

# Training of staff & patients

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## Radiotherapy technician (RTT) training

- RTT as volunteers
- A new skill
- Recognised (& rewarded!)
- RTTs train in pairs on each other,  
are ventilated themselves and ventilate the other
- 1 hour RTT-pair training session per day (consolidation)
- Total of 4 hours of RTT training to deliver clinically NIMV & 60 brpm + PEEP
- Final 2 hours for formal assessment and certification
- No formal lectures
- Hands on the ventilator from day 1
  
- Fun for RTTs and patients
  
- Trained RTTs will give 1 hour pre-treatment training session to each patient  
then patient treatment occurs on subsequent days

# Training hour 1 of 4, Trainer demonstrates on the artificial lung and ventilates RTT-1

(Offer our publications and reviews for later reading)

Demonstrates the Hamilton ventilating artificial lung to understand the **NIV-ST mode** for spontaneous breathing and mechanical ventilation

Basic menu:- flow trig, Ti, Rate, P<sub>insp</sub>, PEEP, oxygen

More menu:- P ramp, Ti max, ETS

in the **NIV-ST mode** trainer explains spontaneous breathing (patient controls the ventilator)

and being ventilated (ventilator controls ventilation)

Trainer holds face-mask against their own face for spont breathing

trainer controls the ventilator,

mechanical ventilator controls ventilation, cough, swallow, refusal.

Explain blood gases and SpO<sub>2</sub> and PCO<sub>2</sub> limits and heart rate

Explain noting typical values for each patient (for later reference).

Explain air (and 60% O<sub>2</sub>)

Explain pressure limits

Demonstrate on RTT1 with RTT-1 holding the facemask on their own face

Trainer Connects facemask to RTT-1 by strap to ventilator

RTT-1 experiences spontaneous breathing on ventilator and NIMV at 14 brpm, progresses to 30 brpm, 45 brpm + PEEP, 60 brpm + PEEP

**Training Hour 2 of 4 Trainer demonstrates on RTT-2**

Repeat as hour 1 above only now RTT-2 is ventilated



## Training hour 3 of 4

## Trainer demonstrates preparing the Hamilton & both RTTs prepare Hamilton

In NIV-ST mode, Settings Alarm volume, Alarms

Limits 1, pressure 4-46 mmHg (holds at max – 10 mmHg else stops and dumps pressure).

Danger of applying pressures above 40 cm H<sub>2</sub>O

Limits 2 PCO<sub>2</sub> 19-60 mmHg (but lower for f=60)

SpO<sub>2</sub> 94% to Off

RTTs practice explanatory dialogue

### Calibrating the Hamilton (for every new ventilator tubing circuit)

Tightness disconnect patient tighten system (thumb etc) disconnect

O<sub>2</sub> do nothing (white O<sub>2</sub> line connect to wall socket = 100% O<sub>2</sub>)

CO<sub>2</sub> disconnect from airway (leave CO<sub>2</sub> head joined to plastic adaptor)

Flow sensor disconnect patient

Calibrate sensor the usual way round i.e.,

blue sensor's small end to corrugated tubing, white-cal-tube narrow to wide blue

“manoeuvre in progress” (audible singing at different speeds)

“turn sensor”

Calibrate sensor the other way round i.e.,

blue sensor's wide end to white-cal-tube wide, white-cal-narrow to corrugated tubing

RTTs explain when trig at most sensitive (0.5) and least sensitive (20) settings

Both RTTs setup ventilator

Demonstrate the problem if you **strap on the mask without turning on ventilator (!)**

# **Training Hour 4 of 4, RTTs on RTTs, Spontaneous breathing & 14-60 brpm + PEEP**

Both RTTs prepares ventilator and NIV-ST mode

Both RTTs practice explanatory dialogue

Both RTTs Setup ventilator for Spontaneous breathing on the ventilator

Connect each other via facemask to ventilator

Establish spontaneous breathing and note normal physiological values

Establish NIMV at 14 brpm, 30 brpm, 45 brpm+ PEEP, 60 brpm + PEEP for 5 min

**Do RTTs feel confident to deliver 30 brpm, 60 brpm & PEEP?**

**Does trainer feel confident that RTTs are competent to deliver above?**

**Both RTTs take assessment (hours 5 + 6)**

**RTTs should then practice for 30 min per week on rubber lung in their own (work) time**



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- After certification, RTTs are able and allowed to independently ventilate healthy volunteers and patients for research purposes



# ‘Train-the-trainer’

- N = 2 RTTs were trained to train their peers
- In less than 4 hours
- Assessment & certification

! Certified RTTs now train their peers

Focus on 60 brpm with 15cm H<sub>2</sub>O PEEP

N = 15, in pairs

- 2 sessions (2 hours each)
- Pre-assessment session (2 hours)



Subject ID: Date: Session: Operator(s):	Basic tab						More tab			Vital signs			Monitoring tab		Time zero  Clock time (actual time)
	Flow trigger	Ti *	Rate	$\Delta$ P <sub>insp</sub>	PEEP	%O <sub>2</sub>	P-ramp	Ti max	ETS	P <sub>et</sub> CO <sub>2</sub>	sPO2	HR	Spontaneous breathing and ventilation		
	Ventilator sensitivity to patient's breathing	Inspiration time (s)	Ventilation frequency (brpm)	Inspiration pressure (cmH2O)	Positive end expiratory pressure (cmH2O)	default 21	Slope of pressure rise (ms)	Max inspiratory time (s)	Expiratory Trigger Sensitivity (%)	end tidal PCO <sub>2</sub> (mmHg)	Oxygen saturation (%)	Heart Rate (bpm)	frequency (brpm)	volume (L)	
Start in NIV-ST settings for spontaneous breathing	0.5	1.3	5	8	0	21	0	3	5						+1 minuut
															+5 minuten
NIV-ST change to ventilation for controlled breathing	20	1.3	14	15	0	21	0	3	5						+1 minuut
															+5 minuten
NIV-ST change immediately to 30 brpm	20	0.8	30	15	0	21	0	3	5						+1 minuut
															+5 minuten
NIV-ST change immediately to 45 brpm	20	0.5	45	15	5	21	0	3	5						
NIV-ST change immediately to 60 brpm - confirm regular ventilation pattern (wait 5 - 10s) - increase PEEP in +1 to +2cmH <sub>2</sub> O steps, up to 15cmH <sub>2</sub> O	20	0.5	60	15	5 → 15 in steps of +1 or +2	21	0	3	5						+1 minuut
															+5 minuten
NIV-ST change immediately (anti-clockwise) for spontaneous breathing	0.5	1.3	5	8	0	21	0	3	5						+1 minuut
<p>Stel de grafiek-tijdschaal in op 30s. Volgorde: cmH<sub>2</sub>O, Flow, PCO<sub>2</sub>.</p> <p>Tijdens NIMV, moet elke beademings'wave' op de ander lijken. Amplitude en plateaus ongeveer hetzelfde.</p> <p>Verzeker je ervan dat de proefpersoon/patiënt tijdens de beademing niet zelf ademt. Als de lijn onder de nul komt, ademt de proefpersoon/patiënt over NIMV heen (paarse driehoekjes). Check "monitoring" tabs + extra tabs.</p> <p>60 brpm + PEEP; als de proefpersoon/patiënt moeite heeft 15cmH<sub>2</sub>O PEEP, reduceer dan de PEEP tot 10cmH<sub>2</sub>O, (of begin opnieuw vanaf 30 brpm).</p> <p>PetCO<sub>2</sub> metingen zijn niet betrouwbaar gedurende 30-45-60 brpm. Let op dat je de PetCO<sub>2</sub> noteert direct na het stoppen van de beademing en het overgaan naar spontane ademhaling.</p>										<p>Notities:</p>					



# NIMV-training materials

- Optimised training manual & e-learning modules
- Electronic Learning Environment
  - E-learning modules
  - Instruction videos
- Enhanced training efficiency



# Training of patients (& healthy volunteers)

1. Pilot study  Amsterdam UMC  
Innovation Impulse 2020

N = 18 healthy volunteers

2. BreaCoRTH study  **KWF**

N = 24 healthy volunteers

N = 18 patients with left sided breast cancer



# 1. Pilot study

N = 15 healthy volunteers

Breathing control strategies

- 22 brpm
- Prolonged breath-holding

To compare with DIBH and F



**1<sup>st</sup> training session  
(1h.15m)**

**2<sup>nd</sup> training session  
(45m)**





## 2. BreaCoRTH study

N = 24 healthy volunteers

- N = 12 Thorax
- N = 12 Upper abdomen

Breathing control strategies

- 60 brpm with 15cm H<sub>2</sub>O PEEP
- High frequency jet ventilation (60-400 bprm)
- Prolonged breath-holding with sips of air

*Veldman, JCA Advances 2024*

To compare with DIBH and FB

**1<sup>st</sup> training session (2 hours)**

**2<sup>nd</sup> training session (1½ hours)**





## 2. BreaCoRTH study

N = 18 patients with left-sided breast cancer

**1h training**

**<1h MRI**

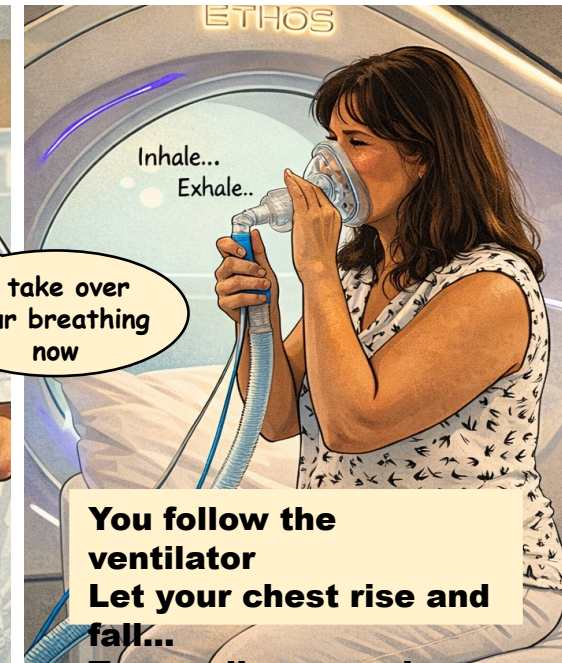
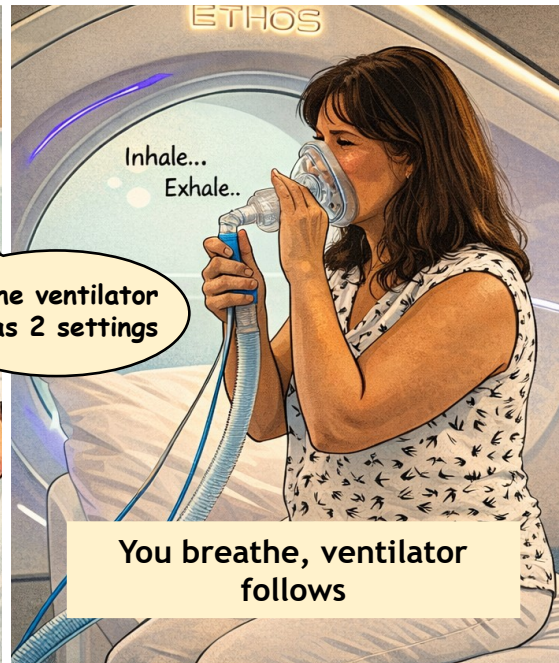
Breathing control strategies

- 60 brpm with 15cm H<sub>2</sub>O PEEP

To compare with DIBH and FB

## The trainer

- Explains mask & filter
- demonstrates own mask/filter on himself
- Gives patient new mask/filter
- Lets patient try spontaneous breathing





# Training of patients

1. Pilot study  Amsterdam UMC  
Innovation Impulse 2020

N = 18 healthy volunteers

2. BreaCoRTH study  KWF

N = 24 healthy volunteers

N = 18 patients with left sided breast cancer

N = 18 with lung cancer

N = 12 with mediastinal tumors

N = 18 patients with upper abdominal tumors

3. oART-OES

  
A Siemens Healthineers Company

N = 35 patients with esophageal cancer



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