


Why Noninvasive Ventilation?

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Course Objectives

- Recognize the different uses of NIV therapy and the different disease states it applies to
- Describe what tools are available to not only treat the disease, but improve patient comfort and outcomes



CRS14-0215

What Happens When We Sleep?




CRS14

Nocturnal Ventilation Characteristics



- "Normals" have about a 5% decrease in ventilation during sleep
- Increased load is counteracted by increased effort
- Small reductions in tidal volume are compensated by an increase in rate
- During REM, there is a loss of muscle tone (atonia)
- Respiratory insufficiency patients have an additional 10–15% drop in ventilation at sleep onset (SO) and a further reduction in REM sleep (10–20%)

Buckley et al. Am J Respir Crit Care Med 1999

When CPAP Is Not Enough

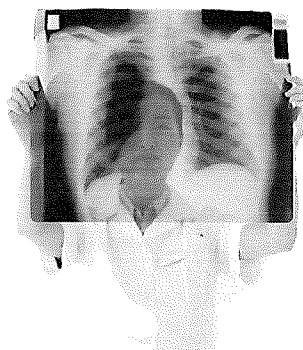


Why Make the Switch from CPAP to Bilevel?

<p>Patient comfort</p>  <ul style="list-style-type: none"> • Cannot tolerate CPAP • On a high CPAP pressure and cannot tolerate it 	<p>Ventilation</p>  <ul style="list-style-type: none"> • Obstructive disease • Restrictive disease • Neuromuscular disease
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Guy P et al. Sleep 2008

⑤ COPD




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⑤ COPD Market Size

What is the size of the market?

- Over 12M people in the U.S. diagnosed with COPD¹
- Estimated 12M to be undiagnosed with COPD¹
- Third leading cause of death in the U.S.¹
- Major leading cause of disability¹
- Estimated 49.9B direct and indirect costs to healthcare system in 2010¹
- Around 22% of COPD Medicare beneficiaries are readmitted to the hospital within 30 days of discharge²
- Almost 50% of elderly people (≥ 65 years) have at least three comorbidities, and 20% have five or more comorbidities³



1. National Heart, Lung, and Blood Institute 2011
2. American Medical Association 2010
3. FASEB J 2012; 27: 1228

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⑤ Tools for COPD – What Are the Problems?

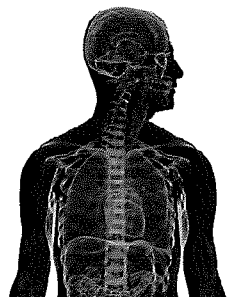
Air trapping

Decrease in lung elasticity

Lung tissue destroyed

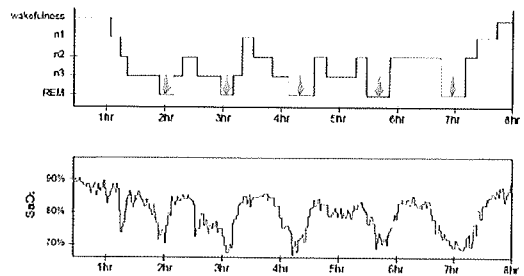
Reliance on accessory muscles

Poor functioning diaphragm



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⑤ Desaturations During REM in COPD Patients



Tutcher EC et al. J Appl Physiol 1983

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⑤ Problems with NIV in COPD Patients

- Standard NIV settings can extend a COPD patient's inspiratory time
- Asynchrony
- Increased work of breathing
- Cycling difficulties (getting into exhalation)

Delayed cycling = Decrease in:

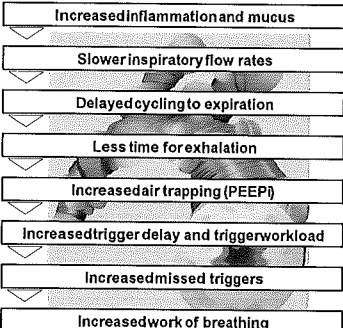
- Expiratory time
- Lung emptying

Decreased expiratory time = Increase in:

- Auto-PEEP
- Missed triggers
- Work of breathing

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⑤ Cycling is Key for COPD Patients



- Increased inflammation and mucus
- Slower inspiratory flow rates
- Delayed cycling to expiration
- Less time for exhalation
- Increased air trapping (PEEP)
- Increased trigger delay and trigger workload
- Increased missed triggers
- Increased work of breathing

Genita M. ResMed Corp 2011

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③ Cycling is Not "One Size Fits All"

"It is paramount to match the appropriate flow-cycling criterion with the specific underlying pathophysiology. Patients with obstructive disease require different cycling criteria than those with acute lung injury or other forms of lung impairment."

Graph 1 (Normal): Peak flow 100 lpm. Flow drops to 25% at 0.4 seconds.

Graph 2 (COPD): Peak flow 60 lpm. Flow NOT dropping at 0.4 seconds.

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③ Utilizing Pressures Effectively

Increase IPAP to achieve:	Adequate tidal volume	Increase EPAP to:	Overcome obstructive apneas and hypopneas
	Respiratory rate (RR) < 25 bpm		Improve oxygenation and FRC
	Decrease work of breathing		Counterbalance PEEP
	Reduction in PaCO ₂		

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③ Bilevel Tools – Rise Time Adjustment

Problem: Patient complains of air hunger
Solution: Decrease Rise Time

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③ Bilevel Tools – Shortening Inspiratory Time

Problem: Patient requires longer expiratory time (i.e., COPD)
Solution: Best option – Shorten TI Max time

Additional options:

- Select higher cycle sensitivity
- Select faster rise time

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③ Bilevel Tools – Sensitivity Adjustments

Adjustable cycle sensitivity

Very High	Quick to cycle	50% of peak flow
High	More sensitive	35%
Med	Default	25%
Low	Less sensitive	15%
Very Low	Slow to cycle	5%


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③ Neuromuscular, Restrictive and Obesity Hypoventilation Patients

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③ What Are the Disease Demographics?

- Amyotrophic Lateral Sclerosis (ALS) makes up the majority of patients with neuromuscular diseases¹
- Estimated 5,000 new patients diagnosed each year²
- As many as 30,000 patients currently affected in the US³
 - Incidence of ALS is about 2 per 100,000 population in the US³
 - War veterans twice as likely to develop ALS as non-war veterans⁴
- Spinal cord injury
 - 12,000/yr, 1/2 need respiratory support⁵
- Muscular dystrophy affects 400–600 live males births each year in the US⁶



1. Guille C. *et al.* *Neurology* 2008; 70: 2033
 2. The ALS Association. www.alsa.org, 2007
 3. www.alsa.org, 2014
 4. www.alsa.org, 2014
 5. www.alsa.org, 2014
 6. The National Institute of Neurological Disorders and Stroke. www.ninds.nih.gov

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③ Control of Ventilation During Sleep in NMD

Drop-out of accessory muscles, especially in REM sleep

Increasing dyspnea when supine

Bulbar disease changes the ability of the upper airway to respond normally

More frequent arousals impair the ability to stabilize ventilation during sleep



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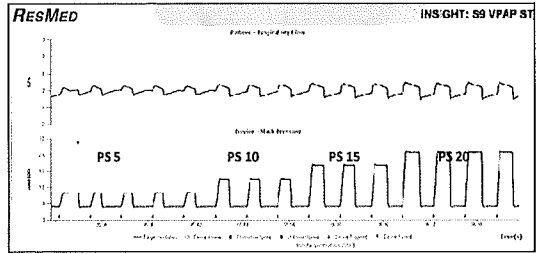
③ Utilizing Pressures Effectively for NMD

<p>Increase IPAP to achieve:</p> <ul style="list-style-type: none"> Adequate tidal volume Respiratory rate (RR) < 25 bpm Decrease work of breathing Reduction in PaCO₂ 	<p>Increase EPAP to:</p> <ul style="list-style-type: none"> Overcome obstructive apneas and hypopneas Improve oxygenation and FRC
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Berry RB *et al.* *J Clin Sleep Med* 2010

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③ Bilevel Tools – When You Need to Ventilate



INS/GHT: S9 VPAP ST

Flow - Respiratory Flow

Pressure - Mask Pressure


PS 5 PS 10 PS 15 PS 20

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③ Bilevel Tools – Restrictive Diseases

Level A – Consensus 4.8.4

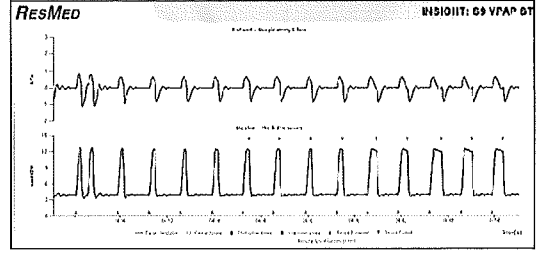
Minimum IPAP duration (if available) may be increased if the device cycles from IPAP to EPAP prematurely (eg, in restrictive chest wall disorders).



Berry RB *et al.* *J Clin Sleep Med* 2010

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③ Bilevel Tools – Increasing the Inspiratory Time



INS/GHT: G9 VPAP ST

Flow - Respiratory Flow

Pressure - Mask Pressure

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③ Bilevel Tools – Sensitivity Adjustments

Adjustable trigger sensitivity

Very High	Quick to trigger	2.4 L/min
High	More sensitive	4 L/min
Med	Default	8 L/min
Low	Less sensitive	10 L/min
Very Low	Slow to trigger	15 L/min

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③ Bilevel Tools – Asynchrony in Restrictive Patients

“However, premature cycling may also have detrimental effects on patient-ventilator synchrony. Premature cycling is simply when the ventilator terminates the breath while the patient requires a long inspiratory period.”

Lungs physically restricted

Paralysis or muscles deteriorated

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③ Using the Right Device at the Right Time

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③ Restrictive Thoracic Disorder

Respiratory Thoracic Disorder

Recommendation of non-invasive device or severe restrictive abnormality in the patient's medical record

Performance of the following:

- **ABG** (arterial blood gas) to determine if patient is hypoxemic, with or without hypercapnia
- **Flow volume** (flow-volume loop) to determine if patient has a restrictive thoracic disorder
- **Retrospectively determine** if patient has a restrictive thoracic disorder

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③ COPD

III COPD

ABG (arterial blood gas) to determine if patient is hypoxemic, with or without hypercapnia

Flow volume (flow-volume loop) to determine if patient has a restrictive thoracic disorder

Retrospectively determine if patient has a restrictive thoracic disorder

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③ Hypoventilation

III Hypoventilation

ABG (arterial blood gas) to determine if patient is hypoxemic, with or without hypercapnia

Flow volume (flow-volume loop) to determine if patient has a restrictive thoracic disorder

Retrospectively determine if patient has a restrictive thoracic disorder

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③ Selecting Appropriate Ventilation Therapy

Life Support?

NO → S/ST E0470/E0471

YES → Valve/Volume Vent E0463/464

Reasons to use a bilevel device	Reasons to use a ventilator
<ul style="list-style-type: none"> Nocturnal, non-continuous, support required Stable patient, less follow-up required Ease of use 	<ul style="list-style-type: none"> Life-support/continuous use required Higher acuity patients require more frequent follow-up Physician prescribes a valve mode or mouthpiece ventilation Patient has daytime use/mobility needs


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③ Life Support

Device	Description	HRSS
Ventilator – Invasive	Life Support – Pressure support ventilator with volume control mode, may include pressure control mode, used with invasive interface (i.e. tracheostomy tube)	E0403
Ventilator – non-invasive	Life Support – Pressure support ventilator with volume control mode, may include pressure control mode, used with non-invasive interface (i.e. mask)	E0464


Documentation to support medical necessity of a ventilator therapy:

- Daily physical order
- Physician diagnosis
- Documentation of medical necessity in medical report
- Ventilator settings
- Documentation detailing the supply's stocking plan in the event primary ventilator breaks down
- Provider history*



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③ Clinical Outcomes with NIV




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③ Outcomes Utilizing NIV

NIV use was associated with improved quality of life (QOL) and improved survival in ALS patients.¹

In selected COPD patients with acute hypercapnic respiratory failure (AHRF) treated with acute NIV, continuation with home NIV therapy is associated with a lowered risk of recurrent severe COPD exacerbation?²

Patients who present with acute respiratory failure related to both COPD and OHS can be prescribed NIV for home use after hospitalization with benefits to survival.³



1. Shaltoni et al. JAMA 2012
2. Chang et al. JAMA 2013
3. Kumbhani et al. Medical Clinics 2013

③ Conclusion

- Patient diagnosis should be a major determinant in which NIV device will be appropriate for the patient
- NIV devices offer a greater number of tools to:
 - Increase comfort and compliance of the patient
 - Increase patient-device synchrony
 - Increase the chances of the therapy goals being met
- Tools available:
 - Rise Time
 - Time cycling
 - Sensitivity adjustments
 - PS

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