RESPIRATION & SWALLOWING

(in neuromuscular disease)

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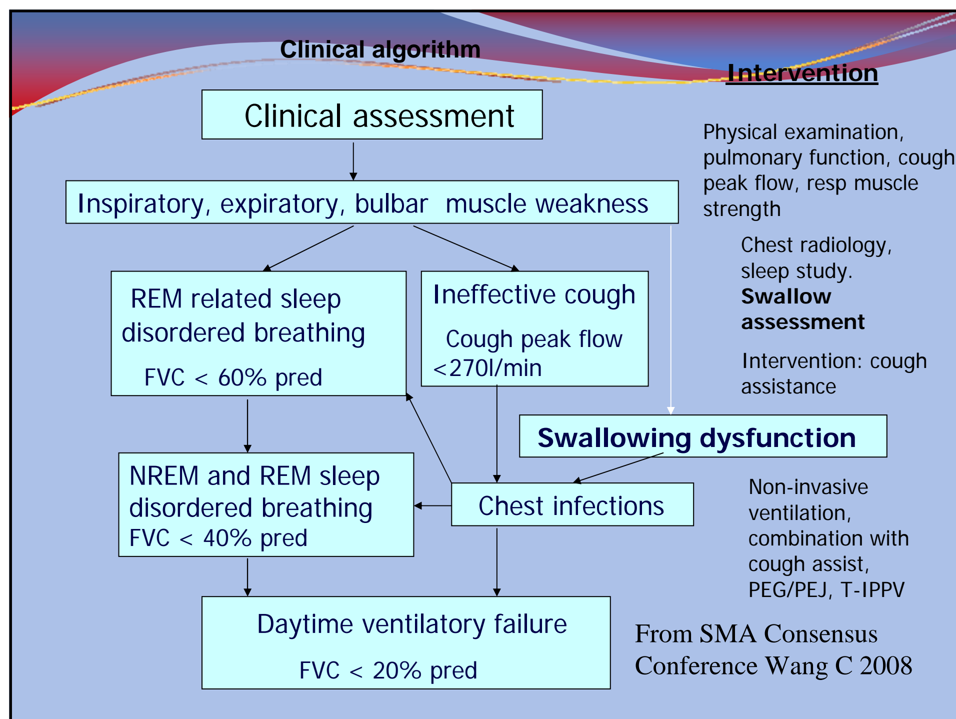
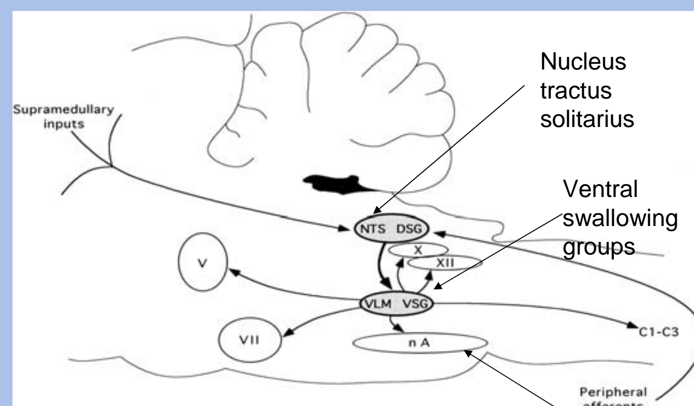


Normal swallowing and breathing

Breathing and swallowing share:

- Central neural control mechanisms
- The pharynx - therefore many muscle groups
- Cortical influences

Neural control mechanisms Medulla



Nucleus tractus solitarius

Ventral swallowing groups

Nucleus ambiguus

Jean, A. Physiol. Rev. 81: 929-969 2001

Normal breathing - swallowing interaction

- Swallowing interacts with breathing so that it causes no or minimal disturbance to normal breathing
- In awake adults swallowing is accompanied by an apnoeic period lasting beween 0.6 and 2.0 secs, and this swallow apnoea is followed by expiration in 95% of swallows.
- Expiration may have a useful role in clearing pharynx of debris before next inspiration
- Protection of lower airway by reflex closure of glottis
- Epiglottis contributes to deflection of food bolus from larygeal openeng to pyriform sinuses

Swallowing and breathing in neurological disease

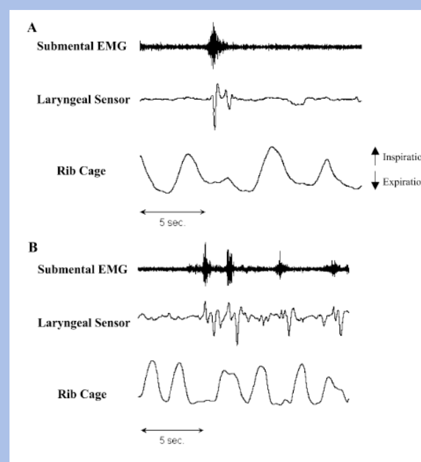
- Hadjikoutis et al Brain 2000 ;123: 1863
- 22 patients with neurodisorders (tetraplegia, CVA, multisystem atrophy)
- 22 normals
- 32 patients with motor neurone disease MND/ALS
- Methods: questionnaire, volume, submental EMG, and resp plethysmo
- Swallow apnoea in patients with brain, spinal cord and periph neuro disease was followed by inspiration in 20/22 (91%) compared to 9% normals
- However when followed long term (12-18 months) those with post swallowing apnoea inspiration did not predict chest infection frequency, survival, choking or coughing.
- MND pts had particular pattern of inspiration after swallowing in 44%, prolonged swallow apnoea and multiple swallows per bolus

Breathing and swallowing in neuromuscular patients

Terzi N et al Am J Resp Crit Care Med 2007;175:269-76

- 29 neuromuscular patients, 10 normal controls
- Interactions assessed by chin EMG and inductance plethymograhy
- Outcome: piecemeal deglutition with several swallow over breathing cycles
- % swallows followed by inspiration 50%, near 100% followed by expiration in normal controls
- In patients with tracheostomies no. of swallows and total swallowing time per bolus was less during mechanical ventilation than when breathing spontaneously

Methodology

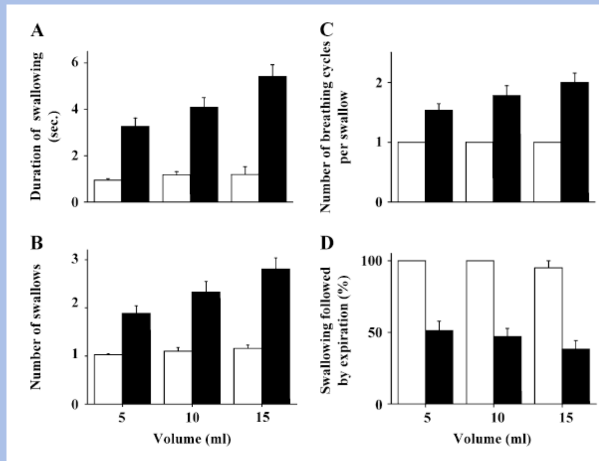


Normal control

Trache patient during SV

Terzi et al 2007

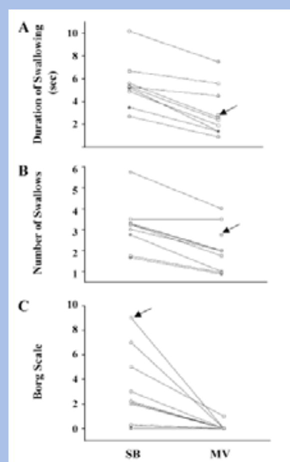
Controls v NMD patients



Open bars – controls
Black bars - patients

Terzi N et al AJRCCM 2007; 175: 269-76

Swallowing during 15 ml bolus in NMD trache patients



Swallowing duration

No of swallows

Breathlessness

Terzi N et al AJRCCM 2007; 175: 269-76

Relationship between lung function and swallowing

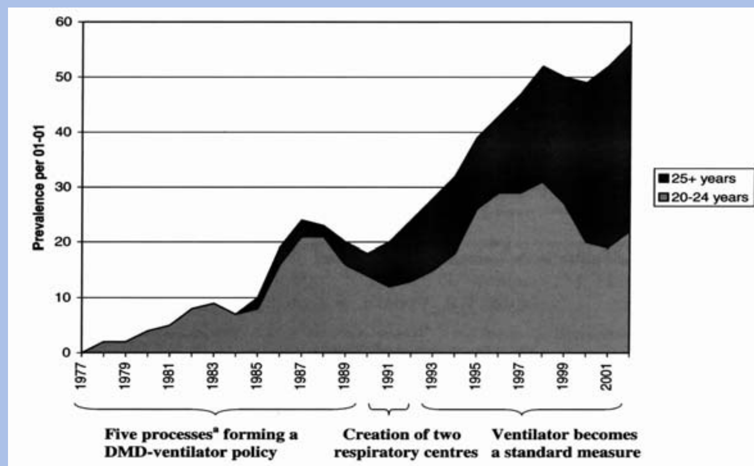
TABLE 3. UNIVARIATE REGRESSION ANALYSIS OF SWALLOWING VARIABLES ON INDICES OF LEVEL OF DISABILITY

	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

Definition of abbreviations: AI = ambulatory index (details are in the online supplement); MEP = maximal expiratory pressure; MIP = maximal inspiratory pressure.

Terzi N et al AJRCCM 2007; 175: 269-76

Prevalence of Duchenne MD

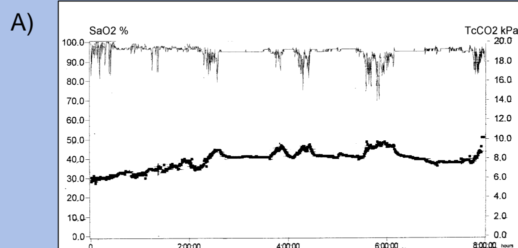


Jeppesen J Neuromusc Dis 2003;13:804-12

Non-invasive ventilation in Duchenne MD

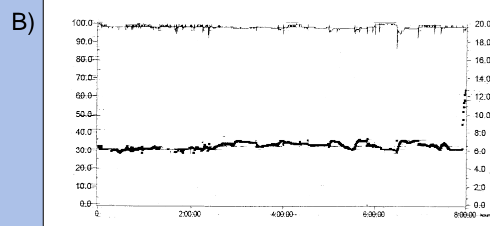
Role of sleep studies

A)



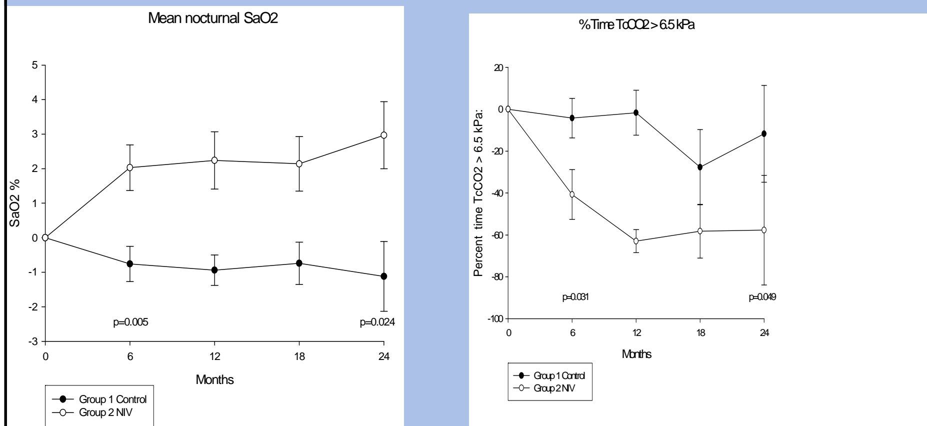
Spontaneous ventilation

B)



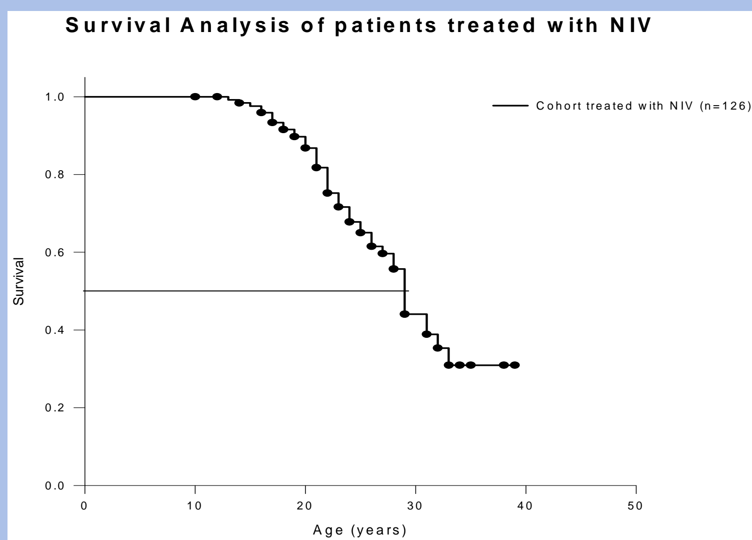
Impact of NIV

Timing of NIV :Mean changes from baseline in nocturnal PCO2 and SaO2 in control and NIV groups



Significant reduction in time TcCO2 > 6.5 kPa and mean Sao2 in NIV group Ward et al Thorax 2005;60:1019-24

Duchenne MD Analysis Royal Brompton 2009

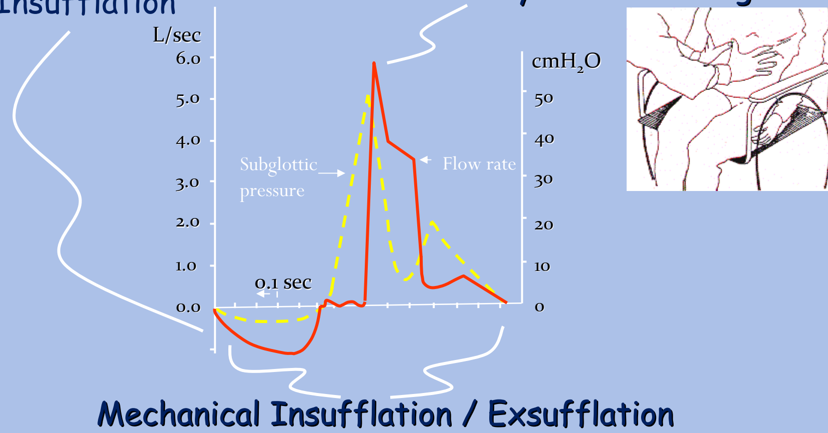


Chatwin & Simonds 2009

Methods to Augment Cough

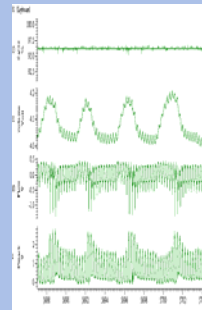
Breath Stacking
Manual / Mechanical
Insufflation

Manually Assisted Cough



Mechanical Insufflation / Exsufflation

Combination of NIV, cough assist and percussionaire in acute RTI



High freq oscillation to airway cf. vest to chest wall

Indications for feeding assessment and outcome of videofluroscopic swallow studies in Duchenne MD

Eur J Paed Neurol 2008 12 239-45 **A Aloysius**

- N=24
- Oral phase most affected
- Pharyngeal phase well triggered but weak with inadequate clearance
- Chewing effortful
- Careful feeding history and observation very valuable

Feeding problems in merosin negative MD

Philpot J et al Arch Dis Child 1999;**80:**542-547

- **On videofluoroscopy only the youngest child (2 years old), had a normal study.**
- **The others all had an abnormal oral phase (breakdown and manipulation of food and transfer to oropharynx).**
- **Nine had an abnormal pharyngeal phase, with a delayed swallow reflex. Three of these also showed pooling of food in the larynx and three showed frank aspiration. These six cases all had a history of recurrent chest infections.**

What we have noticed clinically

- Bulbar weakness and swallowing problems are a relatively late feature in Duchenne MD if breathing problems addressed. Variable onset in other neuromuscular conditions
- Swallowing and nutritional state may improve after initiation of NIV
- Swallowing often deteriorates at the time of acute infective exacerbations, and can recover subsequently
- Many patients are kept nil by mouth for too long during acute episodes and lose ground rapidly. Consider NG feeding or PEG early.
- A combination of NIV and PEG may work well in those with mild to mod swallowing problems.

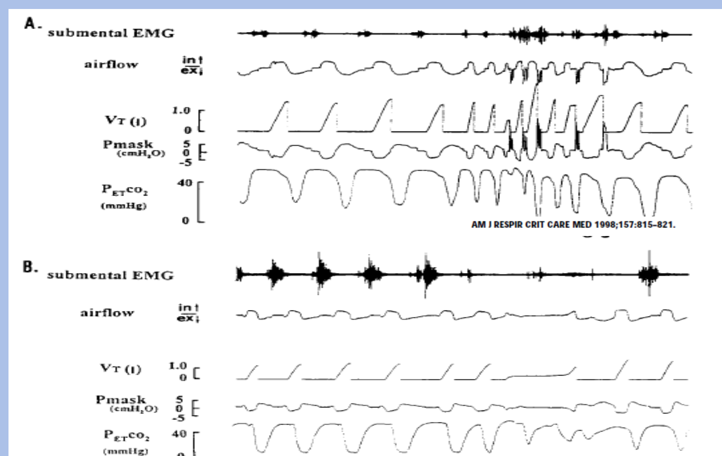
SaO2 and transcutaneous CO2 monitoring

DIFFERENCES IN THE EFFECTS OF HYPERCAPNIA AND HYPOXIA IN CATS: NISHINO et al Br J Anaes

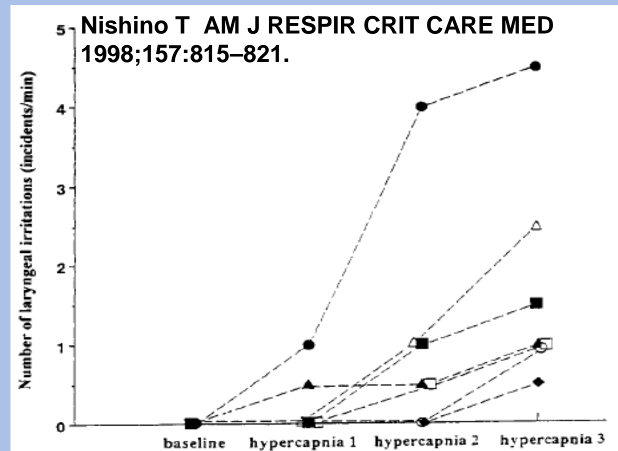
- Swallowing induced by electrical stimulation of superior laryngeal nerve
- Steady state responses assessed at a variety of hypoxic and hypercapnic situations
- Hypoxaemia and hyper capnia stimulated breathing
- Hypoxaemia depressed swallowing reflex
- Hypercapnia had no apparent effect

Hypercapnia Enhances the Development of Coughing during Continuous Infusion of Water into the Pharynx

TAKASHI NISHINO, RISA HASEGAWA, TOHRU IDE, and SHIRO ISONO



But …effects of hypercapnia



Stimulated laryngeal irritation - coughing

NIV and swallowing: what we don’t know

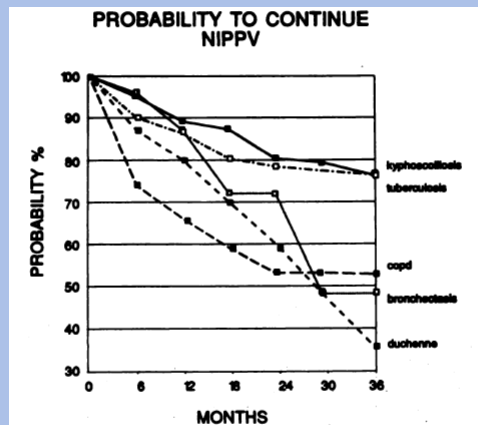
- Does use of NIV help improve swallowing acutely or chronically?
- Should NIV be used when eating or drinking?
- Can PEG feeding be carried out overnight when child/adult using NIV
- What is relationship between triggering of ventilator and control mode

Who needs Tracheostomy ventilation?

- Acute decompensation, not possible to wean onto NIV
- Severe bulbar disease with recurrent aspiration/choking
- Unable to control ventilation on combination of NIV / cough in-exsufflation and PEG
- Personal choice of ventilator dependent pt

Tracheostomy for acute decompensation

Sequential NIV and Tracheostomy: France



Leger P et al Chest 1994

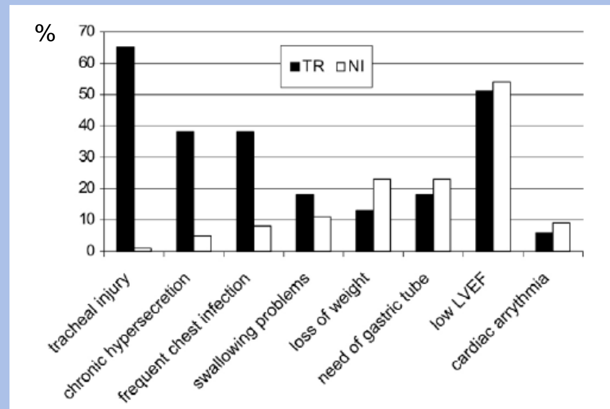
Comparison of tracheostomy and non-invasive ventilation

Table 1 Respiratory characteristics of 42 Duchenne patients at inclusion

		Loss of ambulation (years)	*Age (years)*	*Ventilation duration (years)*	*VV (ml)*	*PEF (l/minute)*	*Pimax (cm H_2O)*	*Pemax (cm H_2O*
Tracheostomy	Mean	9.5	32.7*	8.8	347	52*	8	7
(*n* = 16)	SD	1.0	5.1	3.8	145	18	4	5
Noninvasive ventilation	Mean	9.7	27.0	3.1	428	67	11	11
(*n* = 26)	SD	1.3	5.7	2.4	181	23	6	6

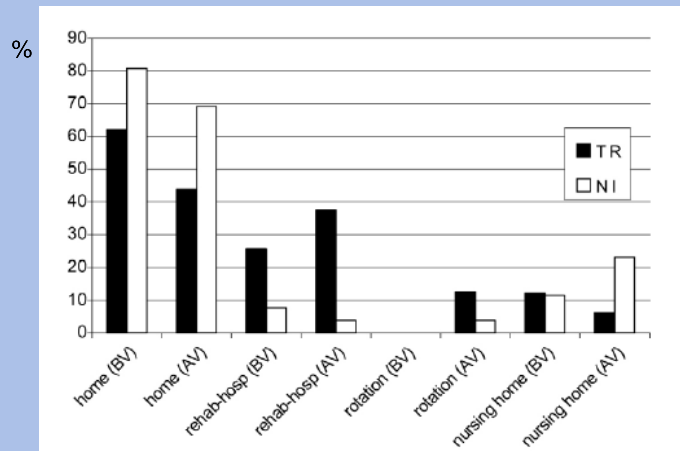
Soudon P et al Chronic Resp Dis 2008; 5:87

Tracheostomy v. non-invasive ventilation: problems



Soudon P et al Chronic Resp Dis 2008; 5:87

Tracheostomy v non-invasive ventilation: site of care



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