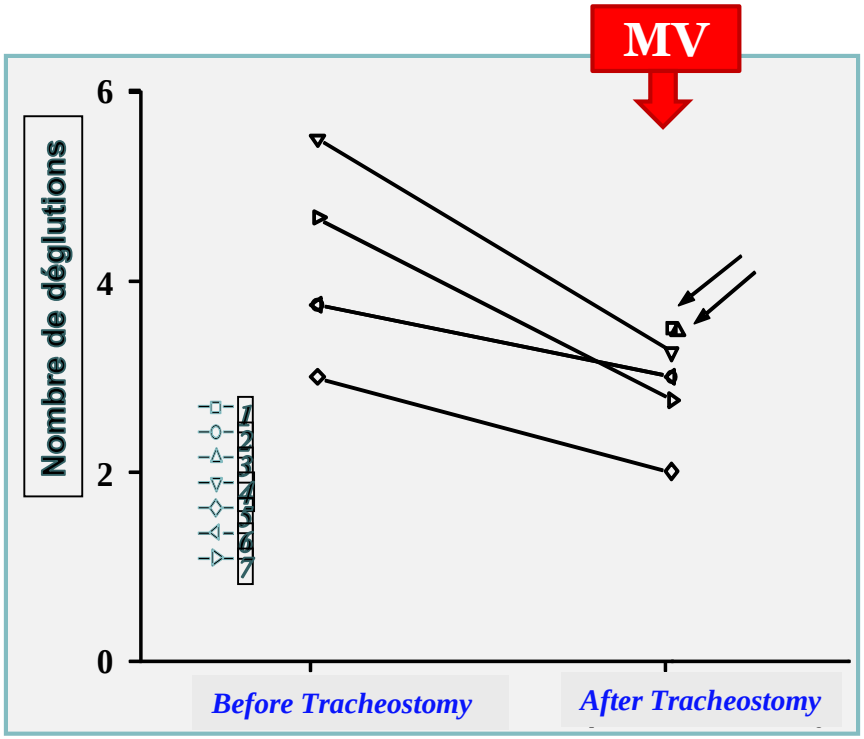
=> 10 tracheostomized subjects



Terzi et al, AJRCCM 2007

Swallowing and respiratory failure and ventilation





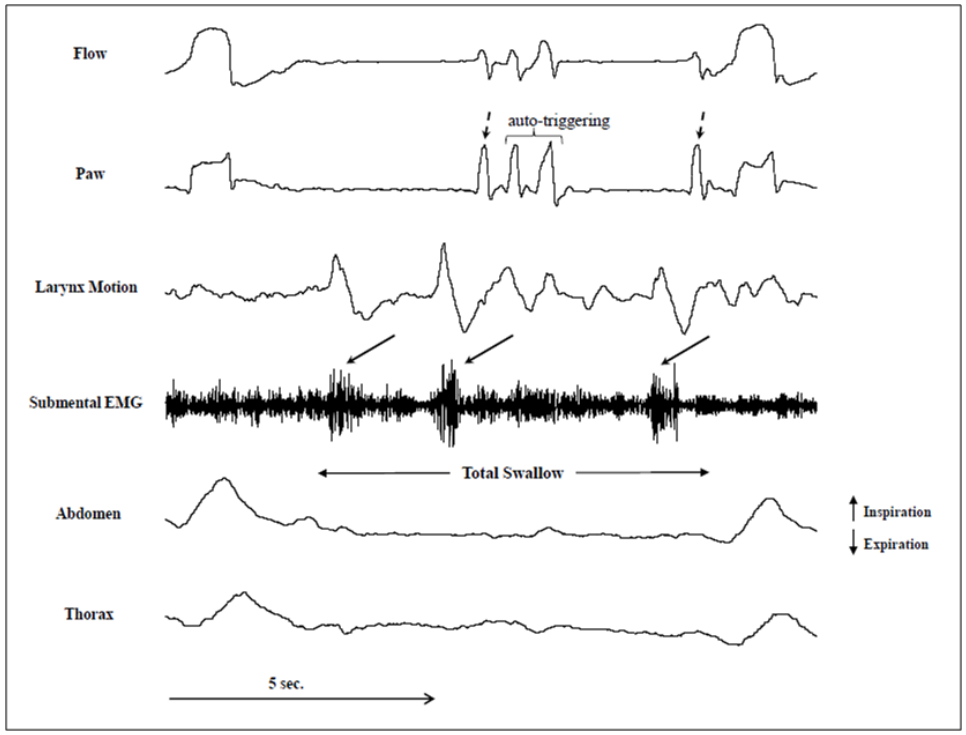
=> Reduction of swallowing fragmentation **after** tracheostomy **while** ventilated

Terzi et al, Neuromuscular Disord 2010

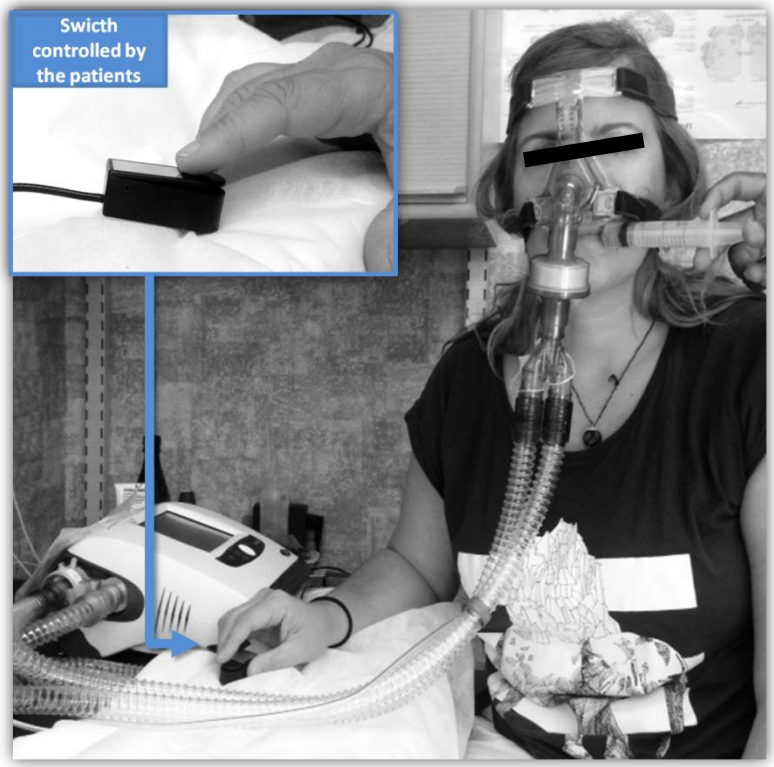
Swallowing and respiratory failure and ventilation

Can NIV use improve breathing-swallowing interactions in NM patients with severe respiratory failure?

Swallowing and NIV



Terzi et al, CCM 2014

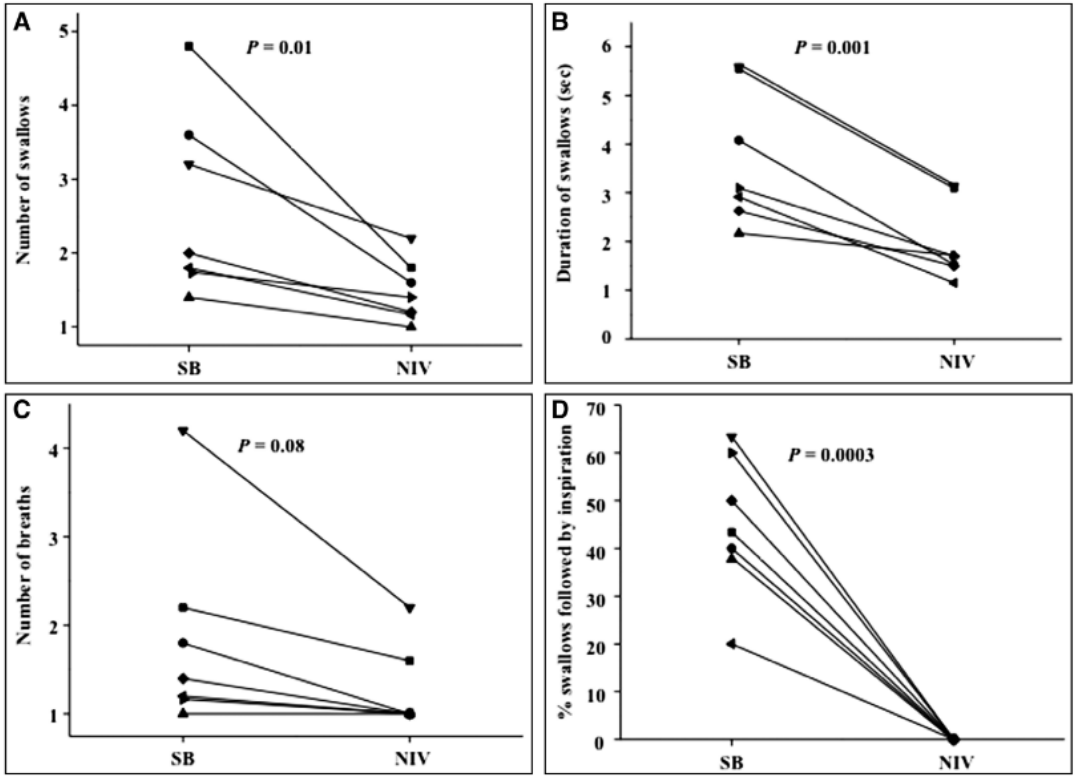


Modified home ventilator
(Elysée 150, ResMed, San Diego, USA)

⇒ Switch activation witholds ventilation

Swallowing and NIV

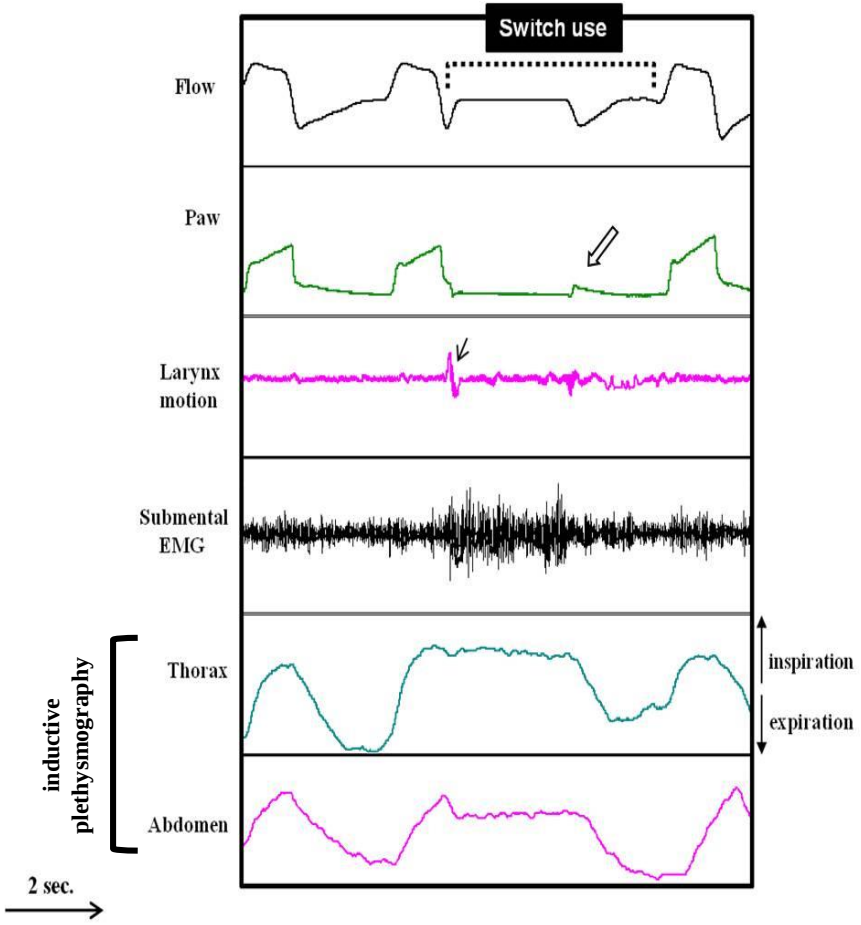
- **COPD** patients, during **acute** respiratory failure, improve breathing-swallowing interactions under NIV



Terzi et al, CCM 2014

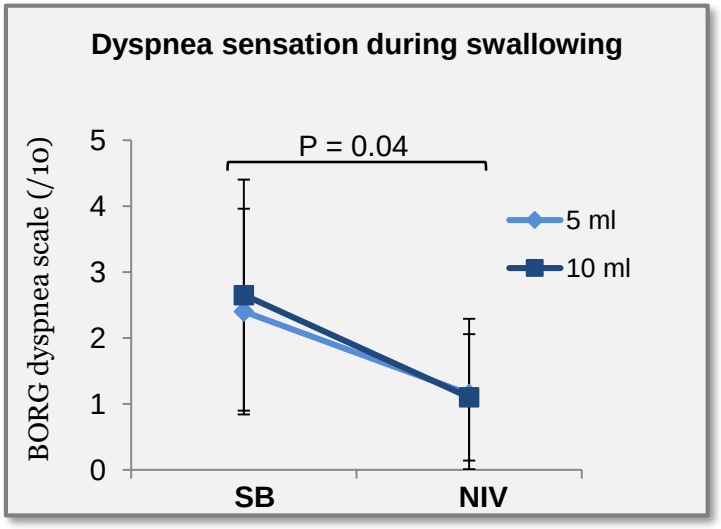
Swallowing and NIV

- **NMD**



- All patients found the device useful
- No episode of aspiration
- No episode of auto-triggering with device

- Swallowing comfort stable under NIV



Garguilo et al, PloSOne, 2016

Swallowing and NIV

	5 ml-bolus		10 ml-bolus		Yogurt		ANOVA (p)		
	SB	NIV	SB	NIV	SB	NIV	Size effect	Texture effect	**NIV effect**
Number of swallows (per bolus)	2.0±0.9	2.8±1.4	2.3±1.3	2.8±1.2	2.6 ±0.9	2.4±1.1	0.4	0.6	0.07
Duration of swallowing (sec)	5.4±4.6	4.6±3.4	7.1±4.5	5.9±3.4	7.1±4.9	5.8±4.2	0.04	0.1	0.1
Swallowing fragmentation (respiratory events per bolus)	1.6±1.8	0.8±1.0	2.3±1.7	1.0±1.4	1.9±1.5	1.1±1.0	0.03	0.3	0.003
% of swallows followed by an inspiration	43.5±23.3	10.3±7.7	46.1±23.6	17.9±19.5	45.7±21.5	21.1 ±16.4	0.2	0.08	<0.0001

Garguilo et al, PloSOne, 2016

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% of swallows followed by an inspiration	3.5±23.3	10.3±7.7	46.1±23.6	17.9±19.5	45.7±21.5	21.1 ±16.4	0.2	0.08	<0.0001

Garguilo et al, PloSOne, 2016

But **without** adaptation:

10 MD

Swallowing evaluation
MPV vs NPPV

MPV > NPPV

NPPV: required more attention to coordination

Table 4 Participant responses on the eating assessment tool-10 (EAT-10)

Eat-10 ITEMS	Mean (SD)
Lose weight	1.2 (1.62)
Interference with eating out	1.0 (1.33)
Extra effort—liquids	0.8 (0.63)
Extra effort—solid foods	1.5 (0.85)
Extra effort—pills	2.0 (1.41)
Pain with swallowing	0 (0.0)
Pleasure of eating affected	0.7 (0.95)
Food sticks in throat	1.7 (1.16)
Coughing with eating	1.3 (0.67)
Swallowing stressful	1.1 (1.10)
Total	11.3 (6.8)

Belafsky et al. [33]

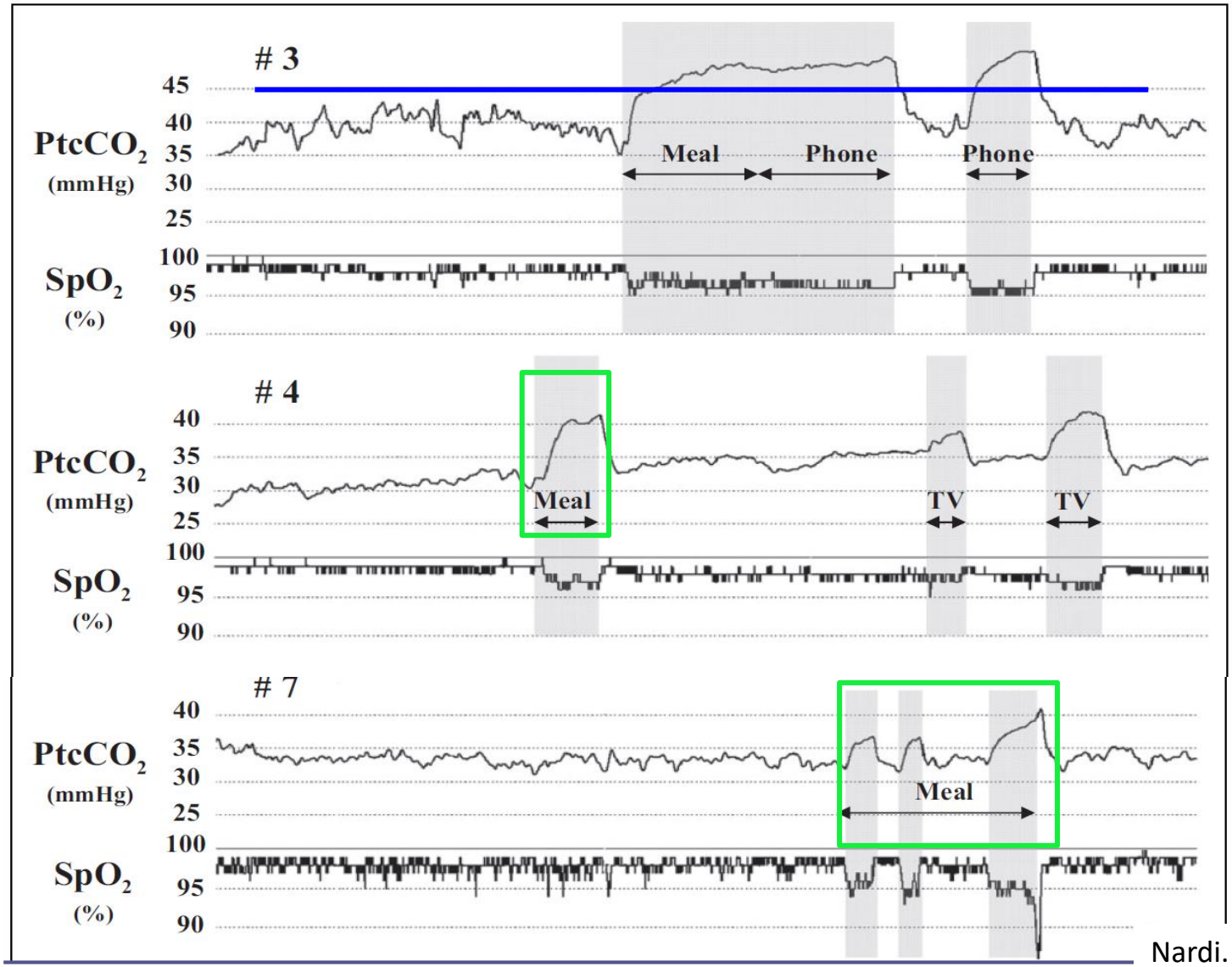
A total score of 3 or higher indicates swallowing abnormality; maximum score is 40 [33]

The range of scores for participants was 3–22

SD standard deviation

Britton et al, Dysphagia, 2019

But eating with MPV



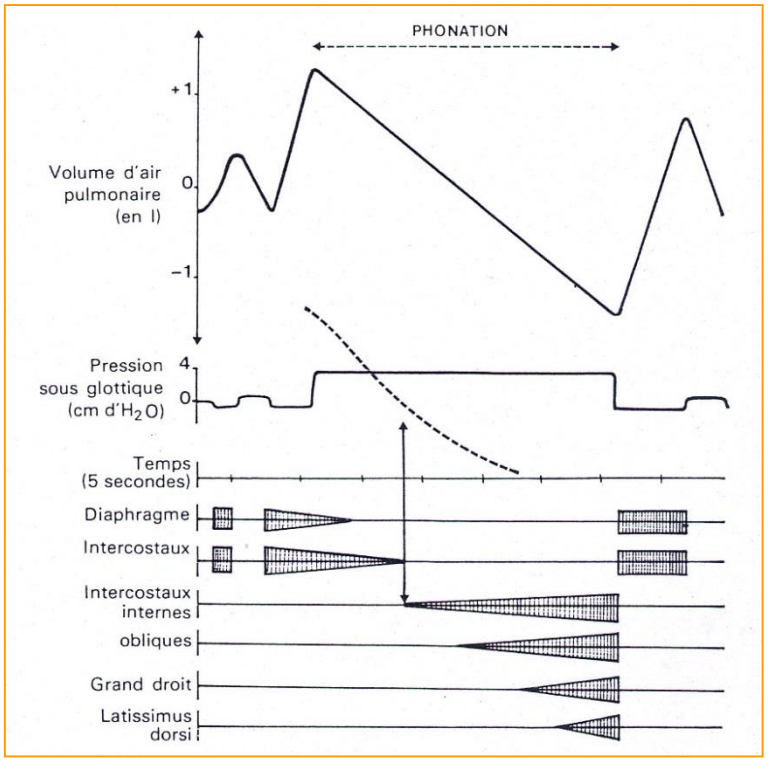
Nardi. *Chron Respir Dis* 2016

Phonation

- Requires precise neuro-motor coordination : *laryngeal, pharyngo-bucco-labial, respiratory, postural muscles.*

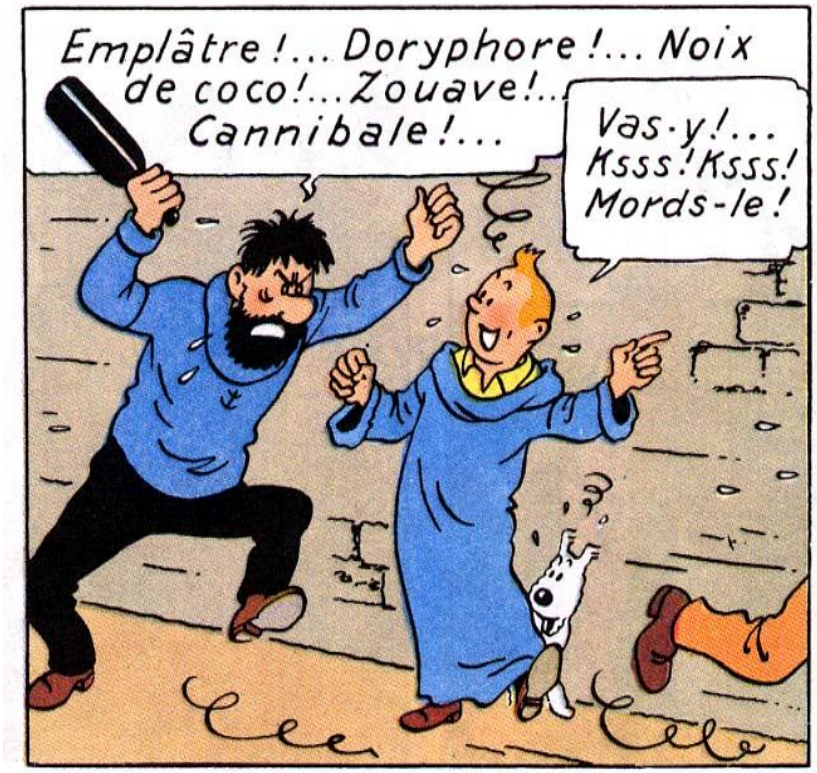
- Exemple of **voluntary** control of ventilation

- Modification of the respiratory cycle and of respiratory muscles involvement in order to maintain the desired vocal production



Draper, 1959

Phonation and breathing interactions



Normal Subject

- **Expiratory** event
- ↑ RR (TI ↓ et TE ↑ ↑)
- ↑ tidal volume

⇒ ↑ minute ventilation

- Alveolar **Hyper**ventilation

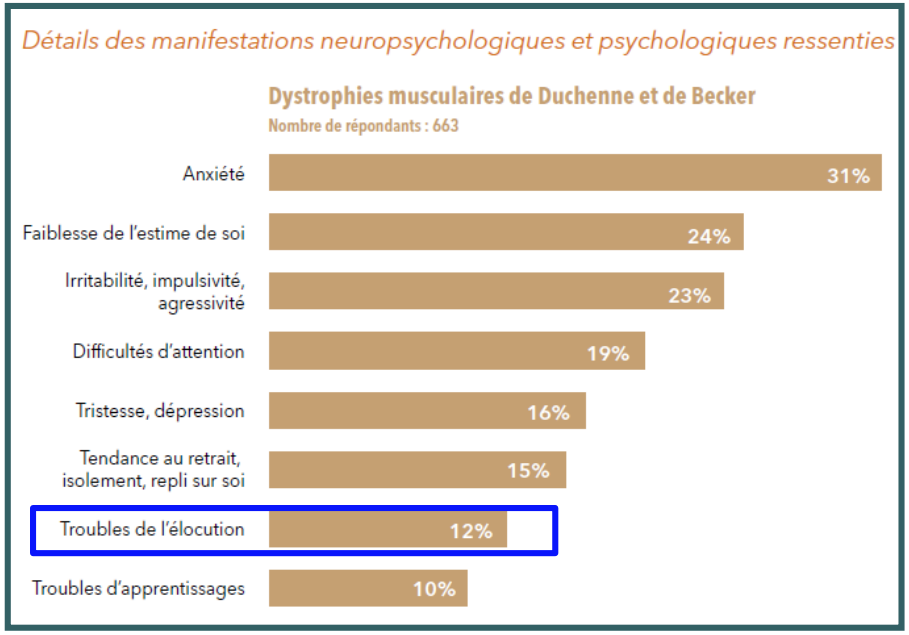
Phonation and NMD

- NMD may impair phonation quality:
  - UAW muscle dysfunction
  - Facial muscle failure
  - Macroglossia

⇒ articulation difficulties
⇒ poor intelligibility

  - Respiratory failure?...

Phonation and NMD



- SCI patients: difficulties to control loudness

Draper et al, BMJ, 1960

- In NMDs:
  - Decreased loudness and pitch
  - Shortness of breath and speaking-related dyspnea

Britton et al, Semin Speech Lang, 2016

Laakso et al, Int J Lang Commun Disord, 2011

AFMTÉLÉTHON
INNOVER POUR GUÉRIR

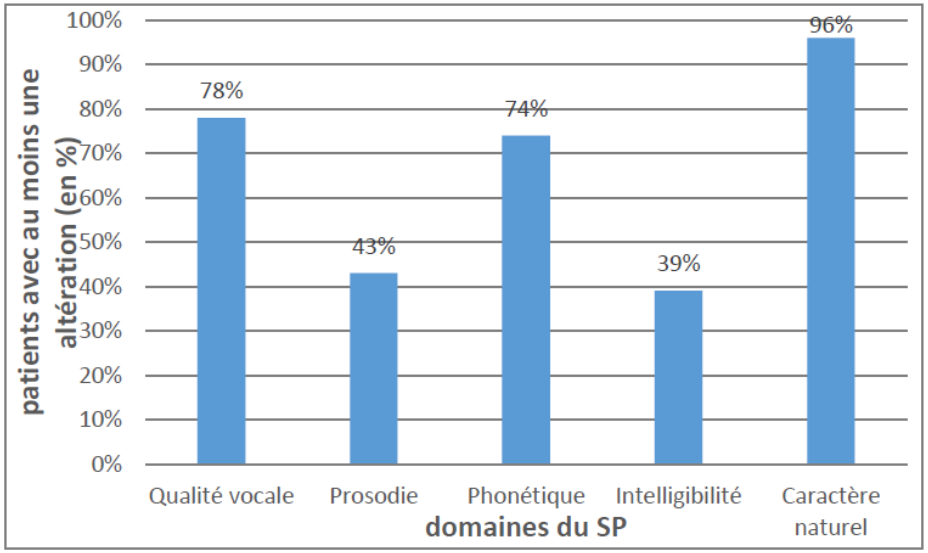
Octobre 2014

Voice quality and NMD

- 27 Duchenne and Becker dystrophies studied during speech in natural breathing

⇒ VHI > 0 for 26/27, significantly altered in 26%

⇒ Deterioration of perception score:

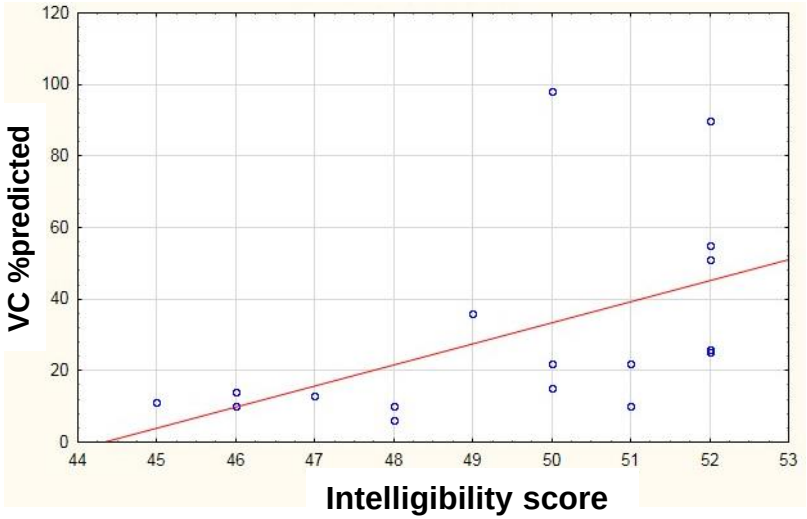


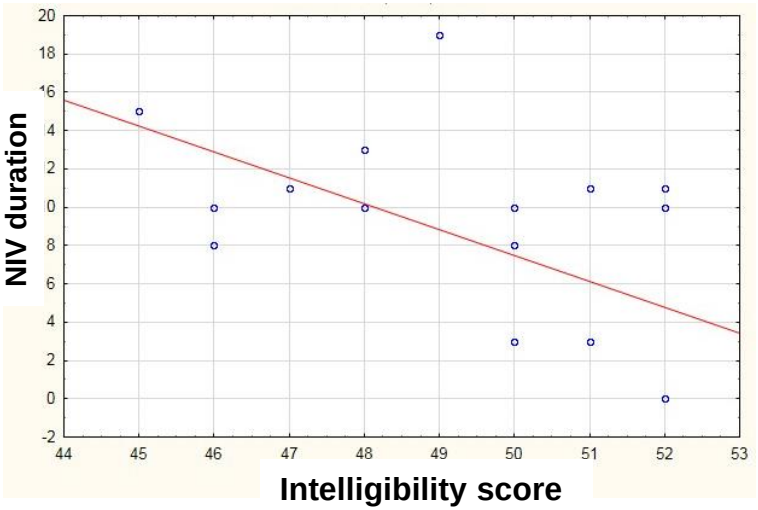
Personal data

Voice quality and respiratory failure

- 19 Duchenne patients' speech during spontaneous breathing

⇒Inverse correlation between intelligibility and respiratory failure severity



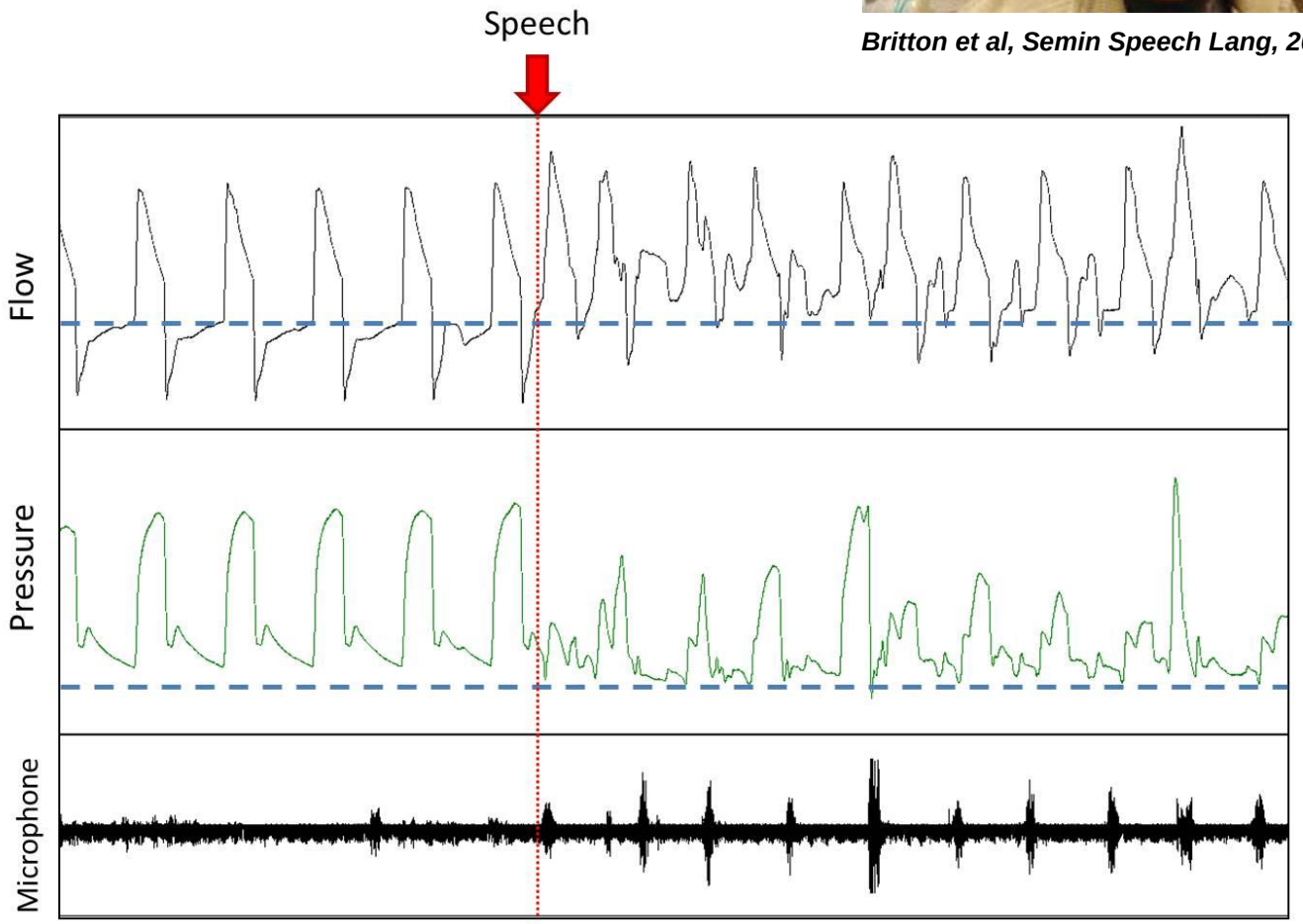


Personal data

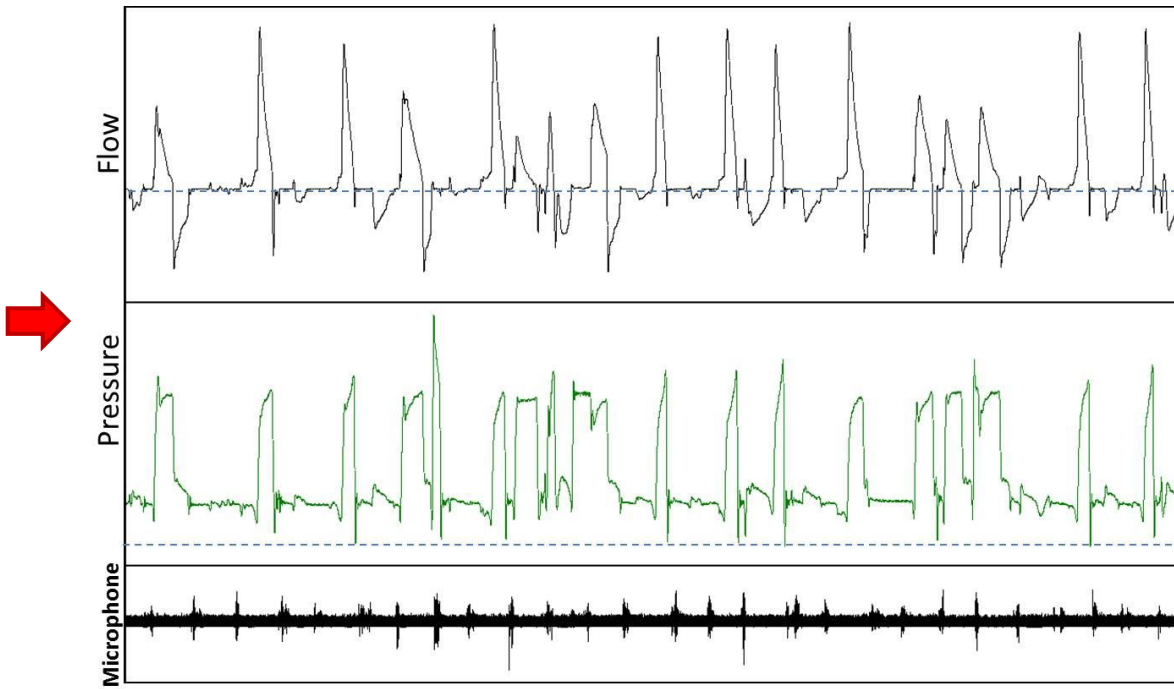
Voice quality and NIV

Britton et al, Semin Speech Lang, 2016

Nasal Mask



Voice quality and NIV



« It's like talking with someone plugging your nose »

With pressure controlled ventilation:

« When I try to talk, the air is leaking out of my mouth »

Britton et al, Semin Speech Lang, 2016
Britton et al, Am J Speech Lang Pathol, 2019

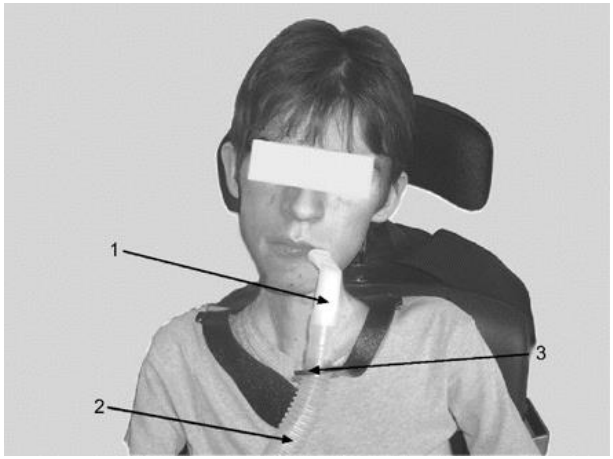
Voice quality and NIV

- Adaptation of the interface for optimized phonation

⇒ Mouthpiece ventilation

Britton et al, Am J Speech Lang Pathol, 2019

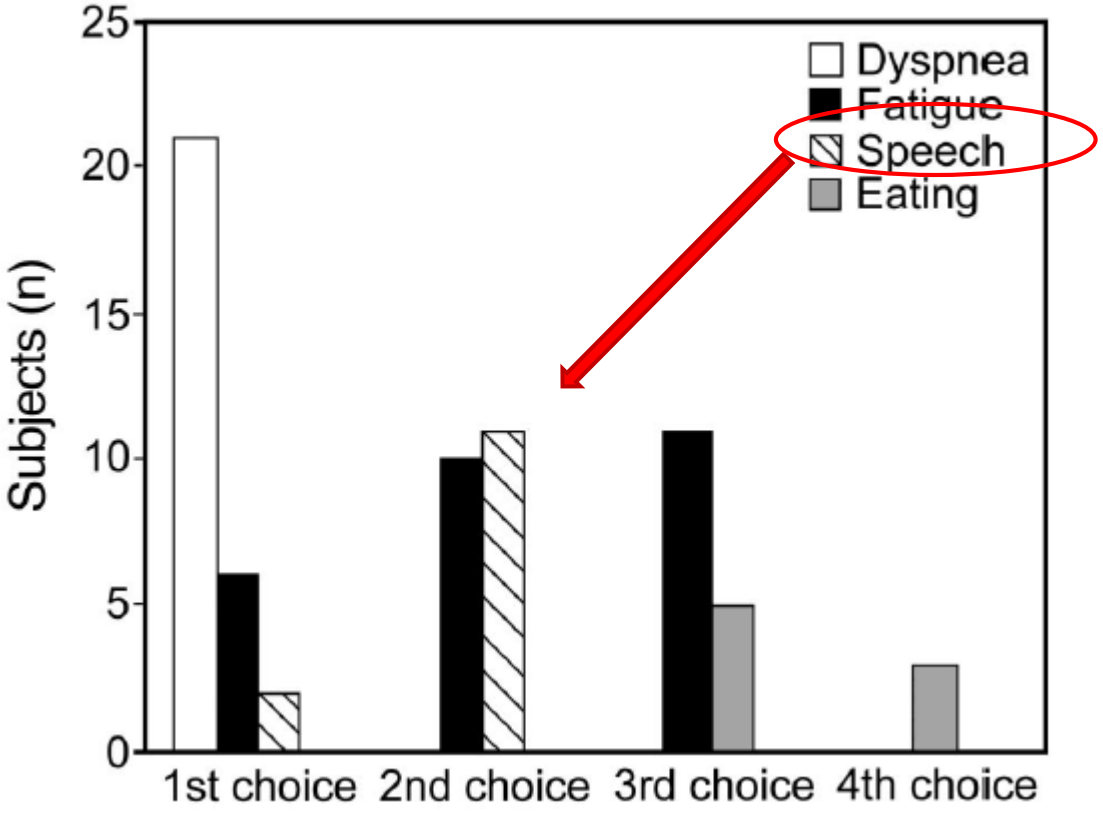
Britton et al, Semin Speech Lang, 2016



Michel Toussaint's team
Belgium (ERJ 2006)

Voice quality and NIV: interface choice

Mouthpiece ventilation



Followed by :

5) better vision,

6) reduction in skin injury,

7) facilitation of swallowing,

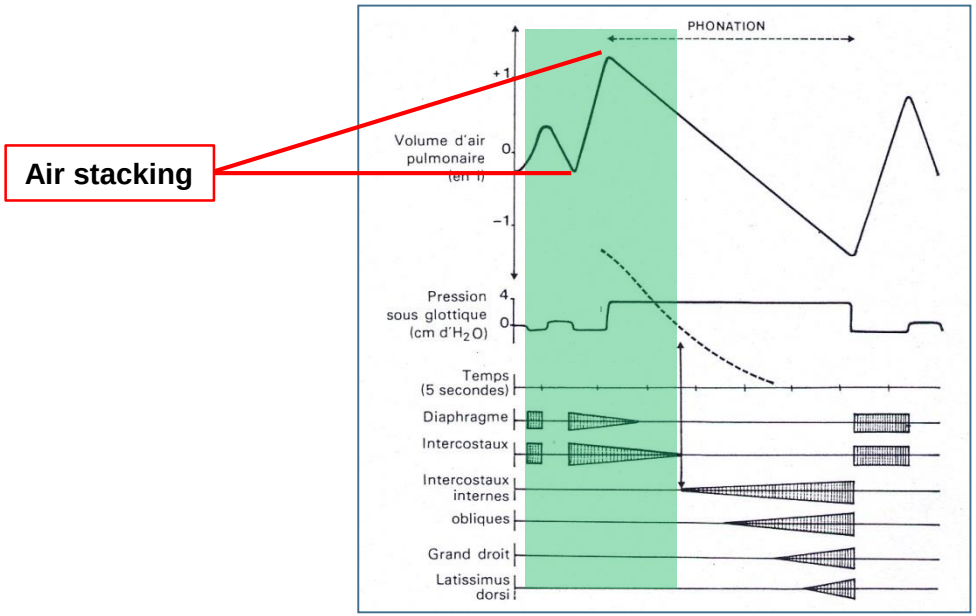
8) decrease of aerophagia

Khirani et al, Respiratory Care 2014

Voice quality and NIV: interface choice

Mouthpiece ventilation

- With **volume controlled**-ventilation, patients can use « breath-stacking » to increase loudness.



Britton et al, Semin Speech Lang, 2016

Voice quality and NIV: interface choice
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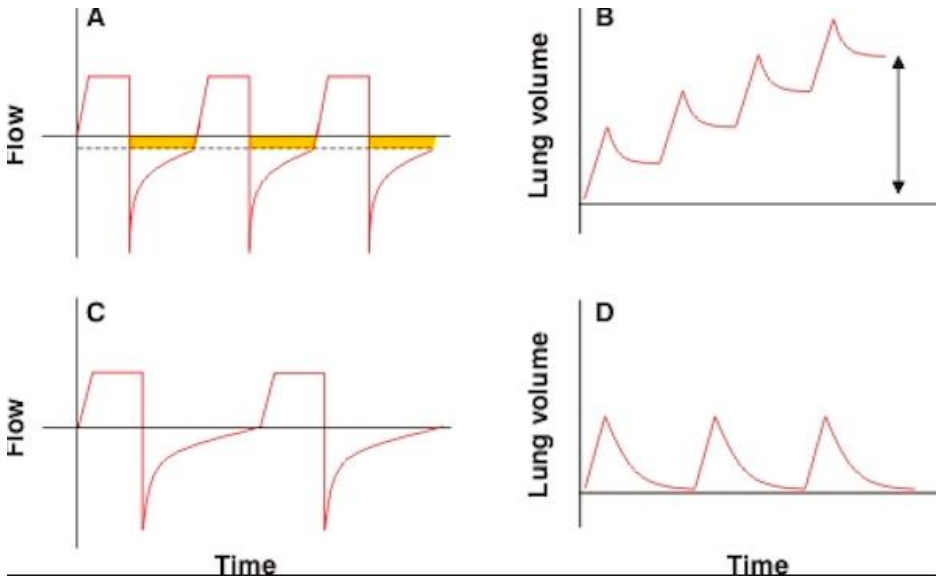
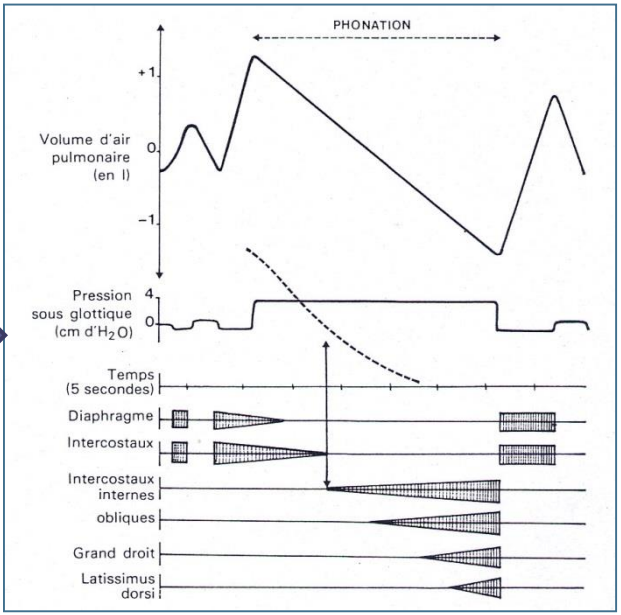
Britton et al, Semin Speech Lang, 2016



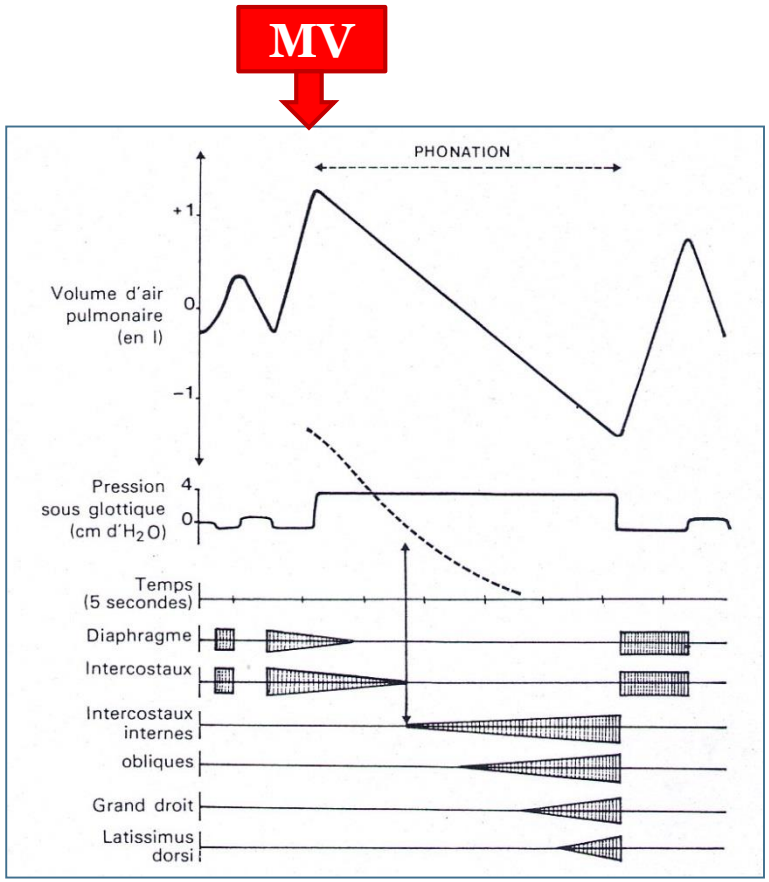
Voice quality and NIV:

- But with mouthpiece ventilation:

Speech occurs during spontaneous breathing **with** severe respiratory failure



Voice quality and NIV



Personal data

Voice quality and NIV

- 10 NMD patients tested under NIV while speaking

- No improvement:
  - Speech parameters
  - Respiratory and speech comfort

?

- **Interaction of nasal mask with voice quality**
- **Insufficient use of NIV for speech support**
- **Patients too severe to manage the increased inspiratory volume**

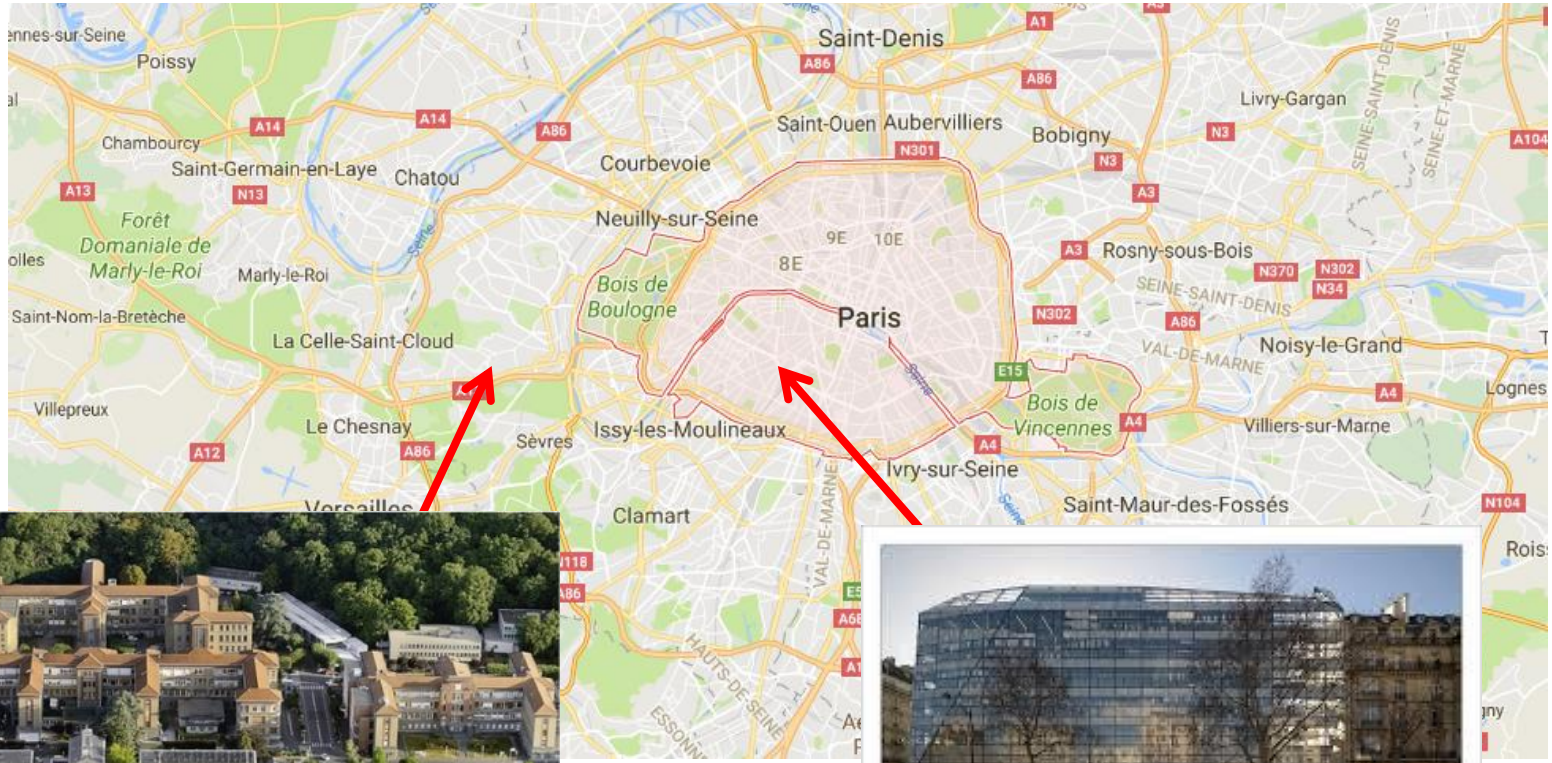
Personal data

Conclusion

- Swallowing **may** improve with NIV in NMD patients with severe respiratory failure (but NPPV would require **specific adaptations**)
- Mouthpiece ventilation ensures **independant speech** as patients may discontinue ventilation
- Speech may be altered by respiratory failure but NIV does not yet provide support for quality improvement, except with breath stacking

Thank you for your attention

Thank you for your attention



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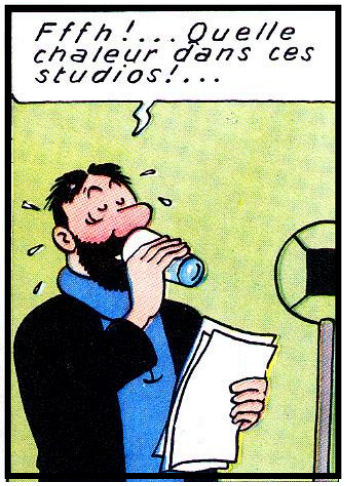
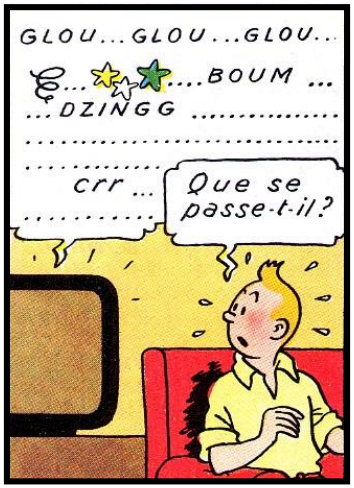
Thank you for your attention





Hergé, 1960