

NIV clinical cases: in built software

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A teenager with Duchenne muscular dystrophy

16-yr-old boy with Duchenne muscular dystrophy

- Lost ambulation at 14 yrs
- Tired and sleepy after school
- One respiratory infection needing ABx treatment in the last year

Diagnosis and management of Duchenne muscular dystrophy, part 2: respiratory, cardiac, bone health, and orthopaedic management



Ambulatory stage	Early non-ambulatory stage	Late non-ambulatory stage
Assessments		
Once yearly: FVC	Twice yearly: FVC, MIP/MEP, PCF, SpO ₂ , p _a CO ₂ /p _t CO ₂	
Sleep study* with capnography for signs and symptoms of obstructive sleep apnoea or sleep-disordered breathing		
Interventions		
Immunisation with pneumococcal vaccines and yearly inactivated influenza vaccine		
	Lung volume recruitment when FVC \leq 60% predicted	
	Assisted coughing when FVC $<$ 50% predicted, PCF $<$ 270 L/min, or MEP $<$ 60 cm H ₂ O†	
	Nocturnal assisted ventilation with back-up rate of breathing (non-invasive preferred) when there are signs or symptoms of sleep hypoventilation or other sleep-disordered breathing,‡ abnormal sleep study,* FVC $<$ 50% predicted, MIP $<$ 60 cm H ₂ O, or awake baseline SpO ₂ $<$ 95% or pCO ₂ $>$ 45 mm Hg	

Gal

- BW 79 kg (89p), BMI 25.5 (88p)
- FVC 2.61 L (54 %pred)
- MIP 45 cm H₂O, PCF 210 L/min
- SpO₂ 96%
- Capillary blood gases:
pH 7.41, PCO₂ 42 mm Hg,
HCO₃ 28 mmol/l

Overnight polygraphy

SpO₂ mean 94%, min. 79%

Time spent with SpO₂ <90%: 8%

PtcCO₂ mean 43 mm Hg, peak 54 mm Hg

Time spent with PtcCO₂ >50 mm Hg: 4%

Gal

Noninvasive ventilation

- Nose mask
- Pressure support mode with volume guarantee and back-up rate
- In-hospital adaptation and titration
- Review visit in 2 weeks



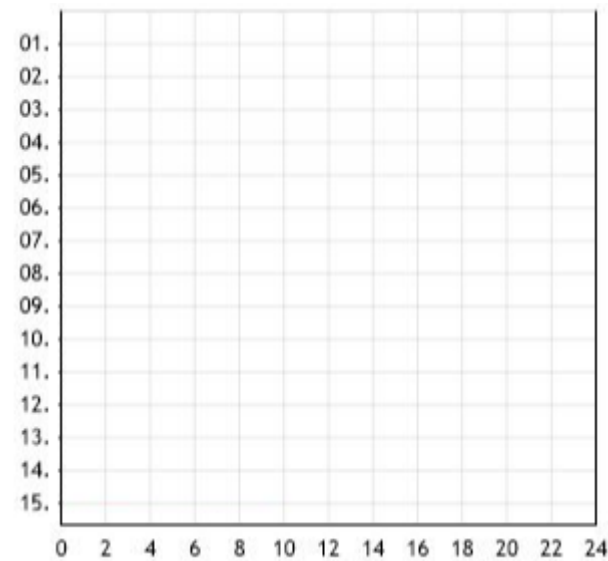
Courtesy of Prof Fauroux

1st visit – ventilator memory card data

Noninvasive ventilation

- Nose mask
- S/T AVAPS
- IPAP 18/12 cm H₂O, EPAP 4 cm H₂O,
- TV 425 ml, RR 16/min,
- Trigger: Auto Trak, Ti 0.9 s
- Rise time 2

Compliance track



Intervention

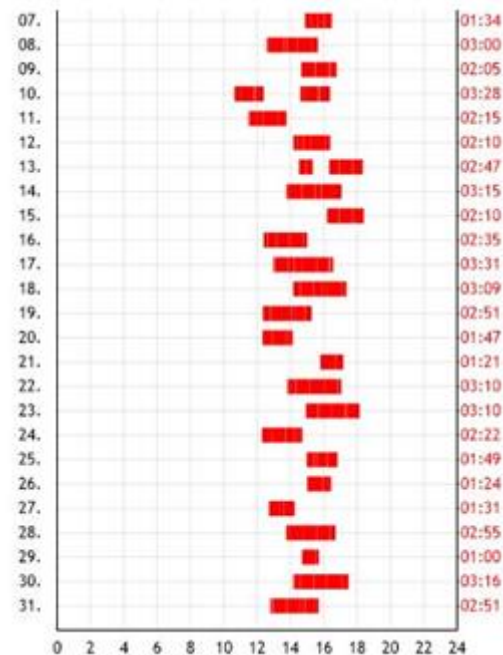
- Minimal contact nasal prongs

2nd visit – ventilator memory card data

Noninvasive ventilation

- Minimal contact nasal prongs
- S/T AVAPS
- IPAP 18/12 cm H₂O, EPAP 4 cm H₂O,
- TV 425 ml, RR 16/min,
- Trigger: Auto Trak, Ti 0.9 s
- Rise time 2

Compliance track



Intervention

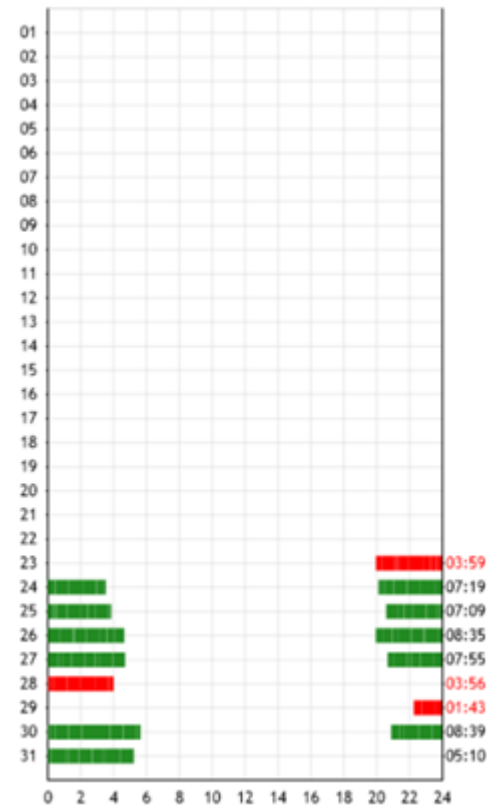
- Rise time ↓ 1

3rd visit – ventilator memory card data

Noninvasive ventilation

- Minimal contact nasal prongs
- S/T AVAPS
- IPAP 18/12 cm H₂O, EPAP 4 cm H₂O,
- TV 425 ml, RR 16/min,
- Trigger: Auto Trak, Ti 0.9 s
- Rise time 1

Compliance track



Intervention

- Screen saver – black
- Buttons' lights off

4th visit – ventilator memory card data

Noninvasive ventilation

- Minimal contact nasal prongs
- S/T AVAPS
- IPAP 18/12 cm H₂O, EPAP 4 cm H₂O,
- TV 425 ml, RR 16/min,
- Trigger: Auto Trak, Ti 0.9 s
- Rise time 1

Compliance track

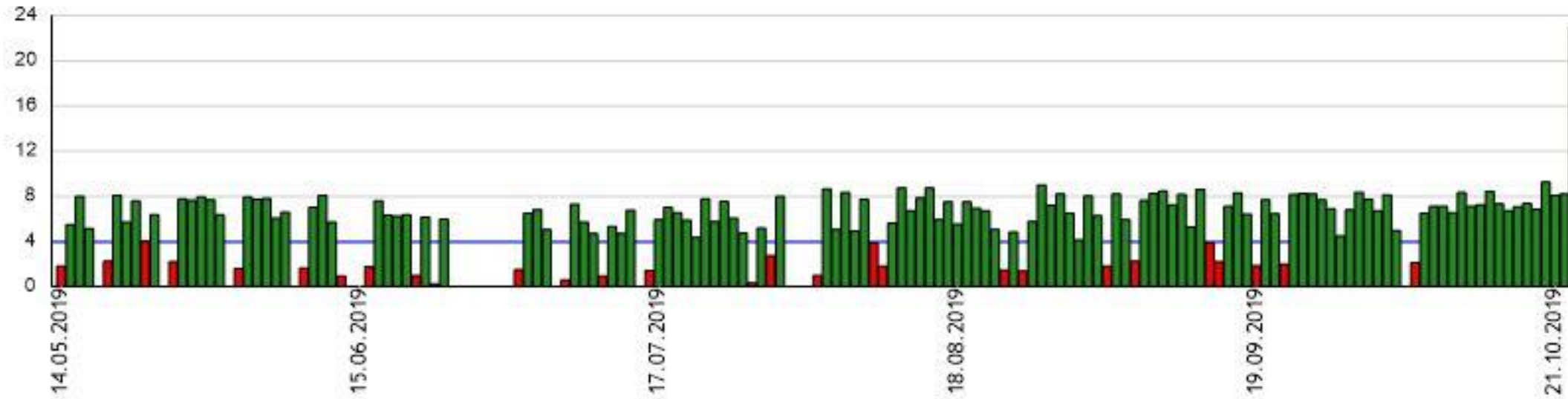


Intervention

- Gentle resilience
- Education

5th visit – ventilator memory card data

Hours of Usage



- [Clinical%20cases-
NIV%20in%20built%20software_3rd%20niv%20congress_UK&SK_def.p
pt#2. Diapositive 2](#)

17-yrs old boy with spinal muscular atrophy

Bor

Attending regular school accompanied by a personal assistant.

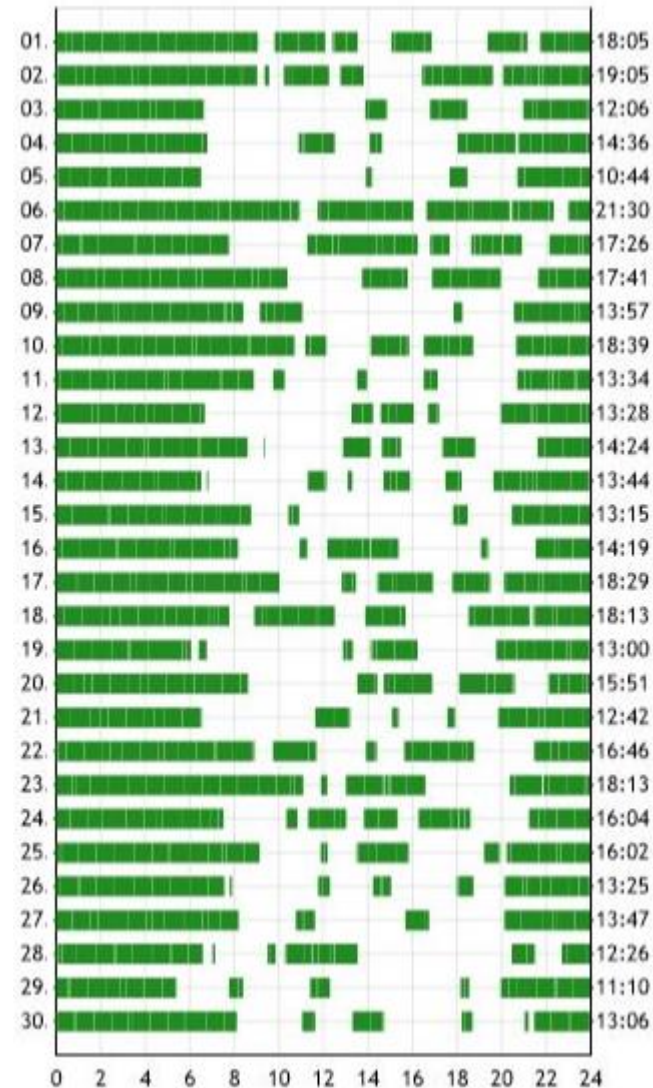
Highly autonomous in his wheelchair.

- NIV since the age of 5 yrs
- Spine surgery at 13 yrs of age
- FVC 35 %pred
- No important respiratory exacerbations in the last 2 yrs

Last check-up visit

Overnight polygraphy:

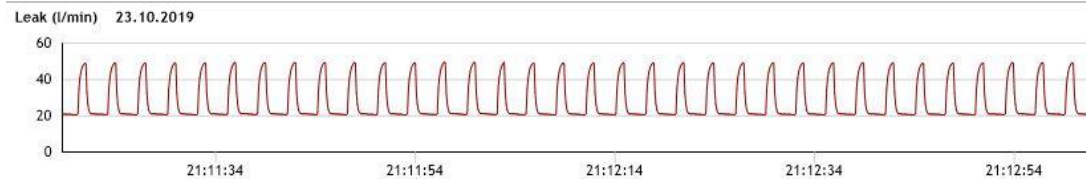
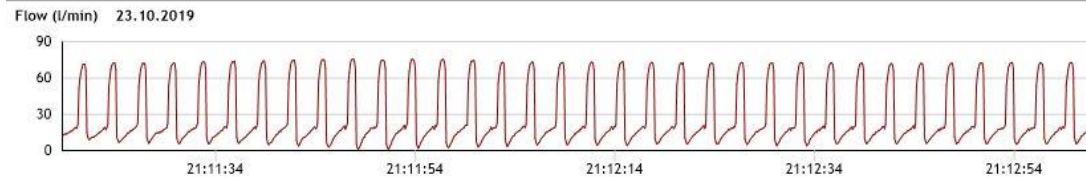
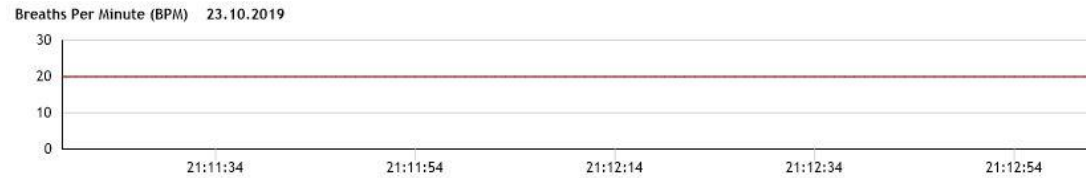
- Single time point measurement
- SpO2 mean 94%, min. 79 %
- Time spent with SpO2 <90%: 3 %
- PtcCO2 mean 42 mm Hg,
peak 48 mm Hg
- Time spent with PtcCO2 >50 mm Hg: 0 %



Memory card data:

- Time range: 187 days
- Days with ventilator use: 100 %
- Time on ventilator/day: 14.6 h
- Average leak: 32 L/min
- Patient triggered breaths: 17 %

In built software



Ventilator's settings:

Mode: Pressure support with volume guarantee
(S/T AVAPS) – hybrid mode

Pressures: IPAP 18/12 cm H₂O, EPAP 4 cm H₂O,

Tidal volume: 425 ml

Back-up rate: 16 breaths/min,

Trigger: Auto Trak,

Inspiratory time: 0.9 s

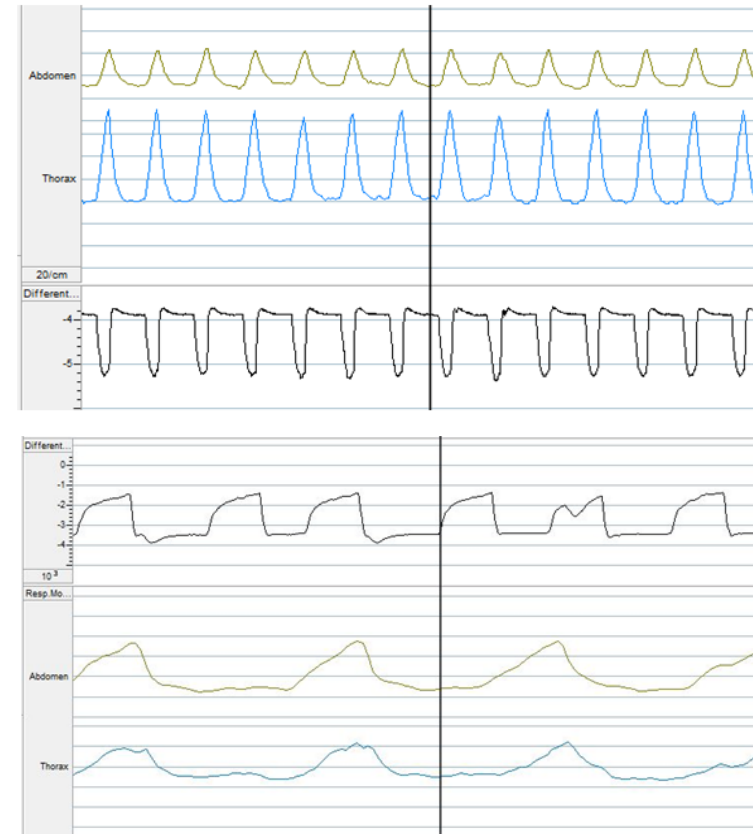
Rise time: 2

Recorded tracings

In build software



Overnight polygraphy



Proposal for a systematic analysis of polygraphy or polysomnography for identifying and scoring abnormal events occurring during non-invasive ventilation

J Gonzalez-Bermejo,¹ C Perrin,² J P Janssens,³ J L Pepin,⁴ G Mroue,⁵ P Léger,⁶
B Langevin,⁷ S Rouault,⁸ C Rabec,⁹ D Rodenstein,¹⁰ on behalf of the SomnoNIV Group

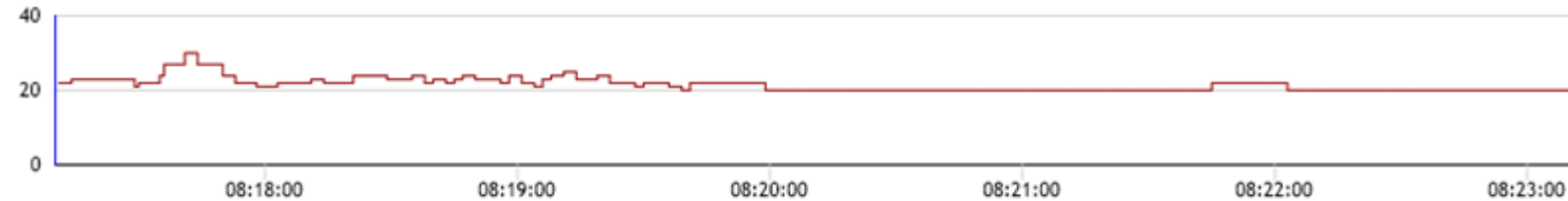
Respiratory event

occurrence of a modification, discontinuity or instability of ventilation which had deleterious consequences on SpO₂, PtcCO₂ and/or sleep (ie, arousals or microarousals)

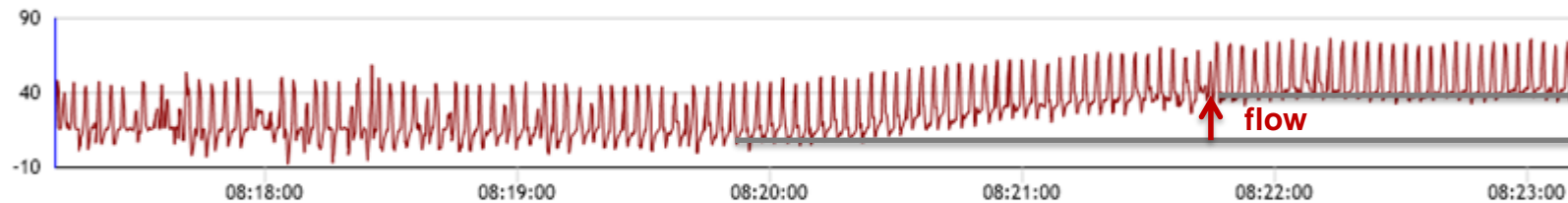
- **Unintentional leaks**
- **Decrease in ventilatory drive**
- **Partial or total upper airway obstruction with reduction of ventilatory drive**
- **Mixed events: partial or total closure of the upper airways and reduced ventilatory drive followed by passive closure of the upper airways and resumption of respiratory drive**
- **Partial or total upper airway obstruction without reduction of ventilatory drive**

Unintentional leaks

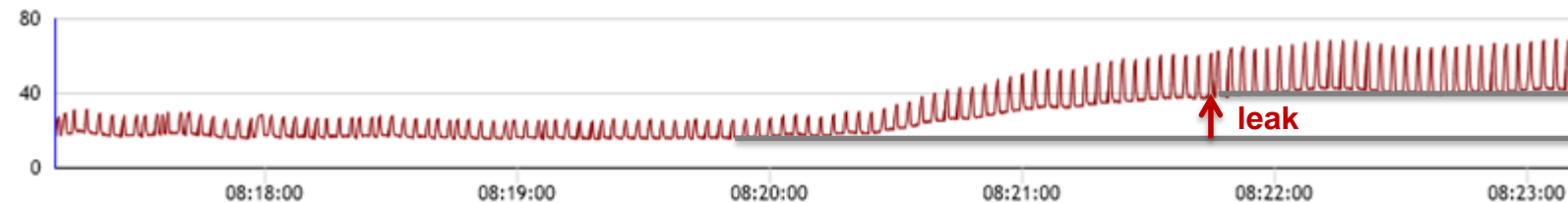
Breaths Per Minute (20 BPM)



Flow (16,7 l/min)



Leak (17,2 l/min)



Pressure support / leak compensation

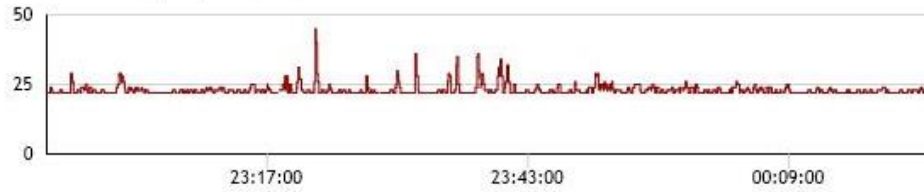
↑ **leak** → ↑ flow within preset pressure limits (18-12 cm H₂O)

⇒

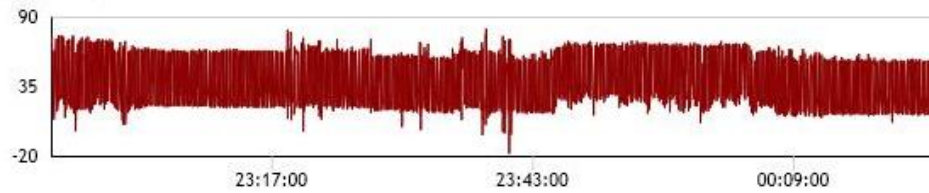
retain tidal volume / minute ventilation despite unintentional leak

Leak compensation

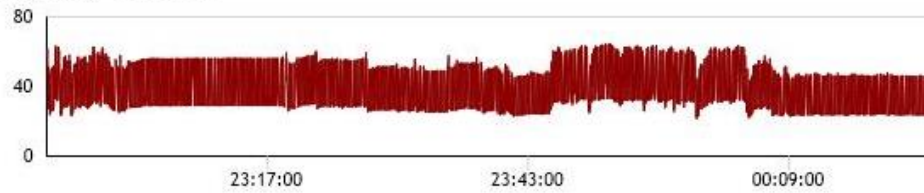
Breaths Per Minute (BPM) 23.10.2019



Flow (l/min) 23.10.2019

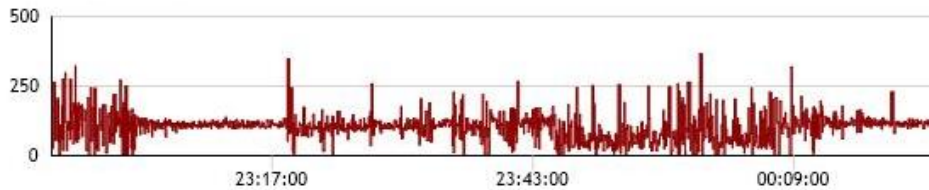


Leak (l/min) 23.10.2019



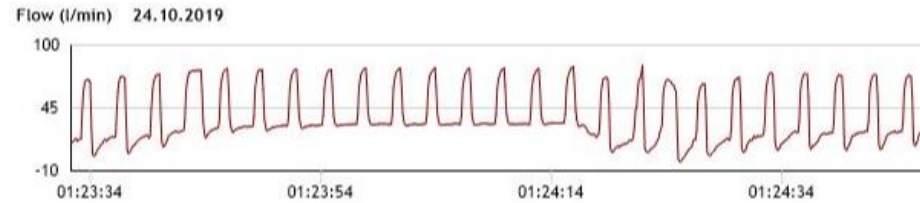
↑ leak

Vte (ml) 23.10.2019



Diminished, but retained **tidal volume**

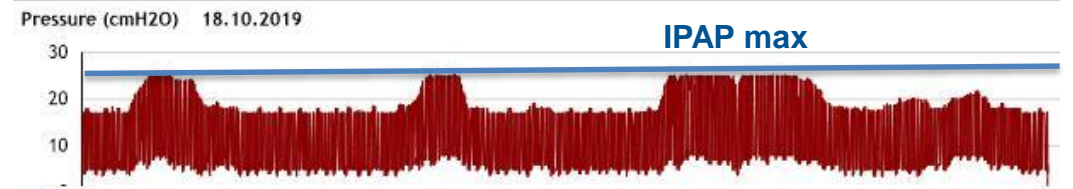
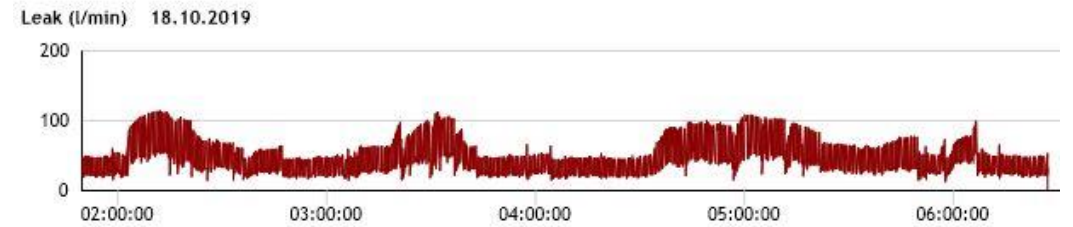
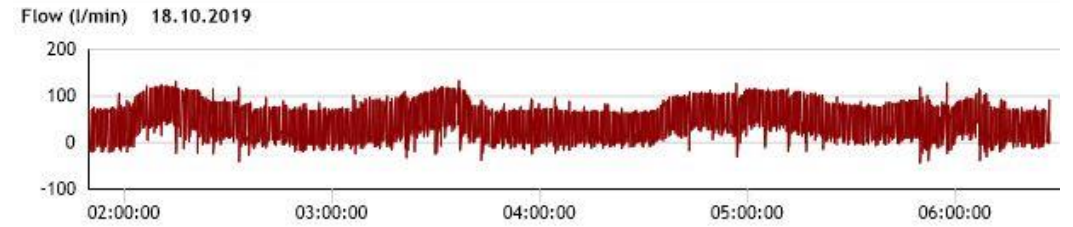
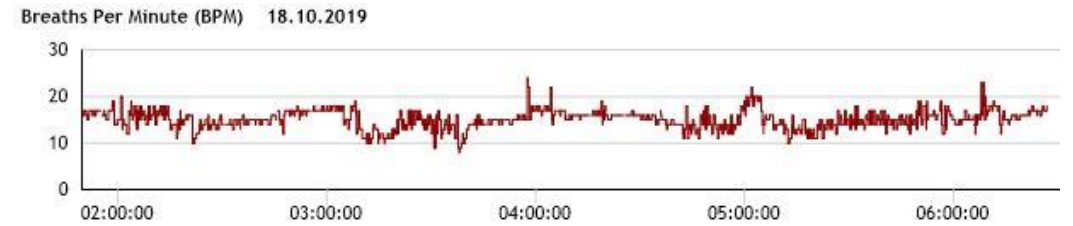
Leak compensation



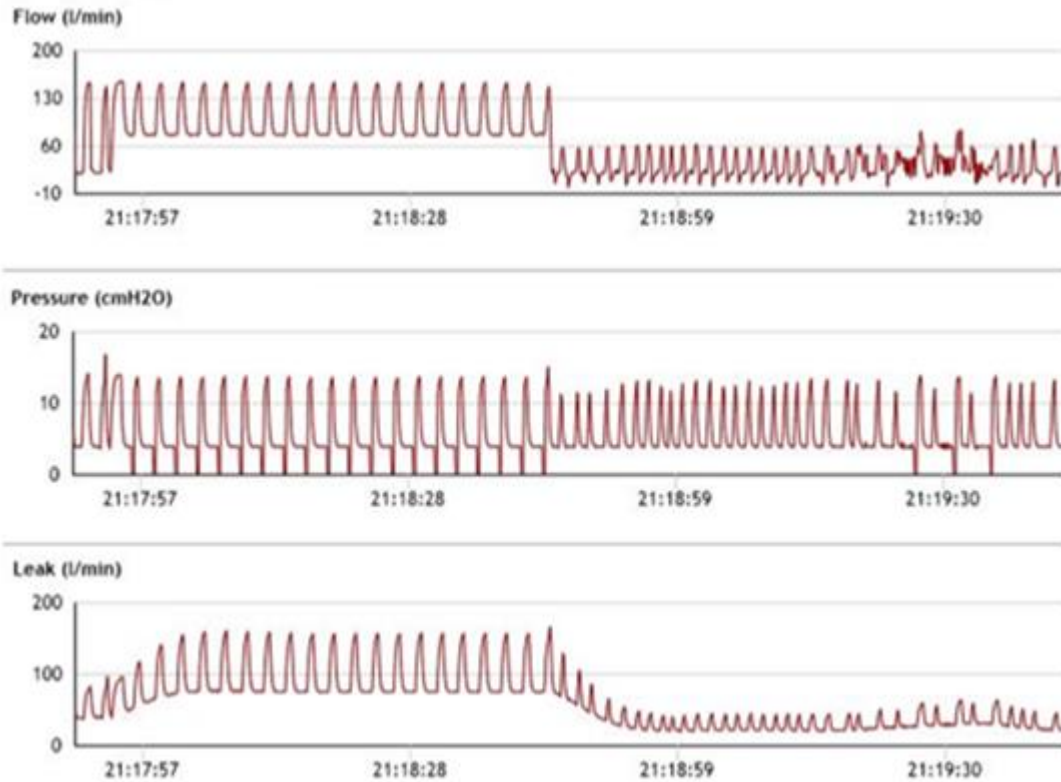
↑ flow

↑ leak

TV not retained

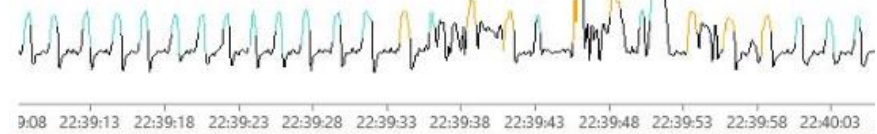


Leaks – effect on triggering



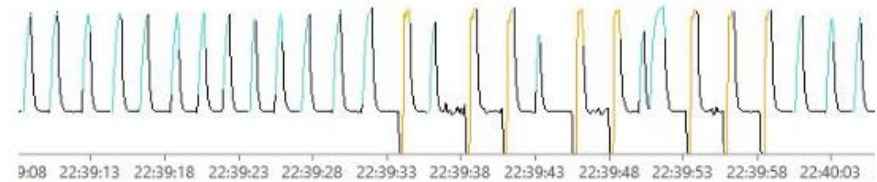
Flow

— Ventilator-Initiated Breaths — Patient-Initiated Breaths



Pressure

— Ventilator-Initiated Breaths — Patient-Initiated Breaths

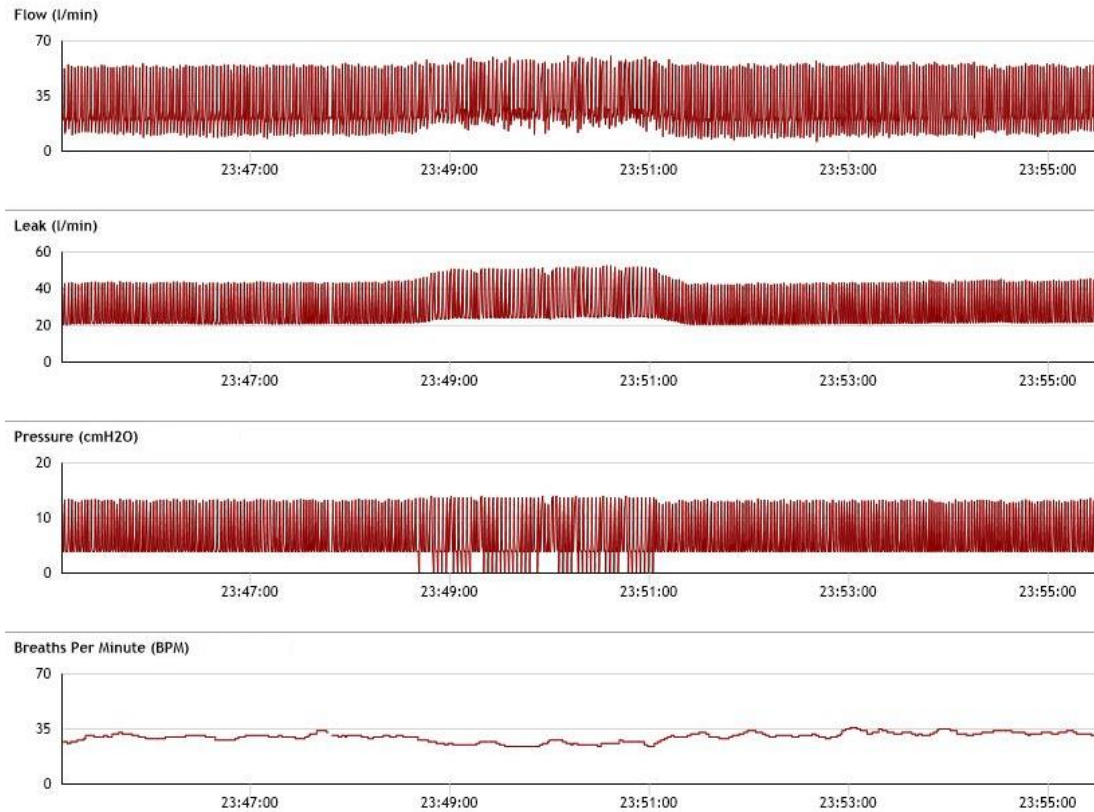


Leak

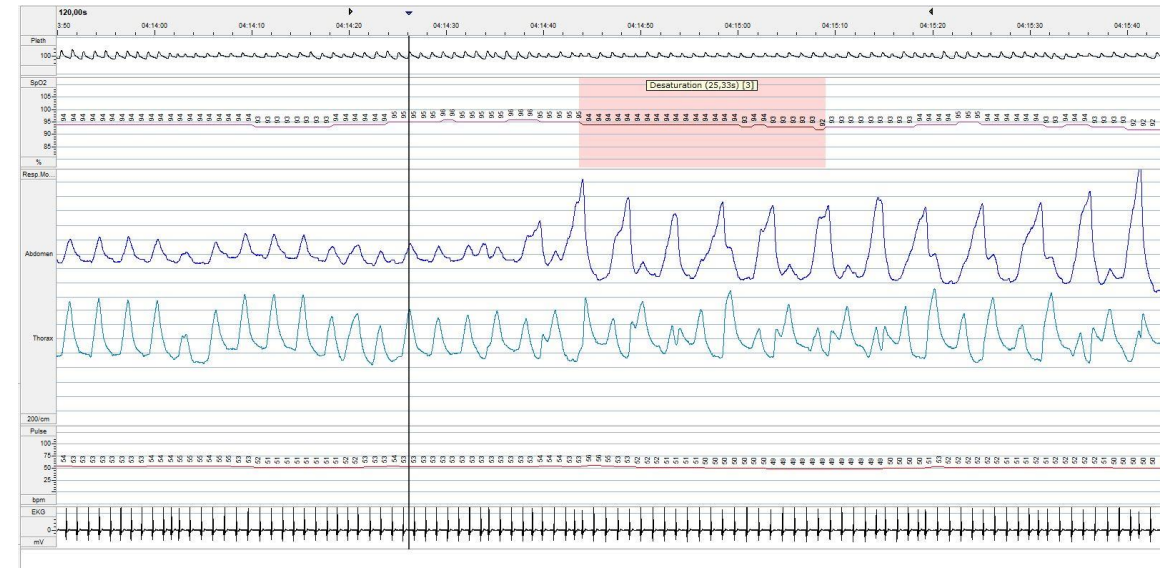


Leaks – effect on triggering

In build software

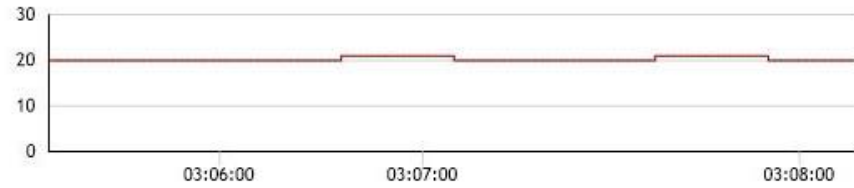


Overnight polygraphy

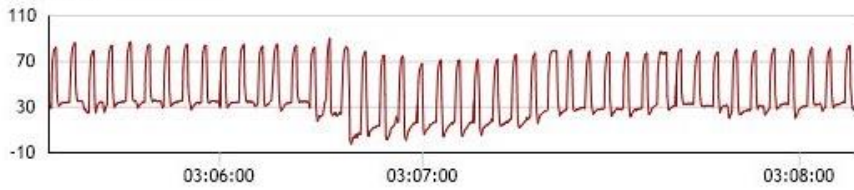


Leaks – tidal volume

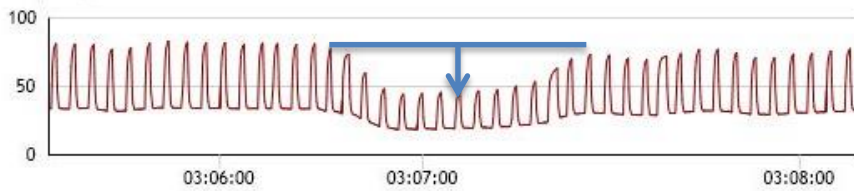
Breaths Per Minute (BPM)



Flow (l/min)

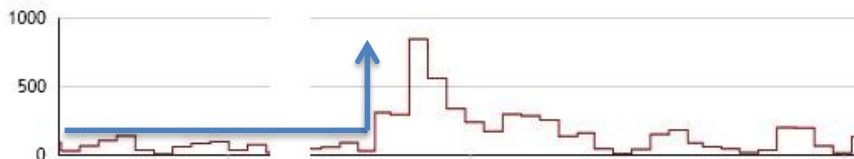


Leak (l/min)



↓ leak

Vte (ml)

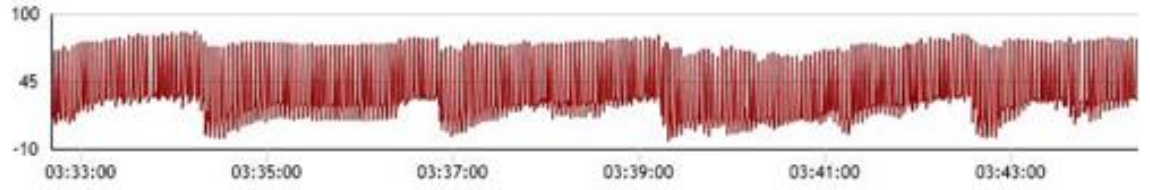


↑ TV

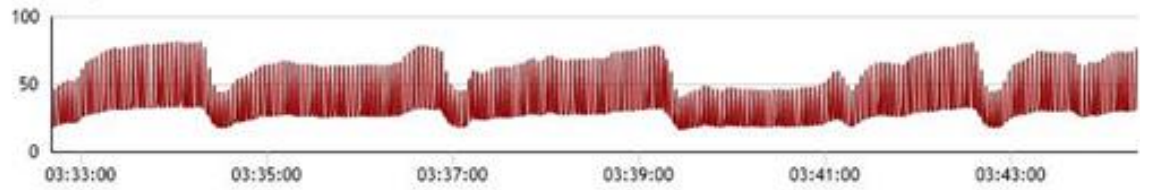
Breaths Per Minute (BPM)



Flow (l/min)



Leak (l/min)

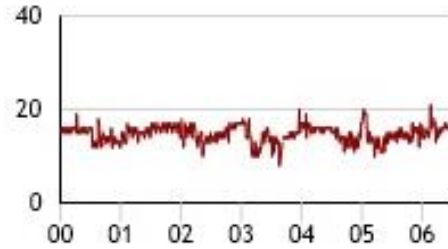


Vte (ml)

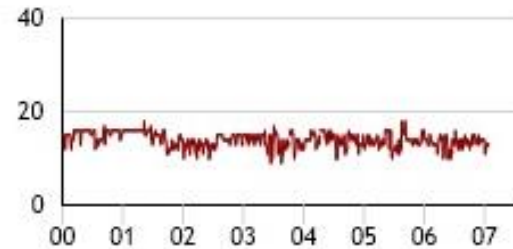


Leaks – effect on minute ventilation

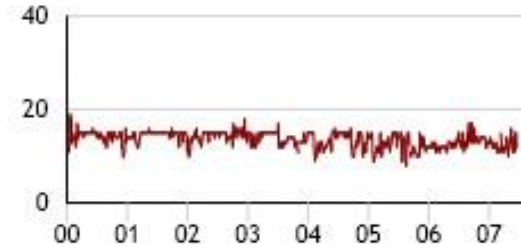
Breaths Per Minute (BPM)



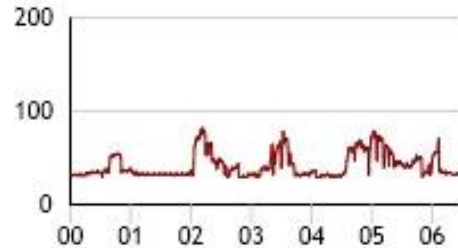
Breaths Per Minute (BPM)



Breaths Per Minute (BPM)



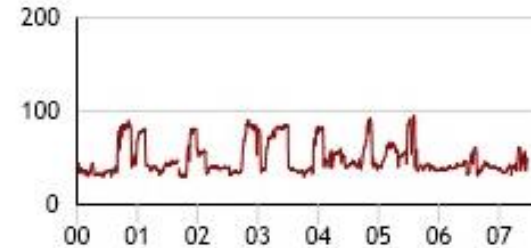
Leak (l/min)



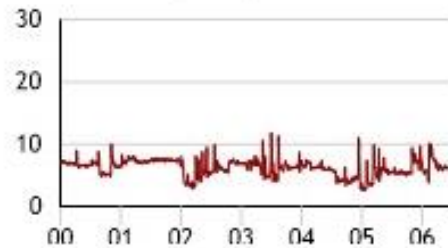
Leak (l/min)



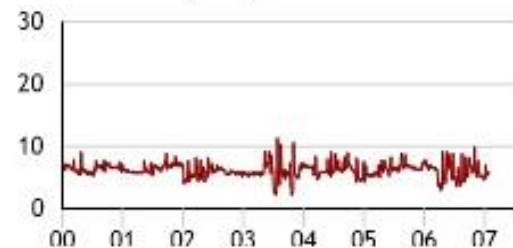
Leak (l/min)



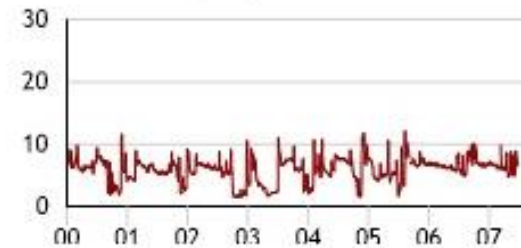
Minute Ventilation (l/min)



Minute Ventilation (l/min)

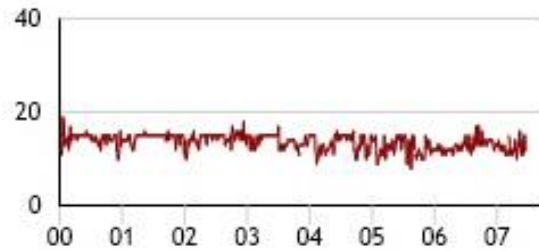


Minute Ventilation (l/min)

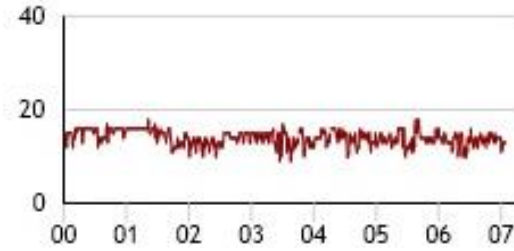


Leaks – effect on respiratory efforts

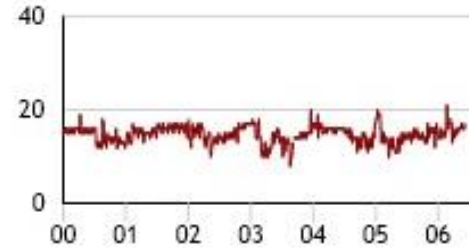
Breaths Per Minute (BPM)



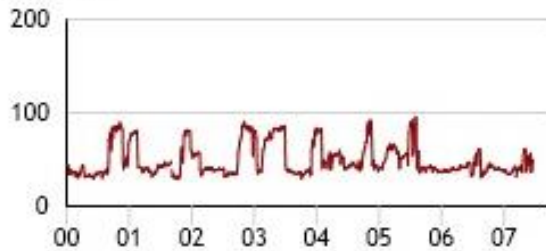
Breaths Per Minute (BPM)



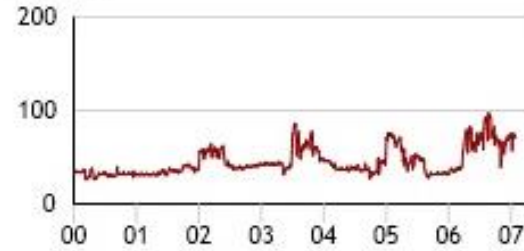
Breaths Per Minute (BPM)



Leak (l/min)



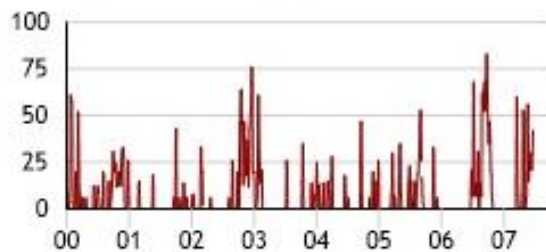
Leak (l/min)



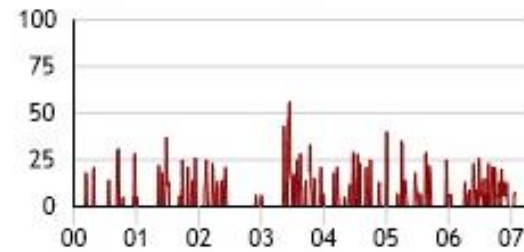
Leak (l/min)



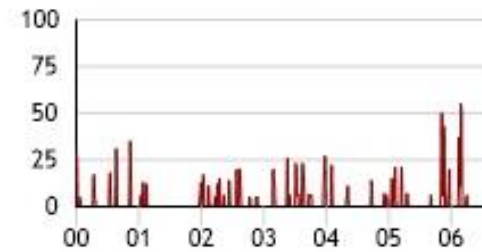
Patient Triggered Breaths (%)



Patient Triggered Breaths (%)

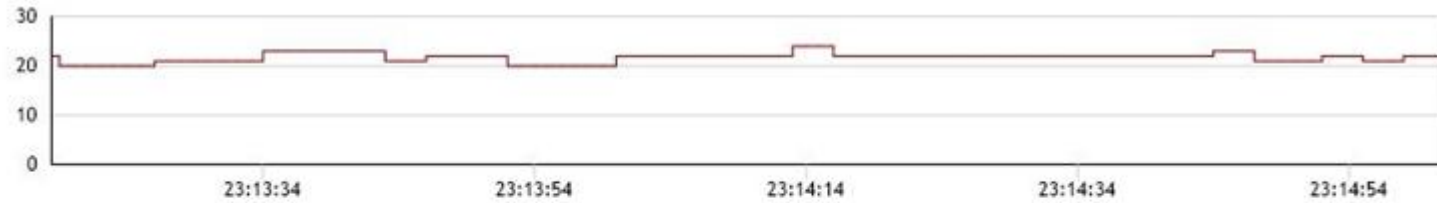


Patient Triggered Breaths (%)

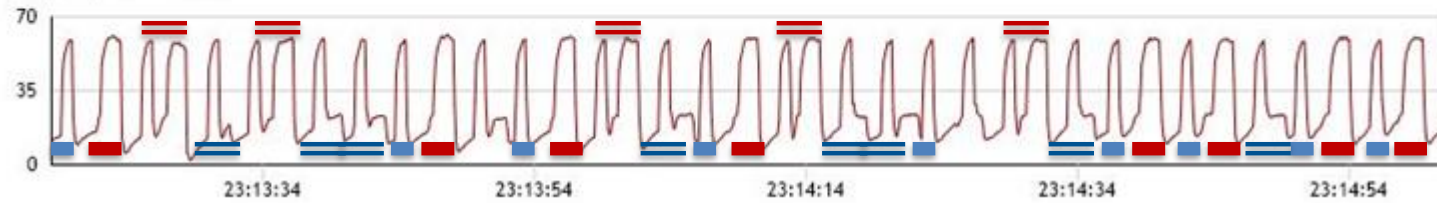


Abnormal events during NIV

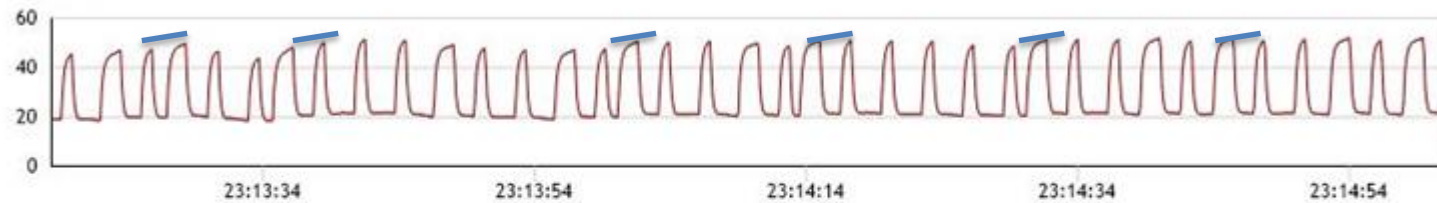
Breaths Per Minute (BPM)



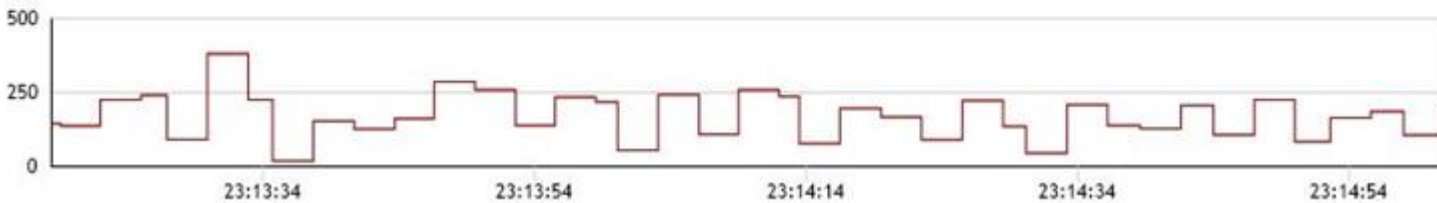
Flow (l/min)



Leak (l/min)



Vte (ml)



Settings:

Mode: Hybrid pressure support with volume guarantee (S/T AVAPS)

- Spontaneous breath (no Ti)
- Controlled breath (defined Ti)
- Double triggering
- Increased leak

Pressures: IPAP 18/12 cm H₂O,
EPAP 4 cm H₂O,

Tidal volume: 425 ml

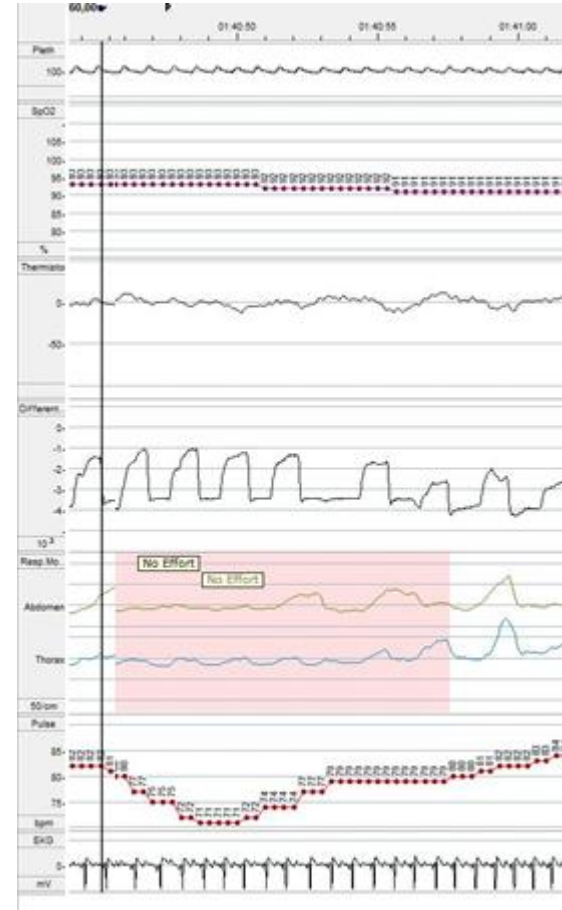
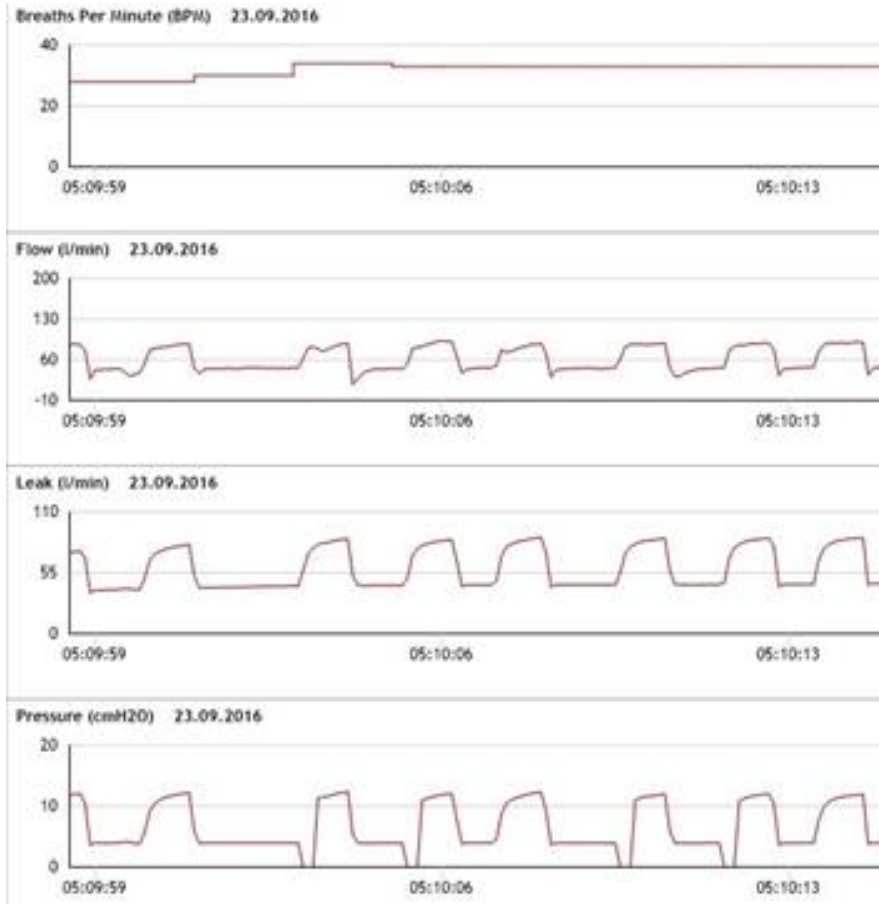
Back-up rate: 16 breaths/min,

Trigger: Auto Trak,

Inspiratory time: 0.9 s

Rise time: 1

Partial / total upper airway obstruction w/wo reduction of ventilatory drive



Thank you for your attention!
Questions?

- [Clinical%20cases-
NIV%20in%20built%20software_3rd%20niv%20congress_UK&SK_def.p
pt#16. Diapositive 16](#)