CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) AND NONINVASIVE VENTILATION (NIV)

Canadian Respiratory Conference

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- I have no conflicts of interest to declare

OUTLINE

- current evidence for NIV in stable COPD
- Practical recommendations for NIV in stable COPD
- Troubleshooting downloads

NIV BACKGROUND

A. Chronic NIV has good evidence in many disorders with respiratory failure: neuromuscular, chest wall, obesity hypoventilation

B. Rescue NIV has good evidence in exacerbation of COPD

C. controversy whether chronic NIV in stable COPD results in:
   - Improved QOL, decreased PCO_2, decreased exacerbations, decreased hospitalizations, decreased mortality

EARLY NIV TRIALS

- Guidelines (CTS 2011) recommended it weakly for decreasing health care utilisation, but no improvements in QOL or mortality were consistently shown
- Over time and since then it became clear that there was significant heterogeneity in how NIV was being applied
  - Low intensity versus High intensity
- Low Intensity NIV
  - Averaged low IPAPs (10-15) and low PS (8-12)
  - Did not lower PCO_2
  - Did not improve, and in fact some worsened QOL
- If artificial ventilation is not improving alveolar ventilation, then how can we expect improved outcomes? - M. Dreher

Ven Der Leest and Duiverman, Respirology 2018
Shah, D'Cruz and Murphy, Journal of Thoracic Disease, 2018

CHRONIC HIGH INTENSITY NIV IN STABLE COPD

- Köhnlein et al., Lancet Respir Med 2014; 2
- 195 individuals, RCT, multicentre, blocks of 4
- Stable COPD FEV1 27%(4 weeks post exac + 4 weeks run in)
- Daytime PCO_2 mean 59 mm Hg to 49 in NIV group and 55.5 in control
- 22/5 BUR 16
- Mortality 33% in control vs 12% in NIV
- Secondary outcomes: quality of life, FEV1 also improved

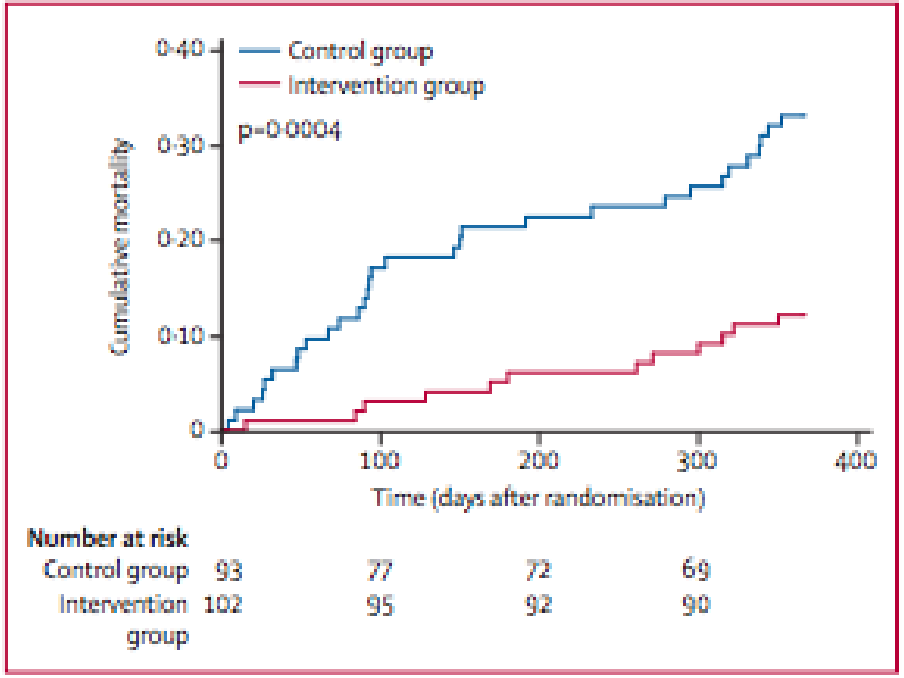


Figure 2: Kaplan-Meier estimate of cumulative all-cause mortality during the first year after randomisation (primary outcome)
The p value results from a log-rank test of the between-group difference.

SUMMARY OF CURRENT EVIDENCE IN COPD

- NIV does not provide benefit in every COPD patient with CHRF.
- insufficiently informed about the factors predicting a favourable response.
- Struik: greater reductions in CO_2 seen if:
  - more severe CHRF (PCO_2 > 55 mm Hg)
  - truly suffer from prolonged CHRF
    - At least >14 days post-hospital discharge.
    - ?optimal timing
  - Higher IPAP (> 18 cm H_2O)
  - Longer nocturnal use (> 5h/night)

Duiverman and Wijkstra Chronic Obstr Pulm Dis. 2016; 3(1): 378–381
Struik et al., Resp Med, February 2014Volume 108, Issue 2, Pages 329–337

QUESTION 1

Consideration for chronic noninvasive ventilation in COPD should occur:

A) in selected individuals with severe COPD

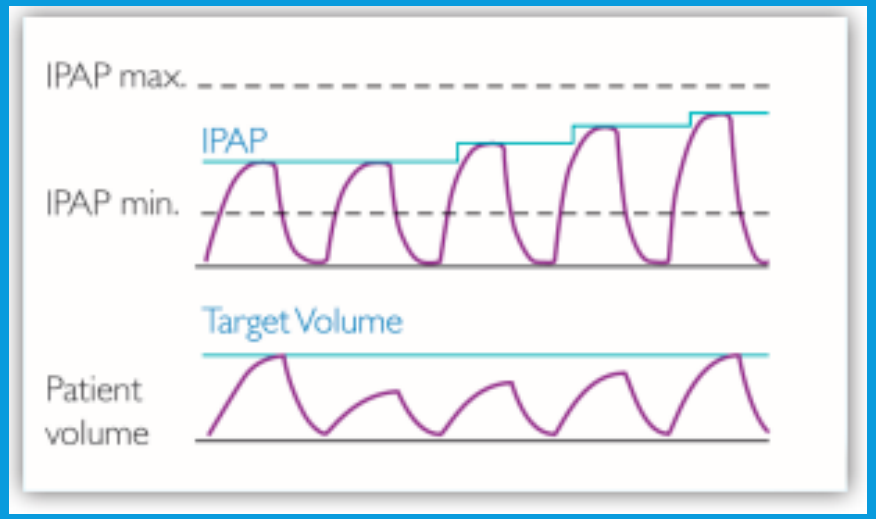
B) in selected individuals with COPD requiring non invasive ventilation during an exacerbation

C) in selected individuals with COPD and chronic severe hypercapnia

D) in selected individuals with COPD with recurrent exacerbations

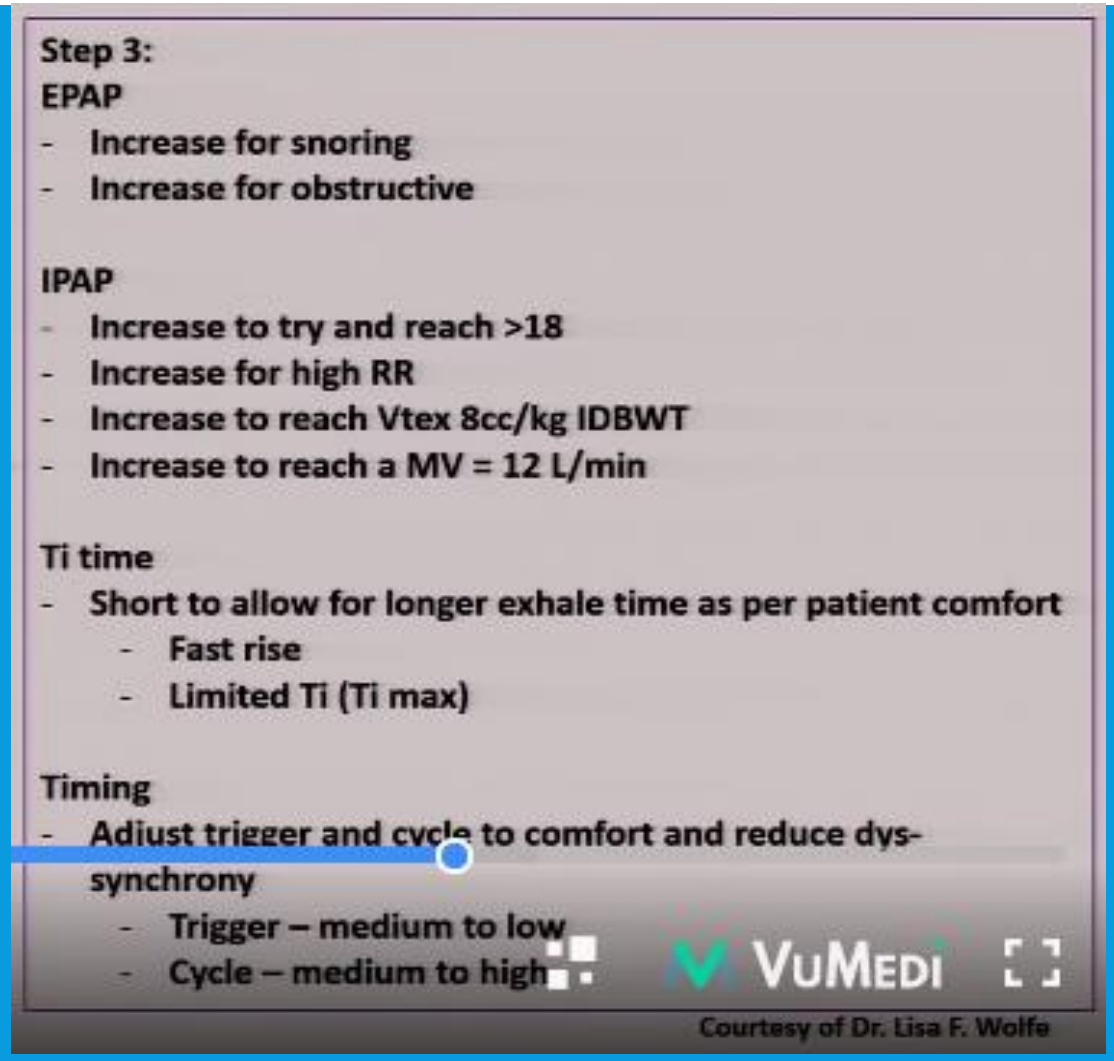
HOW TO TITRATE- CHOOSE A MODE/MACHINE

1. Choose mode: spontaneous, spontaneous/timed, pressure controlled
    1. S mode: Spontaneous – no ability to set Ti (?), no back up rate
    2. S/T mode: Spontaneous/timed: only machine triggered breaths are machine cycled
    3. PC mode: Pressure controlled: all breaths machine cycled (Ti)
2. Consider add ons:
    1. Average volume assured pressure support (AVAPS) to target a tidal volume within a pressure range
    2. auto BUR
    3. Auto EPAP (good if concomitant OSA)



Storre et al., RESPIRATORY CARE SEPTEMBER 2014 VOL 59 NO 9
Murphy et al., Int J Chron Obstruct Pulmon Dis. 2012; 7: 811–818.

HOW TO TITRATE HIGH PRESSURE-NIV IN COPD IN A SLEEP LAP



HOW TO TITRATE NIV OUTSIDE OF SLEEP LAB

Initial AVAPS-AE Suggested Settings

	OHS	COPD - OSA
Mode	AVAPS-AE	AVAPS-AE
AVAPS Rate	4 cmH_2O/min	2 cmH_2O/min
Tidal Volume	8 - 10 ml/kg (ideal bodyweight)	8 ml/kg (ideal bodyweight)
Max Pressure	35 cmH_2O	30 cmH_2O
PS Max	16 - 21 cmH_2O	12-16 cmH_2O
PS Min	10 - 16 cmH_2O	8 - 12 cmH_2O
EPAP Max	8 - 14 cmH_2O	8 - 14 cmH_2O
EPAP Min	4 cmH_2O (5 cmH_2O with FFM)	4 cmH_2O (5 cmH_2O with FFM)
***Breath Rate**	Auto	Auto
Rise	< 4	< 4
Trigger Type	Auto-Trak	Auto-Trak
Ramp	Off	Off

NIV WAKE TITRATION – ALTERNATIVE WITH ST

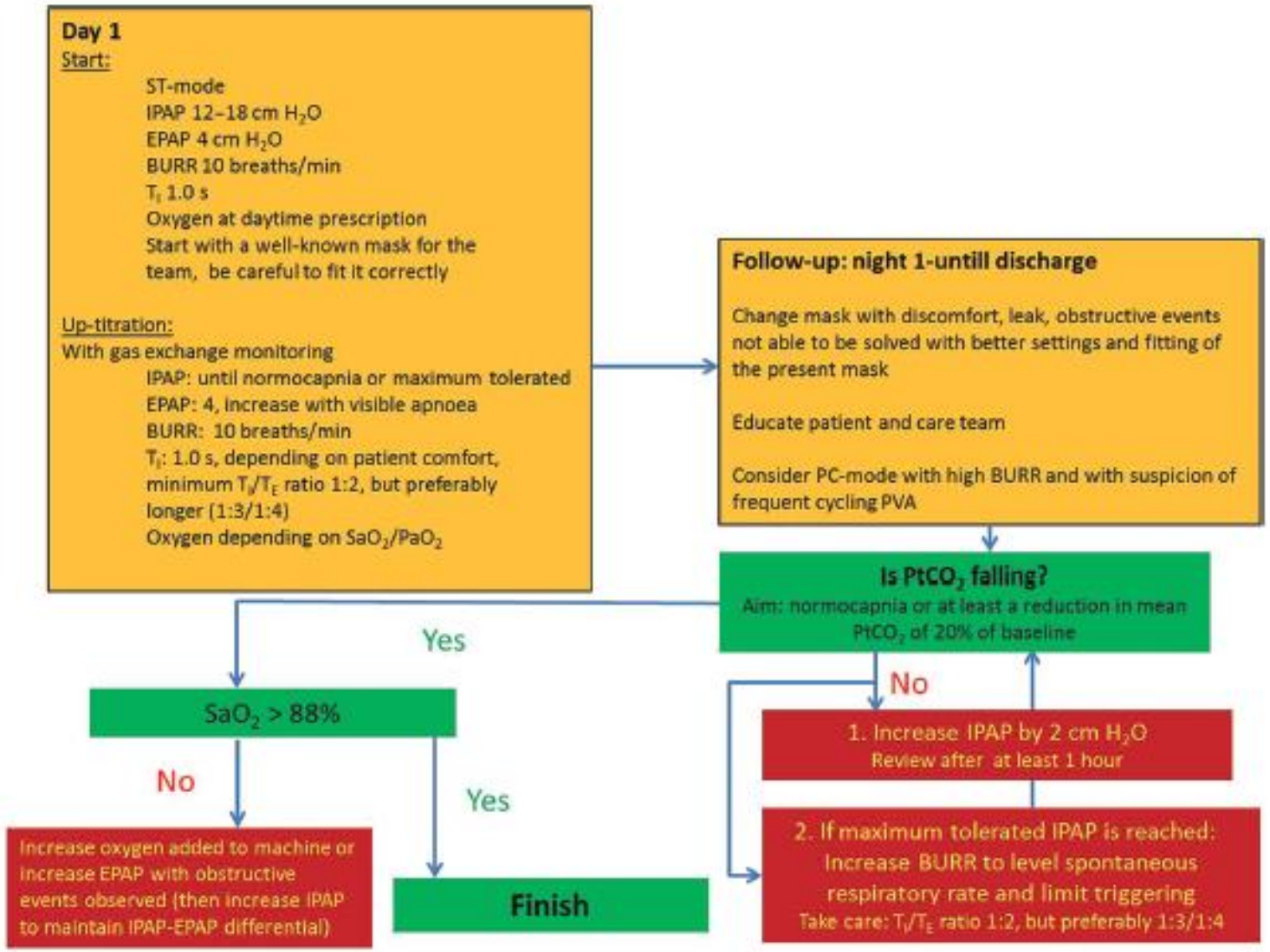


Figure 2 Ventilator set-up for high-intensity NIV at the Home Mechanical Ventilation (HMV) centre Groningen. BURR, back-up respiratory rate; EPAP, expiratory positive airway pressure; IPAP, inspiratory positive airway pressure; NIV, non-invasive ventilation; PaO_2, partial arterial oxygen pressure; PC-mode, pressure-controlled mode; $PtcCO_2$, transcutaneous carbon dioxide tension; PVA, patient–ventilator asynchrony; T_E, expiratory time; T_I, inspiratory time; SaO_2, oxygen saturation; ST-mode, spontaneous-timed mode.

Adapted from Ven Der Leest and Duiverman, Respirology 2018

GOALS!

- Follow up these patients!
- Frequently until goals reached:
- Goals on download:
  - IPAP ≥ 20 cm H_2O
  - Vt close to 8 mL/kg
  - Spontaneously triggered breaths kept low (? <15-20%?)
  - I:E 1:2-1:4
  - > 5-6 hr/day use
- Outcome measure goals: Decrease in PCO_2 at least 20% or < 48 mm Hg
- Goals on overnight oximetry:
  - Titrate or add O_2 to keep mean nocturnal saturations 90-92%
- Then every 1-2 years or if decompensation

QUESTION 2

When providing chronic non invasive ventilation in stable COPD, target ventilation settings include:

A) IPAP greater than 18 cm H_2O

B) tidal volume target 8 cc/kg

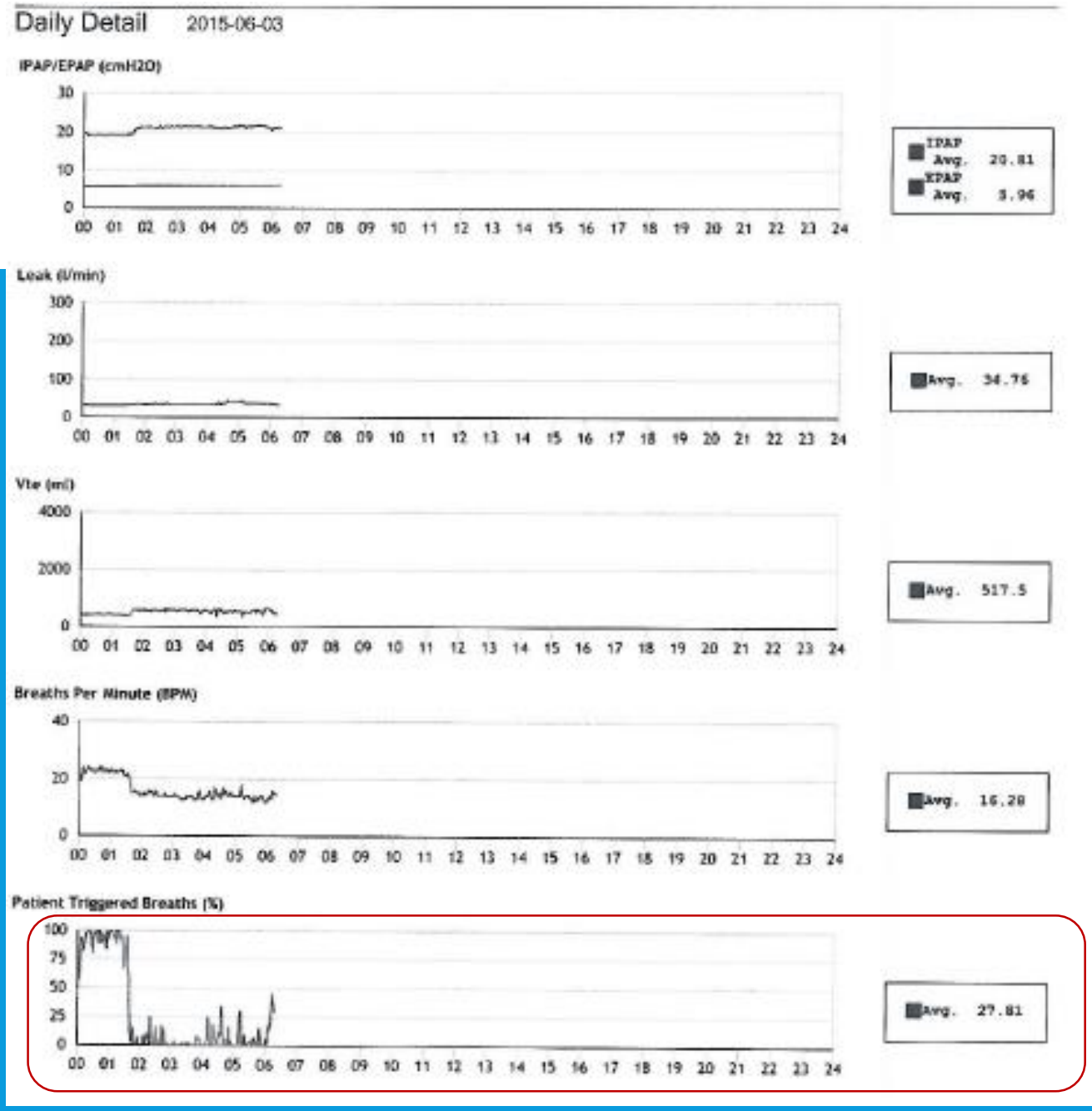
C) minute ventilation target 12 L/min

D) all of the above

SAMPLE DOWNLOAD

- AVAPS – AE (EPAP 6-6)
- Auto BUR
- Max IPAP 30
- Vt 530 ml
- PS 8-16

		2015 05-20	2015 05-27	2015 06-03
IPAP	Max	23.81	22.4	21.75
	Min	5.58	4.4	18.99
	Avg	20.51	20.33	20.81
EPAP	Max	6.04	6.01	6.01
	Min	4.81	5.03	5.85
	Avg	5.93	5.84	5.96
Vte	Max	2276	3336	655
	Min	1	0	351
	Avg	593.41	535.63	517.5
Leak	Max	198	221.2	44.3
	Min	26.5	28.8	31
	Avg	44.41	38.12	34.76
Peak Flow	Max	100.6	112.2	61.6
	Min	19.5	0	28.6
	Avg	44.25	41.69	43.28
Minute Ventilation	Max	20.6	21.3	10.1
	Min	0.6	0	5.9
	Avg	8.47	8.03	8.31
Breaths Per Minute	Max	29	27	24
	Min	6	0	12
	Avg	15.57	15.96	16.28
Patient Triggered Breaths	Max	100	100	100
	Min	0	0	0
	Avg	43.4	41.85	27.81
Ti/Ttot	Max	58	51	36
	Min	18	0	22
	Avg	33.02	31.28	28.26
Unintentional Leak	Max	163.7	187.7	16.6
	Min	1.8	4.9	5.6
	Avg	15.69	10.34	7.83
Obstructed Airway Apnea		0.3	0.1	0.3
Hypopnea		2.2	2	2.2
Clear Airway Apnea		0	0	0
Large Leak		0.5	0.1	0
Periodic Breathing		0.4	0.1	0
RERA		0	0	0
Severe Snore		16.7	8.6	0



COMMON TROUBLESHOOTING IN COPD NIV

ON DOWNLOAD

Tachypnea: results in low Vt, I:E > 1:2

1. Increase PS to increase Vt and reduce RR and decrease inspiratory time

Vt < 8cc/kg IBW or MV < 12 L/min: will worsen V/Q and not allow reduction in PCO_2

1. Increase PS to increase Vt
2. Target tidal volume NIV (AVAPS) modes can help with this

Gas trapping or I:E >1:2 or Ti too long

1. Usually related to first or second problem
2. Rarely need to 'downtitrate'

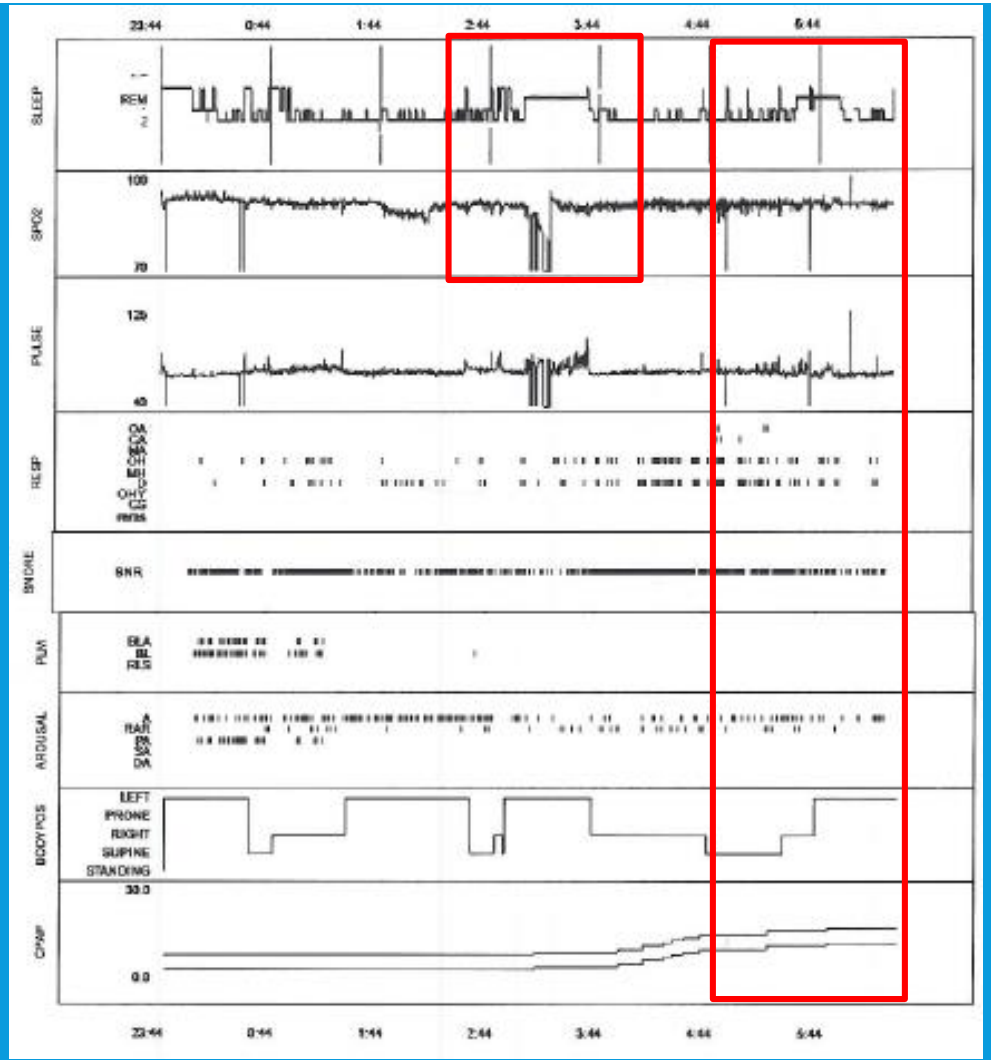
Finally, increase BUR until breathing is controlled (usually at or 1-2 breaths/min above spontaneous RR

If PCO_2 remains high

- Increase IPAP as tolerated (increase tidal volume)
- Increase BUR to 1-2 above spontaneous rate (for more muscle rest)
- May suggest daytime respiratory insufficiency too severe or progressing
  - Get early AM blood gas if possible (usually not possible!)
  - Suggest some daytime use, particularly if fatigued/dyspneic during the day

CASE 1

- 68M with severe COPD FEV1 0.67L or 24%
- Sleep study AHI 36/h with REM desaturations and mild increase in TCCO2 during REM
- Frequent COPDE requiring admission with hypercapnia and use of rescue bilevel
- Jan 2015: Overnight positive pressure titration study
- Titrated to 17/12 cm H2O
- Note: episode of REM desaturation, low EPAP that resolves OAs, ongoing events despite increased pressures (?true OH?)
- What would you do next?

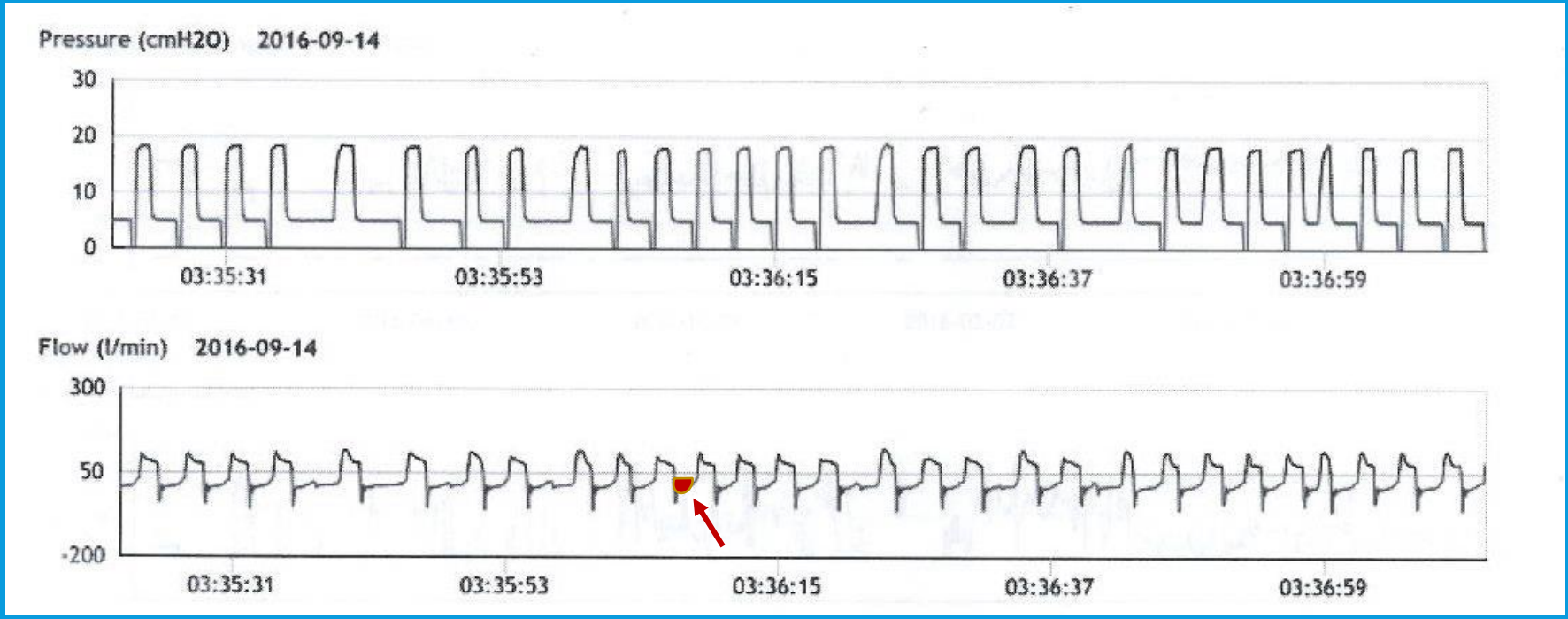


CASE 1

- January 2015 titration sleep study
- Venous blood gas 2 weeks prior:
  - PH 7.38
  - PCO_2 62 mm Hg
- February 2015 Started on AVAPS – AE during inpatient pulmonary rehabilitation
  - Max IPAP 20, min EPAP 5 (PS 5-15 cm H_2O)
  - Vt 670 ml (IBW 80 kg)
  - Ti 1.0 s – 2.5 s
  - BUR auto
- February 2015 arterial blood gas on room air pH 7.41, PCO_2 48 mm Hg

CASE 1 - GAS TRAPPING

- Patient returns a few months later
- States breaths feel too large
- Capillary blood gas pH 7.40, PCO_2 45 mm Hg



GAS TRAPPING - STRATEGIES

- Goal to increase expiratory time for target I:E 1:2 – 1:4
- Goal to decrease inspiratory time
  - Increase IPAP to get Vt in faster
  - Decrease inspiratory time setting
  - Increase rise if tolerated (decreases Ti)
  - 'Down titrate': Decrease target tidal volume (allows patient to decreases Ti)
    - If at target PCO_2 or if Vt to aggressive in AVAPS

- Chose to decrease target tidal volume to 640 ml since PCO_2 optimised and initial Vt was > 8 cc/kg

CASE 2

87 year old gentleman with
COPD, FEV1 32%
PCO_2 53 mm Hg
IBW 75 kg (target Vt = 600 ml)

What are the problems with this download?

How do we optimize his settings?

2019-02-06 **Device: Stellar 150 (S/N: 000000020160659**

Device Settings

Therapy Mode: **SPONT_TIMED**	Expiration Pressure: **6.0 cmH2O**	Inspiration Pressure: **17.0 cmH2**
Backup Breath Rate: **14.0 bpm**	Rise Time: **700.0**	Fall Time: **200.0**
Trigger Sensitivity: **MED**	Cycle Sensitivity: **MED**	Ti Max: **1.9 sec**
Ti Min: **1.5 sec**		

EPAP - cmH2O

5th Percentile:	Median:	95th Percentile:

Leak - L/min

5th Percentile: **3.0**	Median: **35.0**	95th Percentile: **75.0**

Tidal Volume - mL

5th Percentile: **310**	Median: **480**	95th Percentile: **780**

Minute Ventilation - L/min

5th Percentile: **4.4**	Median: **7.3**	95th Percentile: **11.4**

Respiratory Rate - breaths/min

5th Percentile: **14**	Median: **14**	95th Percentile: **19**
% Spontaneous triggered breaths: **26**	% Spontaneous cycled breaths: **10**	

Respiratory Indices - events/hr

Apnea Index: **0.0**	Hypopnea Index: **0.6**	AHI: **0.6**

Total Usage

Used Days >= 4 hrs : **1**	Used Days < 4 hrs : **0**	% Used Days >= 4 hrs : **100**
Days not used: **0**	Total days: **1**	Total hours used: **6:22**
Median daily usage: **6:22**	Average daily usage: **6:22**	

I:E Ratio

5th Percentile: **1:1.85**	Median: **1:1.27**	95th Percentile: **1.22:1**

Inspiratory Time - seconds

5th Percentile: **1.50**	Median: **1.90**	95th Percentile: **1.90**

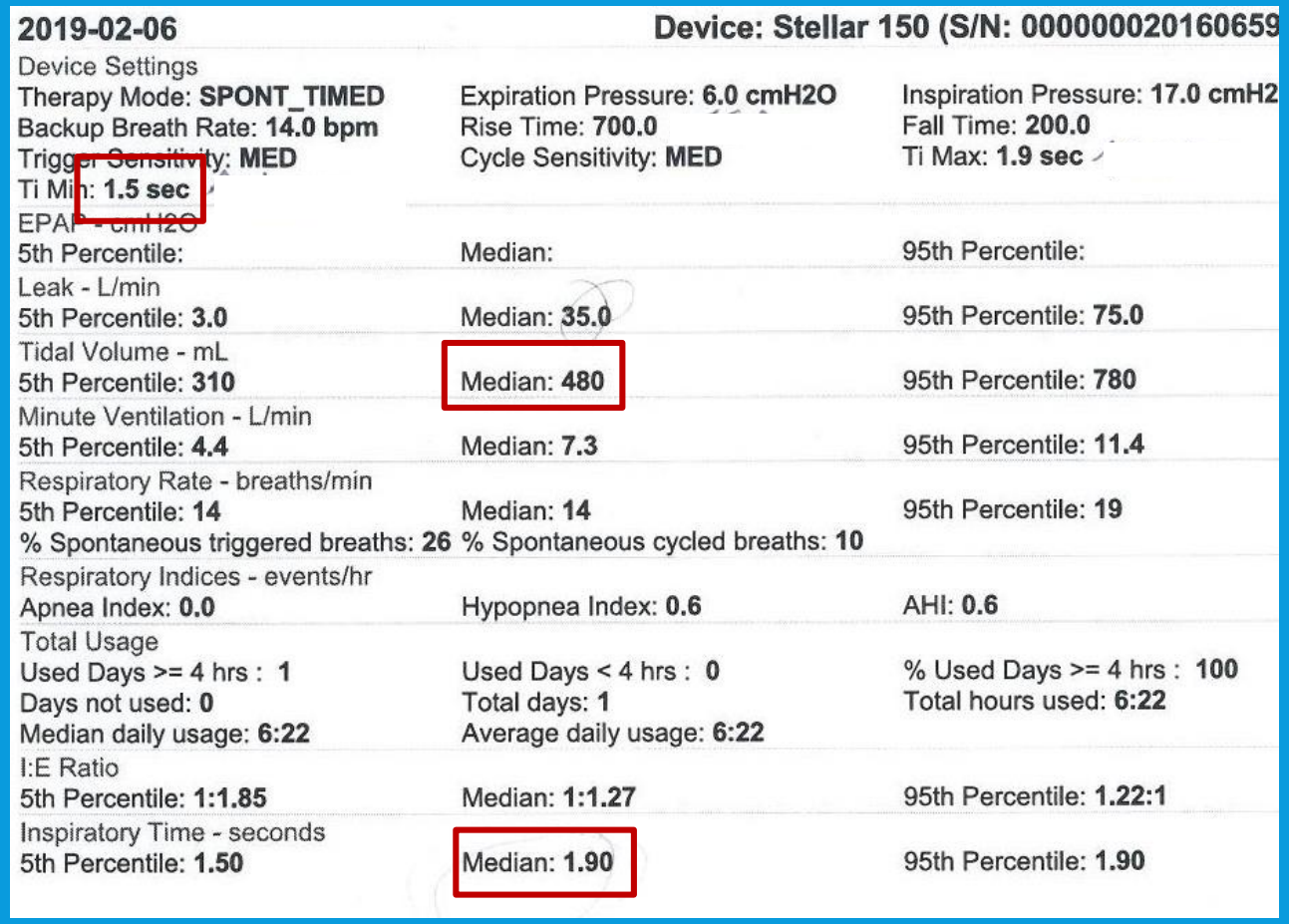
CASE 2

Problem 1:

- Tidal volume too low
- Solution:
  - Increase IPAP to goal > 18 minimum
  - Decrease EPAP to 5
  - Shorten rise time

Problem 2:

- Inspiratory time too long - I:E too high
  - Because patient is needing Vt
- Solution:
  - Increase IPAP until median Ti closer to Ti min and I:E < 1:2
  - Ensure Ti min 1 s or less



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Respiratory Indices - events/hr		
Apnea Index: **0.0**	Hypopnea Index: **0.6**	AHI: **0.6**
Total Usage		
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5th Percentile: **1:1.85**	Median: **1:1.27**	95th Percentile: **1.22:1**
Inspiratory Time - seconds		
5th Percentile: **1.50**	Median: **1.90**	95th Percentile: **1.90**

QUESTION 3

When titrating non invasive ventilation in COPD, which statement is FALSE?:

A) increase IPAP if respiratory rate is high

B) increase inspiratory time to allow for larger tidal volume

C) increase IPAP if tidal volume is too low

D) increase EPAP for snoring or obstructive apneas

SUMMARY OF PRACTICAL EVIDENCE FOR INITIATING NIV IN COPD

- Keep PCO_2 as your target
- Follow and titrate over time
  - Start low intensity for habituation
- Requires high IPAP +/- BUR
  - compliance and effectiveness
- Therapeutic relationship and follow up are important

Is the question whether NIV is effective in COPD or are the questions:

- What are the BEST techniques/settings for NIV in COPD?
- What are the BEST indications for NIV in COPD?