vivo
by Breas

How Vivo 50 supports patients with respiratory failure

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Non-invasive ventilation (NIV) is constantly progressing. As a result of the numerous technological advances in this area, the conventional distinction between volume-controlled and pressure-controlled respirators has become obsolete. The power of the turbines driving these devices allows the necessary ventilatory support to be adapted to the clinical situation, using initial settings for pressure, rise time, rate and FiO_2. These devices also allow for ventilation modes guaranteeing the required tidal volume within certain limits.

There is constant monitoring as the clinician has immediate access via the integrated software to the interaction between patient and machine, which he/she can optimise objectively. The quality of the ventilation administered in this way can, at the same time, be assessed via the monitoring software, which provides an overview of the monitored parameters allowing proper long-term monitoring to be carried out that is no longer restricted. This is a far cry from a single monitoring reading and also paves the way for remote monitoring.

Therefore, it was important, following on from its predecessor the Vivo 40, to provide clinicians with a new instruction guide. The credit for this goes to Dr Luis Carlos Molano, a hospital practitioner, who has taken on this task using the experience he has acquired from numerous years spent with patients admitted to the department's respiratory intensive care unit (RICU).

We are grateful for his efforts for the benefit of the many patients with chronic respiratory failure treated by lung specialists every day.

Pr Jean-François Muir
Head of Respiratory Department and RICU
Rouen University Hospital Centre

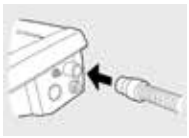
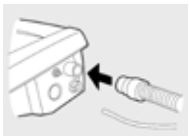
CHAPTERS

Appendix

Quick guide to using the Vivo 50 ventilator

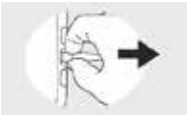
1° Setting up

Ventilation circuit
Oxygen connection

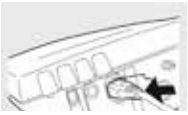



2° Setting up sensors for:

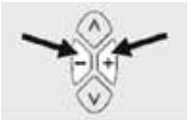
SpO_2
$EtCO_2$
FiO_2

3° Powering up the device



4° Locking/Unlocking



5° Selecting ventilation mode

Pressure-controlled
Volume-controlled
CPAP

6° Selecting respiratory mode

Support
Assist/Control

7° Selecting circuit type

Leakage
Exhalation valve

8° Carrying out pre-use test
before using the ventilator

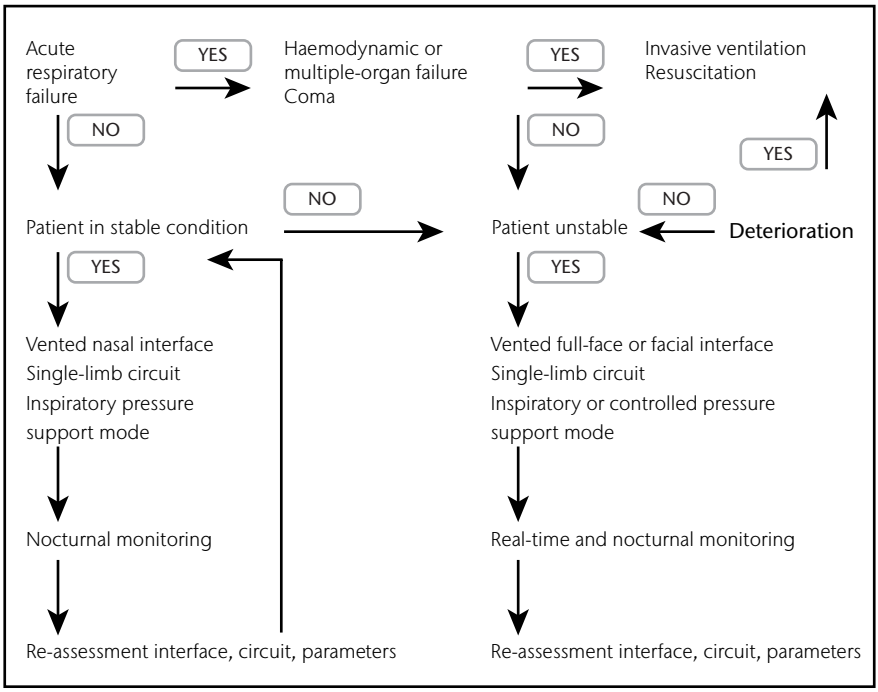
9 ° Setting alarms

The optimum alarm settings supports
the patient monitoring.

It is very important to set the correct alarm ranges for high pressure, low pressure, apnea, disconnection and low SpO_2.

10° Algorithm

Setting up a Vivo 50 ventilator



Setting up a Vivo 50 ventilator for a patient with severe respiratory failure using non-invasive ventilation

1° Use a single-limb circuit and vented or non-vented full-face or facial mask, depending on the circuit type.

3° Start by using either a Pressure Support or an (assisted) Pressure Controlled mode.

4° Initialisation parameters:
Insp Pressure 13cmH_2O
PEEP 3cmH_2O
O_2 for $SpO_2 \geq 90\%$

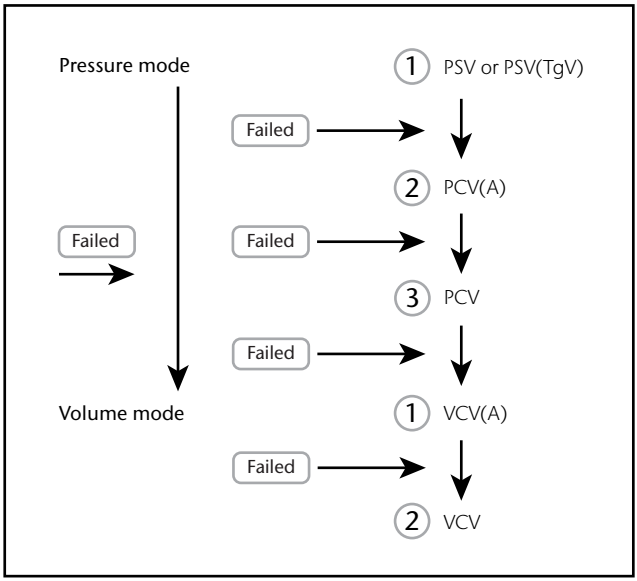
5° Ventilate the patient and re-assess the parameters.

6° It is vital to monitor in real and differed time.

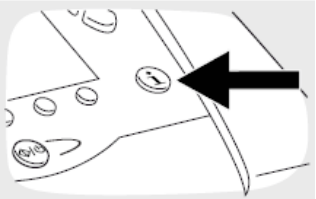
Setting up a Vivo 50 ventilator for a patient in a stable condition

1° Use a single-limb circuit and a vented or non-vented mask, depending on the circuit type.
2° Adapt the interface to the face shape and nasal permeability:
nasal or nostril mask if the permeability is good
otherwise, full-face or facial mask.
3° Start by using an Pressure Support mode.
4° Set the parameters:
Are you receiving too much air or not enough?
Can you comfortably make the effort to trigger the ventilator?
Does the air reach you quickly or not quickly enough?
Adjust the inspiratory and expiratory trigger parameters, rise time, min. and max. inspiratory time, respiratory rate and oxygen flow.
5° Ventilate the patient and balance the parameters.
6° Nocturnal monitoring.

Algorithms for using the NIV ventilatory modes

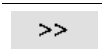


11° i-button



12° Symbols

Symbols Used in the Menu

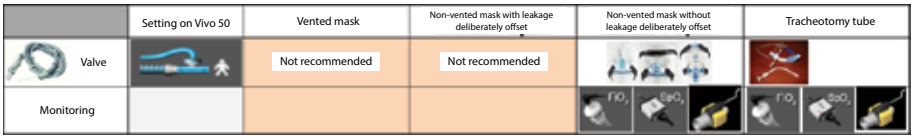
SYMBOL	DESCRIPTION
	Internal battery level
	Click-on battery level
	Home Mode activated
	Leakage circuit selected (Leakage)
	Exhalation valve circuit selected (Exh. valve)
	iOxy connected
	FiO_2 connected
	CO_2 connected
	Multiple pages
	Multiple content available
	High priority alarm event in history list
	Medium priority alarm event in history list

Setting the ventilatory parameters **in support mode**

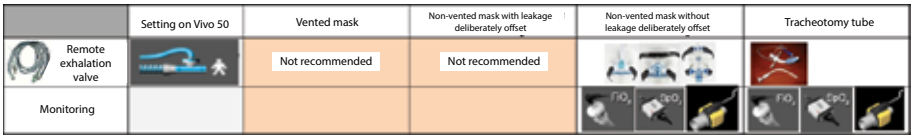
Check that the type of interface being used is suitable for the circuit type in place.

Leakage circuit:

Exhalation Valve circuit:



Dual limb exhalation valve circuit:



Select the inspiratory and expiratory pressure.

Start with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend the Insp Pressure value based on the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Amend the PEEP value based on:

	Obstructive	Obese	Neuromuscular
Benefit	Compensate PEEPi	Prevent obstructive apnea	Prevent obstructive apnea
Start value	3 cm H_2O	5-7 cm H_2O	3 cm H_2O
Titrate	In steps of 1 cm H_2O	Between 5 and 15 cm H_2O	Between 3 and 1 cm H_2O

Select the inspiratory trigger

Most sensitive setting without auto-trigger.

Amend based on the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Select the expiratory trigger

Start with a setting at 3.

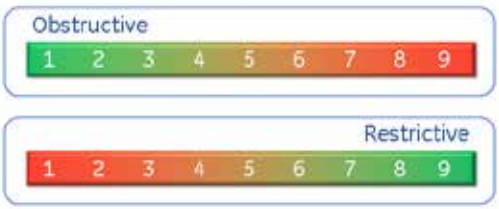
Earlier in obstructive patients to reduce the inspiratory time and the risk of air trapping and auto-PEEP.

Later in restrictive patients to prevent an early end to the respiratory cycle.

Amend based on the following questions:

- Is inspiration too long?
  Yes? Reduce the value.

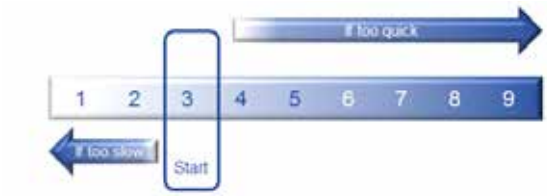
- Is inspiration long enough?
  No? Increase the value.



Adjust the rise time

Adjust according to how comfortable the patient is and amend based on the following question:

- Does the air reach you quickly or not quickly enough?
- If the air is not arriving quickly enough, reduce the rise time value.



Select the maximum and minimum inspiratory time

The minimum inspiratory time must be sufficient to supply the tidal volume.

If it is greater than the patient's minimum inspiratory time, the ventilator may cause patient discomfort.

The maximum inspiratory time may be useful in clinical situations where major leakages are related to a delay in expiratory cycling.

	Restrictive Pat.		COPD
Resp. rate	Ti min.	Ti max.	Ti max.
12	1.3	2.5	1.7
13	1.2	2.3	1.5
14	1.1	2.1	1.4
15	1	2.0	1.3
16	0.9	1.9	1.2
17	0.9	1.8	1.2
18	0.8	1.7	1.1
19	0.8	1.6	1.0
20	0.8	1.5	1.0
21	0.7	1.4	0.9
22	0.7	1.4	0.9
23	0.7	1.3	0.9
24	0.6	1.3	0.8
25	0.6	1.2	0.8
26	0.6	1.2	0.8
27	0.6	1.1	0.7
28	0.5	1.1	0.7
29	0.5	1.0	0.7

Adjust the backup respiratory rate

10 for obstructive patients and 14-16 for restrictive patients.

Adjust the sigh, the max. and min. Pressure and Target Volume

The sigh should be adjusted if required.
Target Volume in specific cases.

Adjust the oxygen flow

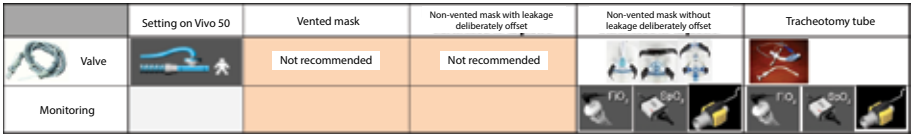
O_2 required to obtain an $SpO_2 \geq 90\%$.

Setting the ventilatory parameters in pressure-controlled mode

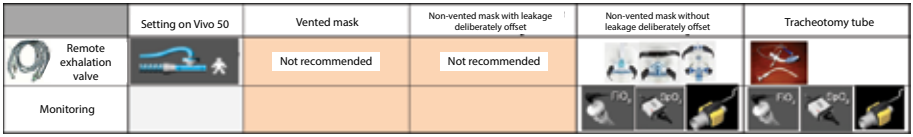
Check that the circuit type is suitable for the interface type being used.

Leakage circuit:

Exhalation Valve circuit:



Dual Limb Exhalation Valve circuit:



Select the inspiratory and expiratory pressure

Start with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend based on the following questions:

Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Amend the PEEP value based on:

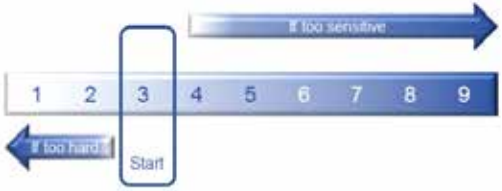
	Obstructive	Obese	Neuromuscular
Benefit	Compensate PEEPi	Prevent obstructive apnea	Prevent obstructive apnea
Start value	3 cm H_2O	5-7 cm H_2O	3 cm H_2O
Titrate	In steps of 1 cm H_2O	Between 5 and 15 cm H_2O	Between 3 and 1 cm H_2O

Select the inspiratory trigger

Start with a setting at 3

Amend based on the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.



Adjust the rise time

Adjust according to how comfortable the patient is.
Does the air reach your quickly or not quickly enough?

- If the air is not arriving quickly, reduce the rise time.

Adjust the inspiratory time

The more obstructive the patient is, the shorter the inspiratory time and longer the expiratory time. In fact, the expiratory time constant is higher for obstructive patients.

Set the respiratory rate

10 for obstructive patients and 14-16 for restrictive patients.

Adjust the sigh, the max. and min. Pressure and Target Volume

The sigh should be adjusted systematically.
Target Volume in specific cases.

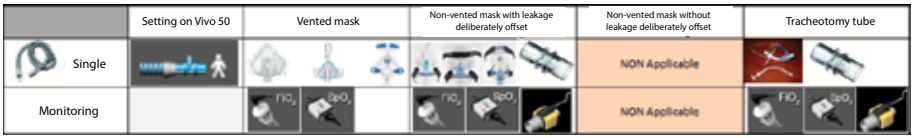
Adjust the oxygen flow

O_2 required to obtain an $SpO_2 \geq 90\%$.

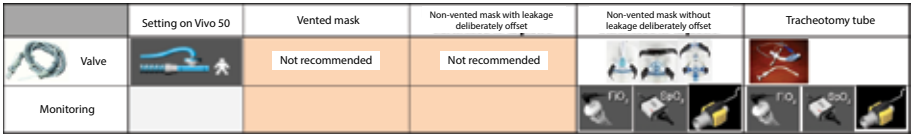
Setting the ventilatory parameters in volume-controlled mode

Check that the circuit type is suitable for the interface type being used.

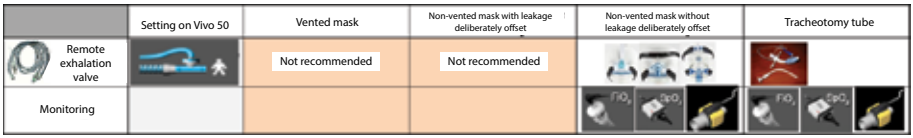
Leakage circuit:



Exhalation Valve circuit:



Dual Limb Exhalation Valve circuit:



Select the tidal volume.

Non-invasive Ventilation: 10 – 12 ml/kg of the IBW
Invasive Ventilation: 8 – 10 ml/kg of the IBW

It should be amended depending on whether there is persistent hypoventilation.

Size (cm)	Ideal weight (IBW=24)
150	55 kg
155	59 kg
160	61 kg
165	64 kg
170	68 kg
175	73 kg
180	77 kg
185	82 kg
190	86 kg
195	90 kg

Select the PEEP value

Start with PEEP at 3 cm H_2O.

It should be amended depending on whether there is any apnoea, hypopnoea or flow restrictions, auto-PEEP.

Amend the PEEP value based on:

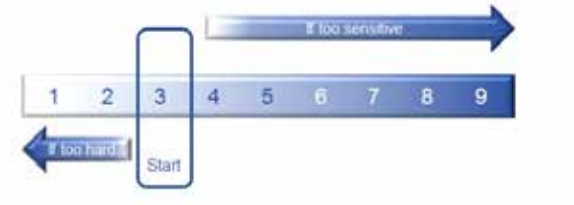
	Obstructive	Obese	Neuromuscular
Benefit	Compensate PEEPi	Prevent obstructive apnea	Prevent obstructive apnea
Start value	3 cm H_2O	5-7 cm H_2O	3 cm H_2O
Titrate	In steps of 1 cm H_2O	Between 5 and 15 cm H_2O	Between 3 and 1 cm H_2O

Select the inspiratory trigger

Start with a setting at 3.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

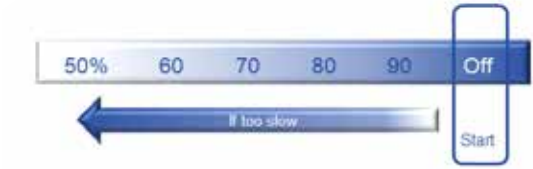
- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.



Adjust the Rise Time

Adjust according to how comfortable the patient is.
Does the air reach your quickly or not quickly enough?

- If the air is not arriving quickly enough, reduce the rise time value.



Set the respiratory rate

10 for obstructive patients and 14-16 for restrictive patients.
In fact, the expiratory time constant is higher for obstructive patients.

Adjust the flow curve type

Square or decelerating.
Preferably choose a square flow as this has less of an impact on the inspiratory time.

Adjust the sigh, the max. and min. Pressure and Target Volume

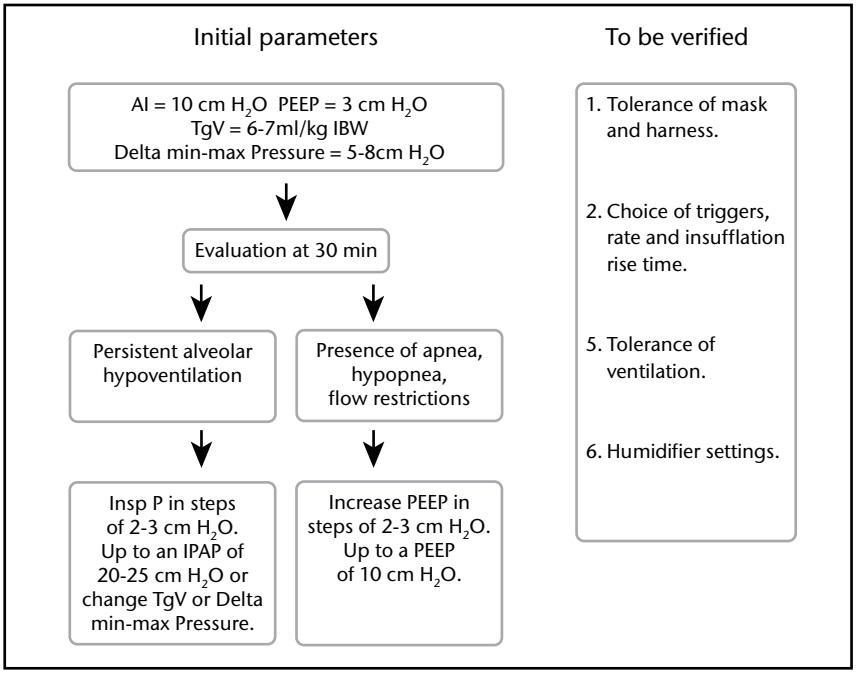
The sigh should be adjusted systematically.
Target Volume in specific cases.

Adjust the oxygen flow

O_2 required to obtain an $SpO_2 \geq 90\%$.

Specific settings for Target volume

We use this in particular for obese patients and patients with thoracic deformities, be aware of the fact that its use may entail an increased frequency of ventilatory asynchrony.



How to choose the connection between machine and patient?

What type of circuit?

The choice of circuit will determine the mask type used.

Available circuits

- Single-limb leakage circuits should be used with non-vented masks.
- Single-limb exhalation valve circuits should be used with non-vented masks.
- Single-limb non-vented circuits should be used with vented masks.
- Single-limb circuits with added intentional leak should be used with non-vented masks.

Choosing the right circuit

It is preferable to start with the simplest circuit, in this case, a non-invasive ventilation, vented or non-vented single-limb circuit.

In the case of invasive ventilation, a single- or double-limb valve circuit is preferable.

Choice of mask

There is currently a large variety of industrial masks available: nostril, nasal, full-face, facial, helmet and oral.

The choice of interface and its harness is an important aspect of ventilation management of patients. Choosing the right mask means good tolerance and good compliance with treatment.

Several factors are taken into consideration when choosing the right mask:

- Face morphology (depth of nasolabial fold, size of cheeks, face shape). Choosing the right size is very important.
- Patient's distribution of hair (moustaches and beards increase leakages).
- Nasal permeability (use a full-face mask for oral respirators).
- Presence of a dental prosthetic (don't ventilate patients with a dental prosthetic in place).
- Patient's mobility (be careful with the usage of using full-face masks for neuromuscular patients with low mobility).
- Problems encountered by patients in relation to their life experience (nostril masks are used for patients with claustrophobia).
- Patient's history of allergies (latex allergy).

Finally, made-to-measure masks can be made available.

During an acute phase, full-face and facial masks are the most commonly used.

During a stable period, an attempt will be made to switch to a nasal mask where possible.

A non-vented mask must be used with leakage or exhalation valve circuits.
Whether to choose a nasal, nostril, facial or oral mask depends on the patient's clinical condition, morphology and the ventilatory parameters set on the respirator.

Monitoring

When and how to do it

The Vivo 50 enables patients under ventilation to be monitored via the Breas software. Monitoring can be carried out in real or differed time. Every patient who has had ventilation initiated must be monitored. When ventilation is initiated, monitoring must involve patients being monitored in real and differed time during the night.

Real-time monitoring

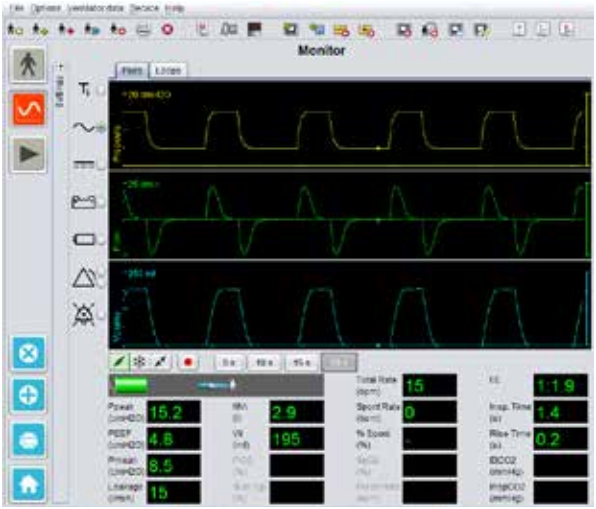
Real-time monitoring provides access to pressure, flow and volume curves, as well as flow/pressure, flow/volume and pressure/volume loops.
Ventilatory parameters can be modified in real time while the patient is being ventilated.

Real-time monitoring

Pressure

Flow

Volume



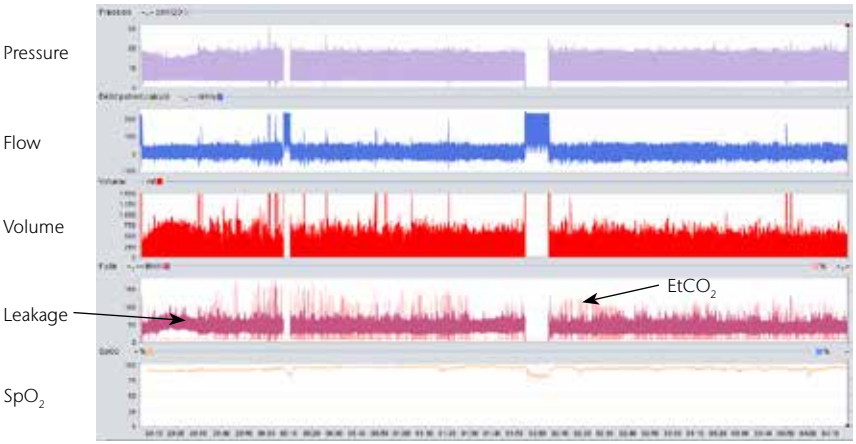
Differed monitoring

In the case of differed monitoring, modifications are made afterwards, after the entire night's results have been displayed and the asynchronous events which have been identified when reading the tracing have been analysed.

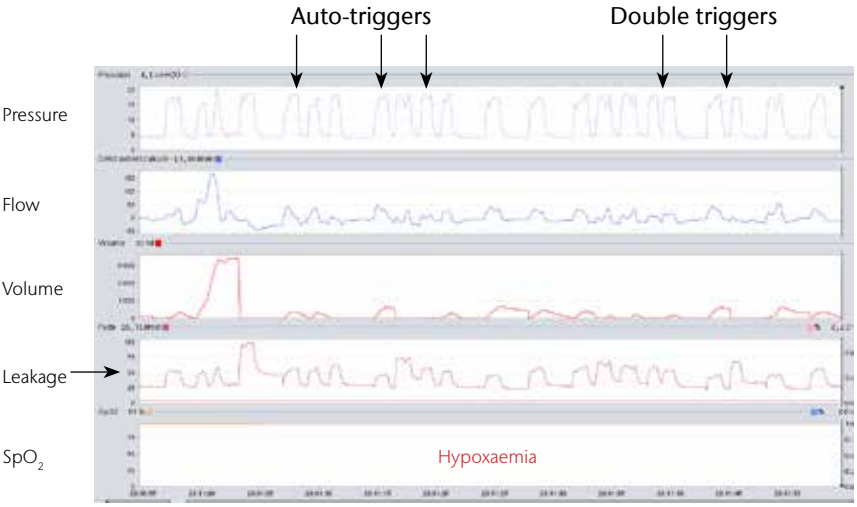
Displaying the entire night's results makes it possible to identify problems involving leakages, a reduction in flow and oxygenation, while zooming in on certain periods on the tracing allows asynchronous events to be analysed in finer detail.

Once this overall view has been produced, the periods indicating anomalies are zoomed in on, in particular, without forgetting to review the entire tracing.

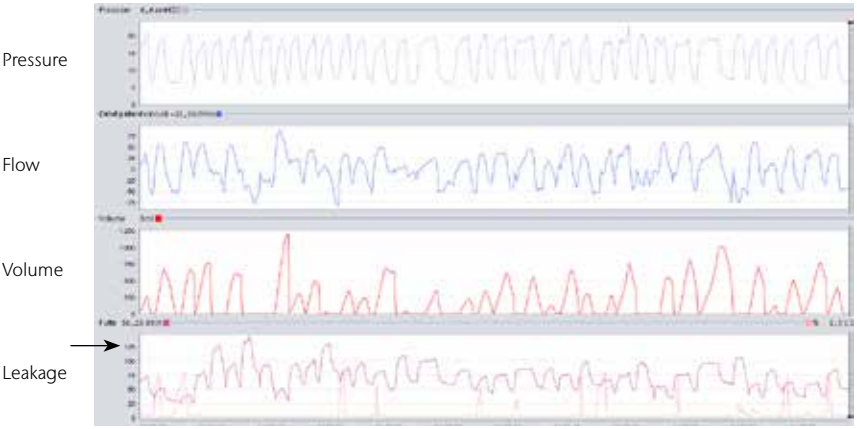
Overall view



Zoom



Leakage

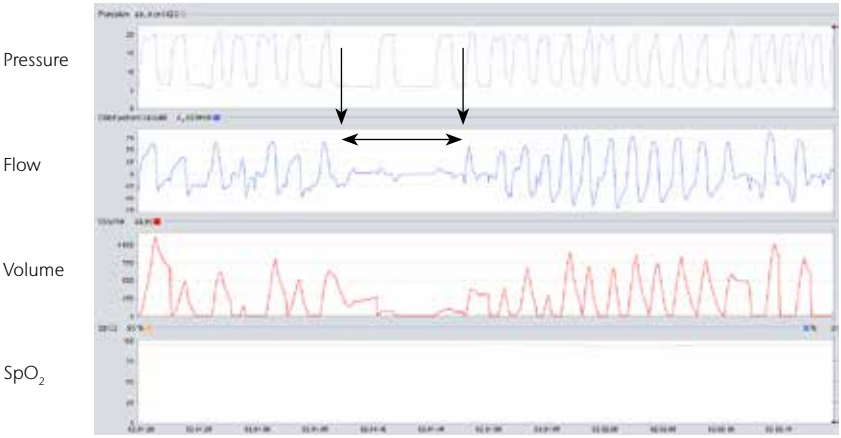


When leakages are present, the following action is required:

- reassess whether the interface being used is suitable for the patient.
- adapt the inspiratory trigger. Make it less sensitive.
- adapt the expiratory trigger. Make it respond earlier.
- reduce the inspiratory pressure.
- avoid using Target Volume.

Adjusting the interface and ventilation parameters correctly will play a vital role in the occurrence of leakages. Excessive pressure inside the mask, auto-triggers and an over-sensitive trigger will result in major leakages, which means that non-invasive ventilation will not be tolerated well.

Apnea

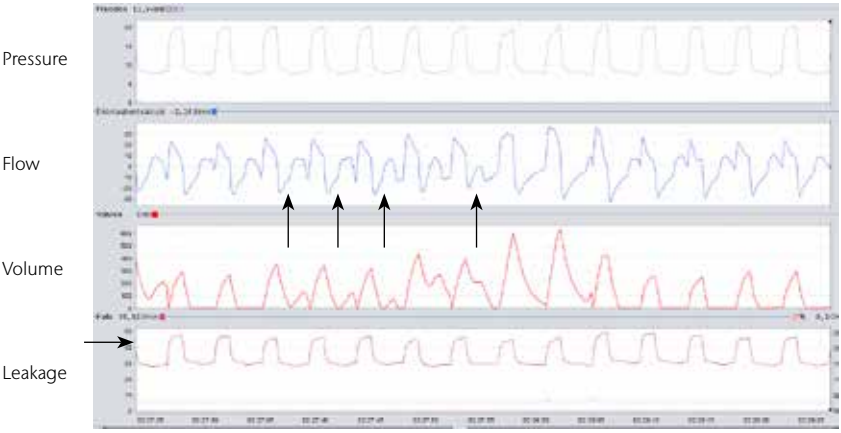


Action to take in the event of apnea:

- increase the PEEP value.

Applying positive expiratory pressure prevents inspiratory collapse of the airways and the occurrence of apnoea and hypopnoea.

Ineffective efforts



Ineffective effort: effort produced by the patient which has not been detected by the ventilator.

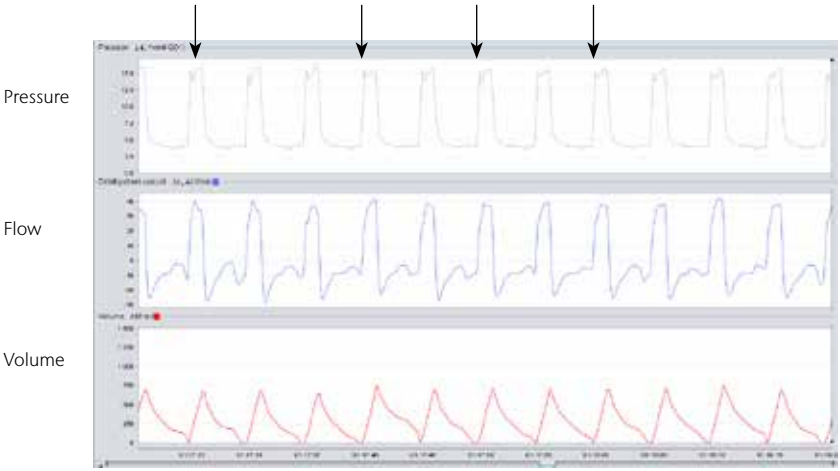
Causes: Auto-PEEP, hyperinflation, excessive ventilatory support.

When ineffective efforts are present, the following action is required:

- make the inspiratory trigger more sensitive.
- reduce the inspiratory pressure.
- increase the expiratory pressure.

If ineffective efforts are present, this indicates that the respiratory effort made by the patient is not sufficient to trigger the ventilator (increase or existence of significant auto-PEEP, muscular fatigue etc.). Modifying these parameters may improve the ventilation's efficiency.

Pressurisation asynchrony

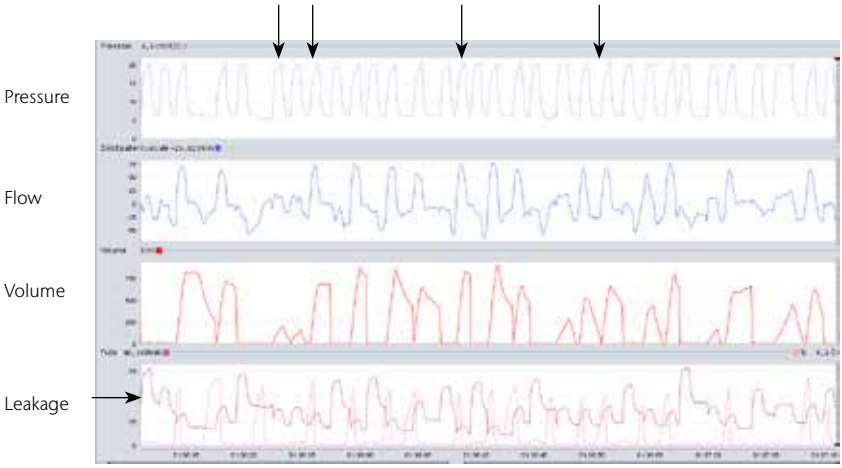


Action to take in the event of pressurisation asynchrony: (asynchrony due to an increase in pressure being too quick in relation to the patient's demand)

- increase the inspiratory rise time.

Increasing the inspiratory rise time value will make it possible to adapt the pressurisation flow better to the patient's demand.

Auto-triggers



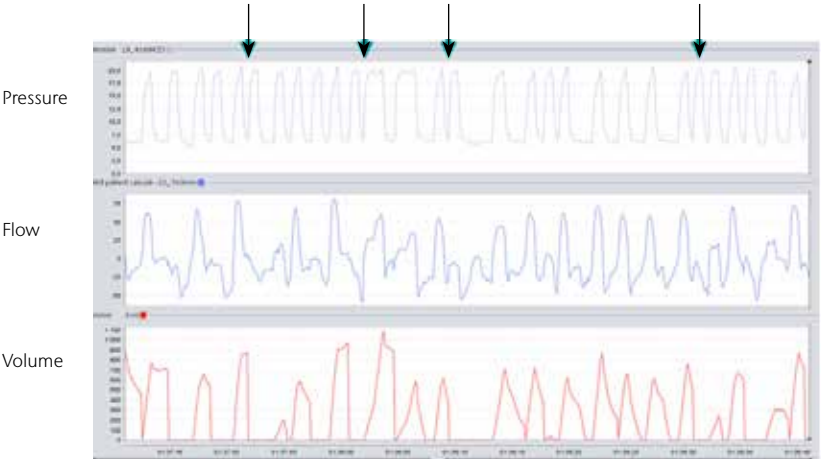
Auto-trigger: cycles delivered when there is no effort.
Causes: cardiac oscillations, leakages, circuit noises, over-sensitive trigger.

When auto-triggers are present, the following action is required:

- inspect and rectify leakages.
- make the inspiratory trigger less sensitive.

An over-sensitive trigger will set off the ventilator cycles easily and leakages may be interpreted by the ventilator as an inspiratory flow generated by the patient.

Double trigger



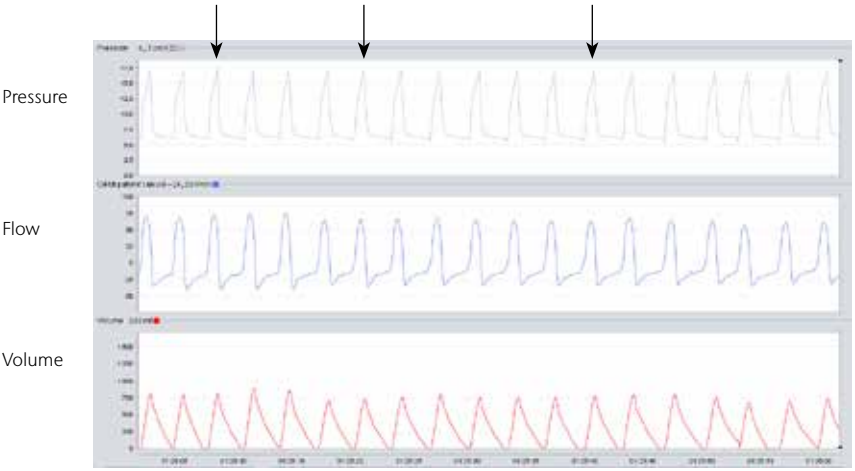
Double trigger: excessive ventilatory demand + excessively short insufflation time.
Cause: insufflation time lower than neural time.

Action to take in the event of double triggers:

- increase the inspiratory pressure
- extend the inspiratory time

Increasing the inspiratory pressure reduces the patient's demand for ventilation, while extending the inspiratory time increases the insufflation time. This allows double triggers to be reduced.

Asynchrony at the end of inspiration



Action to take in the case of asynchronous events at the end of inspiration:
(asynchrony due to the difference between the patient's inspiratory time (shorter) and the cycle set on the ventilator)

- increase the inspiratory pressure
- reduce the inspiratory time

Reducing the inspiratory time of the patient's ventilator cycle reduces the difference between the patient/ventilator inspiratory times.

Clinical cases

Case 1

Female, 90 years old, hospitalised due to acute respiratory failure (ARF).
History: restrictive CRF in addition to right diaphragmatic paralysis, PH group 3, bipolar problems, complete arrhythmia due to atrial fibrillation.

Height 149 cm; Weight 53 kg; Heart rate 98/min; BP 110/60 mm Hg; RR 16/min.
Diffuse hypoventilation without superimposed noise, regular cardiac sounds without any murmur, no oedema of the lower limbs.

RFT FVC 0.80 L FEV 0.67 L FEV/FVC 83%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 O2	7.32	10	8.5	49.6	93
D1 NIV	7.35	9	15	52	99

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode
Leakage circuit as a first intention; the circuit type will be changed in the event of failure.

Mask selected

Non-vented facial mask.

Inspiratory and expiratory pressure selected

Started with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O

Amend according to the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Select the inspiratory trigger

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Expiratory trigger selected

Expiratory trigger 4.

Rise time setting

Setting 1 due to pulmonary restriction.
Adjust according to how comfortable the patient is.

- Does the air reach your quickly or not quickly enough?

Min. and max. inspiratory times selected

(0.8 – 2)

Backup rate setting

16 because the patient is in ARF.

Target Volume

No, because the settings without Target Volume are efficient.

Oxygen flow

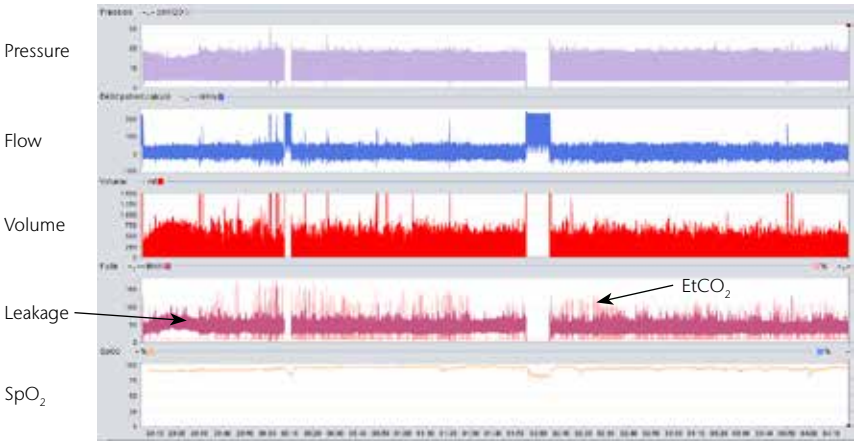
O_2 required to obtain an $SpO_2 \geq 90\%$.

Selected parametres

PSV mode
Insp Pressure 18. PEEP 4. Back-Up Rate 16. Inspiratory trigger 4. Expiratory trigger 4. Back-Up Insp Time 1.2. Rise Time 1, Min Insp Time 0.8, Max Insp Time 2, sigh + Oxygen 4 l/min.
Duration 3h 3h 8 hours
Simple supplemental oxygen 5 l/min. outside the NIV ranges.

Monitoring and adjusting parameters

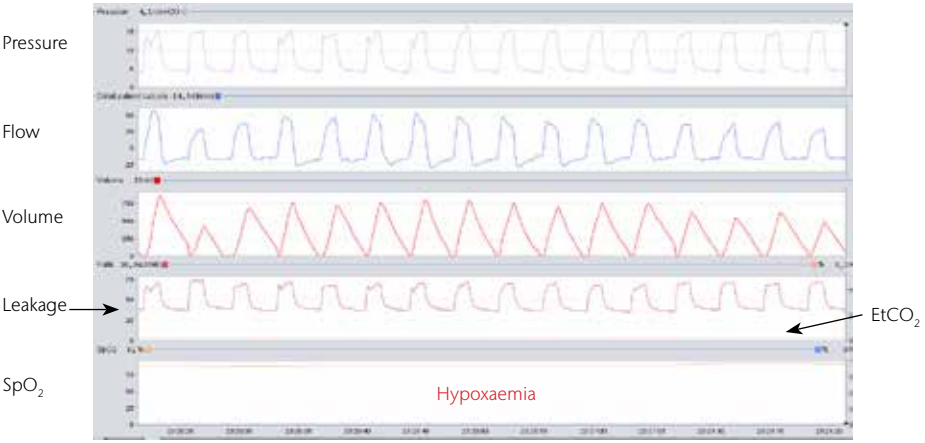
Presentation of overall night results



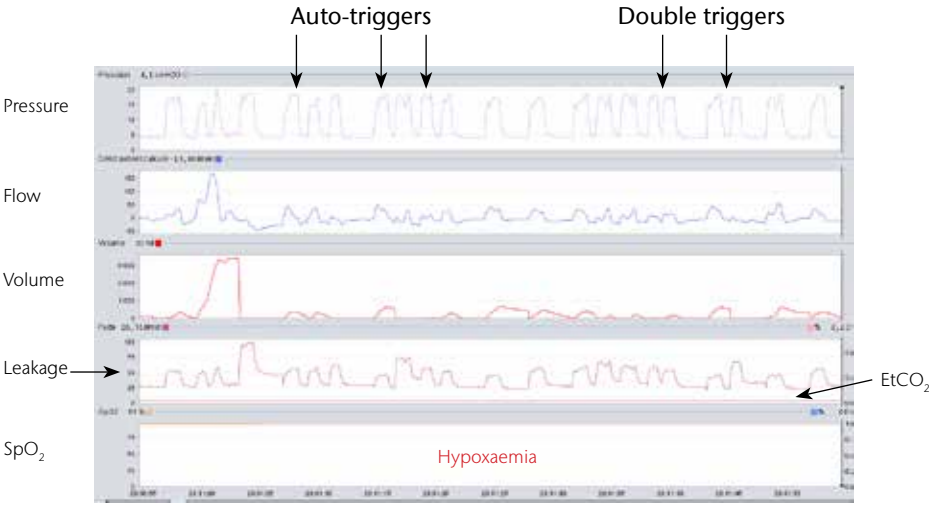
Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.47	8	10.1	48.6	96

Zoom on night-time periods

Leakages around the mask



Zoom on night-time periods



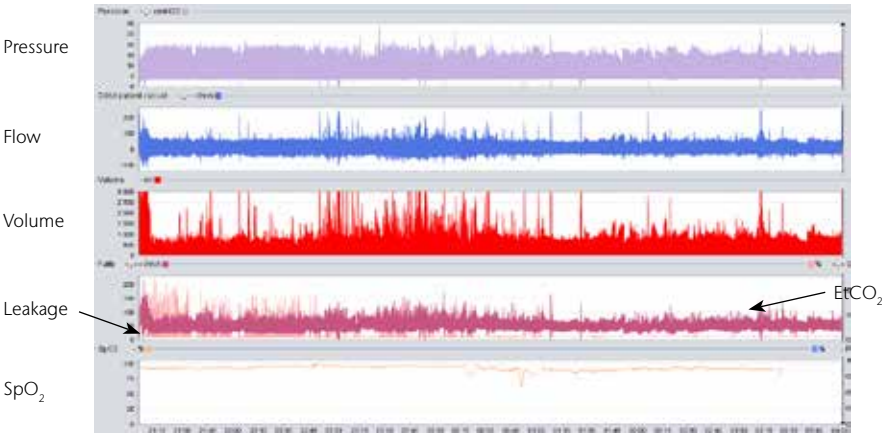
Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D3 under NIV	7.49	7.2	10	43	96

Ventilator parameters

Clinical and paraclinical improvement with medical treatment, non-invasive ventilation and supplemental oxygen.

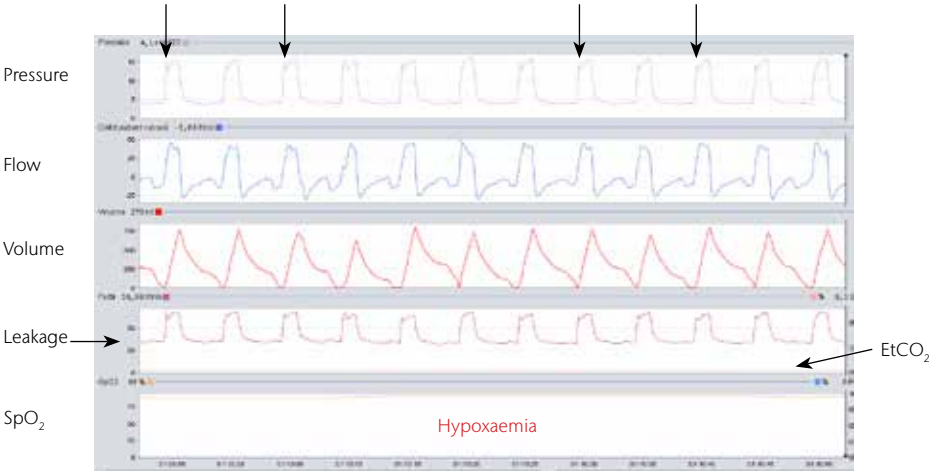
Ventilator parameters unchanged but reduction in leakages because of the patient adapting well to her respirator.

Presentation of overall results for the following night



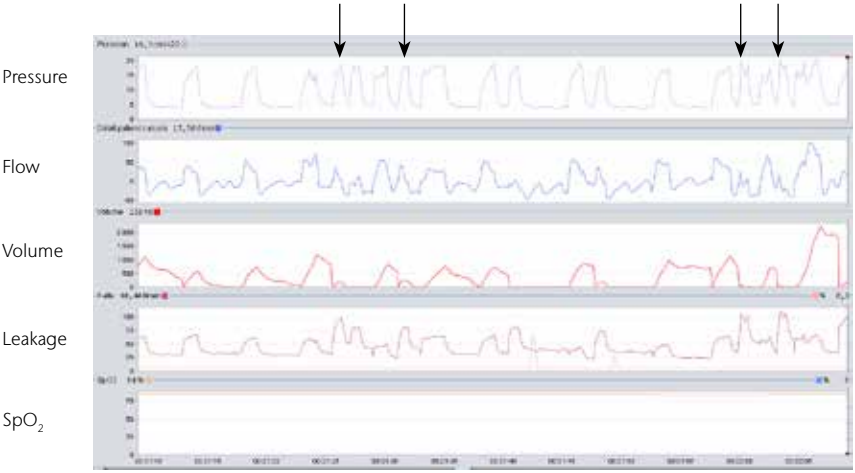
Zoom on night-time periods

Asynchronous events due to pressurisation



Improvement but events persist

Auto-triggers



Case 2

Male, 73 years old, admitted to respiratory intensive care unit (RICU) for acute respiratory failure in addition to a bronchial superinfection and pulmonary oedema.

History: Post-smoking COPD, PAD, right T3 N2 bronchial epidermoid carcinoma in remission.

Height 170 cm; Weight 83.5 kg; Heart rate 70/min; BP 100/70 mm Hg; RR 23/min. Diffuse hypoventilation with basal wheezes, irregular cardiac sounds without any murmur, oedema of the lower limbs.

RFT FVC 2.66 L FEV 1.65 L TLC 3.89 L FEV/FVC 62% DLCO/VA 54%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 O2	7.47	9.3	6.3	53	85

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode Leakage circuit.

Mask selected

Non-vented facial mask.

Inspiratory and expiratory pressure selected

Start with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend according to the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Inspiratory trigger selected

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Rise Time Setting

Setting 2

Adjust according to how comfortable the patient is.

- Does the air reach you quickly or not quickly enough?

Inspiratory time selected

1.3

Respiratory rate setting

14

Oxygen flow

O_2 required to obtain an $SpO_2 \geq 90\%$.

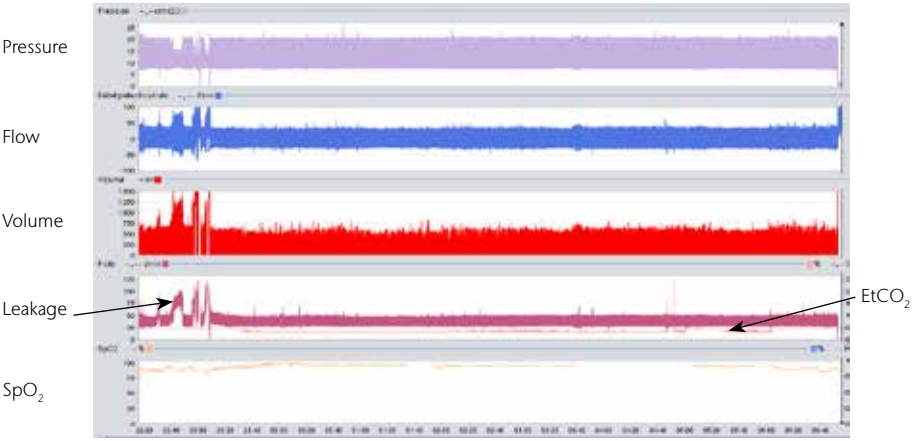
Selected parametres

PCV mode. Intolerance of PSV mode.
Poor tolerance of PSV mode in relation to polypnoea and a certain degree of ventilatory chaos.
A more controlled mode allowed the patient to be ventilated properly.

Insp Pressure 20; PEEP 8; RR 14; Inspiratory trigger 4; Inspiratory time 1.3; Rise Time 2; Oxygen 5 l/min.
Duration 2h 2h 8 hours
Simple supplemental oxygen 8 l/min. outside the NIV ranges.

Monitoring and adjusting parameters

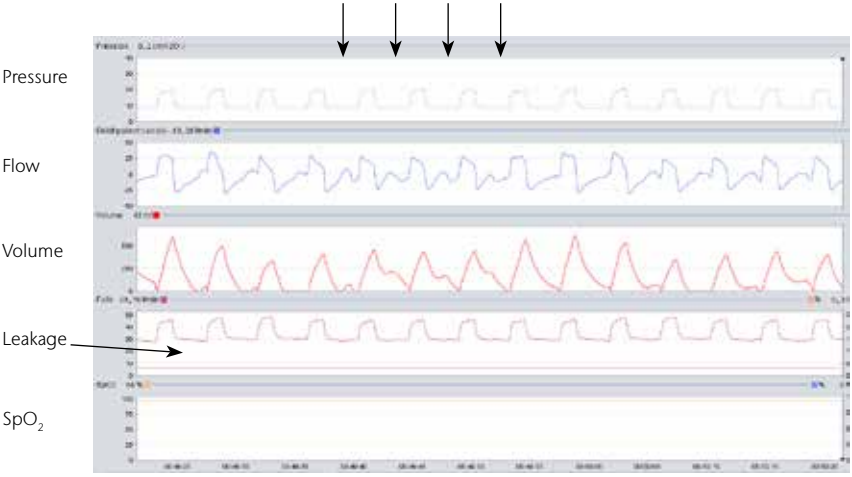
Presentation of overall night results



Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.42	10.7	8.7	52	93

Zoom on night-time periods

Ineffective efforts



Ventilator parameters for the following night

Inspiratory efforts not compensated throughout the night.

Non-invasive ventilation discontinued for tolerability reasons. The patient would agree to be ventilated a few days later successfully.

Case 3

Male, 84 years old, admitted to respiratory intensive care unit (RICU) for acute respiratory failure in addition to left lower lobar pneumonia and pulmonary oedema.

History of dilated cardiopathy, complete arrhythmia due to atrial fibrillation, COPD.

Height 165 cm; Weight 69.7 kg; Heart rate 86/min; BP 150/80 mm Hg; RR 17/min. Outbreak of left basal crepitations, irregular cardiac sounds without any murmur, oedema of the lower limbs.

RFT FVC 2.03 L FEV 1.23 L TLC 3.89 L FEV/FVC 60% DLCO/VA 60%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 under O2	7.27	9.2	9.5	31.7	92

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode Leakage circuit.

Mask selected

Non-vented facial mask.

Inspiratory and expiratory pressure selected

Started with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend according to the following questions:

Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Inspiratory trigger selected

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Expiratory trigger selected

Expiratory trigger 2.

Rise time setting

Setting 3.

Adjust according to how comfortable the patient is.
Does the air reach you quickly or not quickly enough?

Min. and max. inspiratory times selected

(0.8- 1.8)

Backup rate setting

12

Target Volume

No.

Oxygen flow

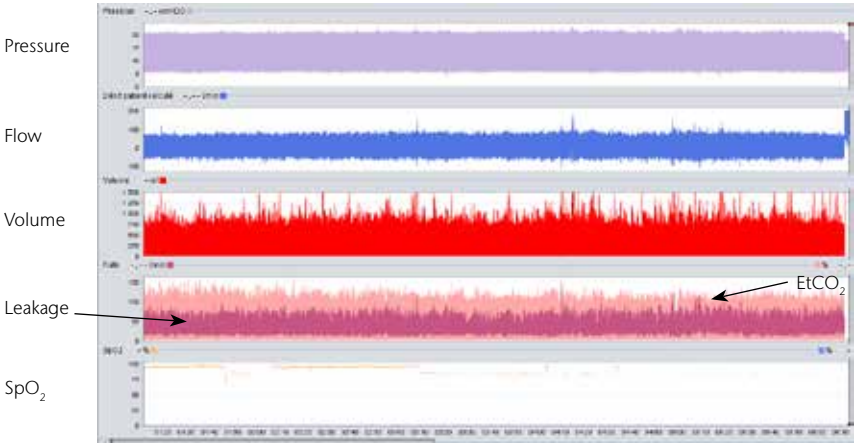
O_2 required to obtain an $SpO_2 \geq 90\%$.

Selected parameters

PSV mode
Insp Pressure 20; PEEP 6; RR 12; Inspiratory trigger 4; Expiratory trigger 2; Inspiratory time 1.3; Rise time 3; Min. insp. time 0.8; Max. insp. time 1.8; sigh + Oxygen 3 l/min.
Duration 3h 3h 8 hours
Simple supplemental oxygen 3 l/min. outside the NIV ranges.

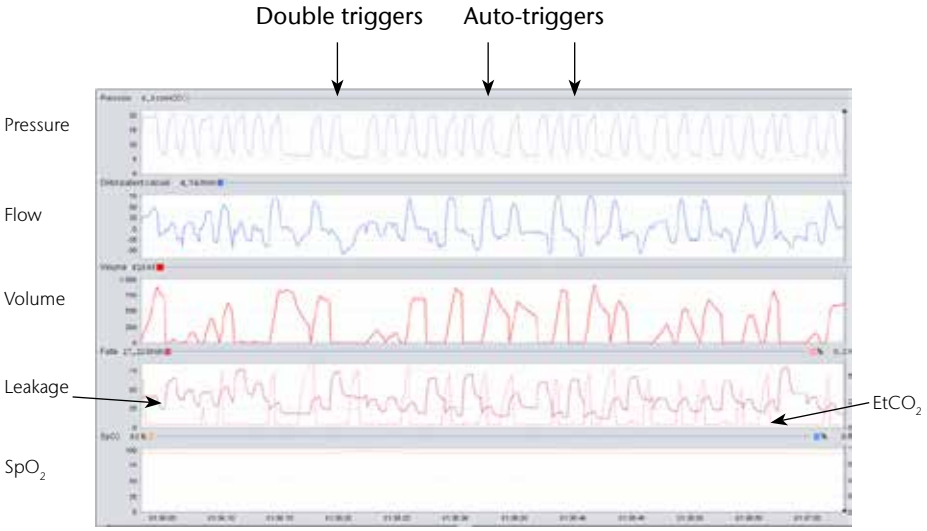
Monitoring and adjusting parameters

Presentation of overall night results

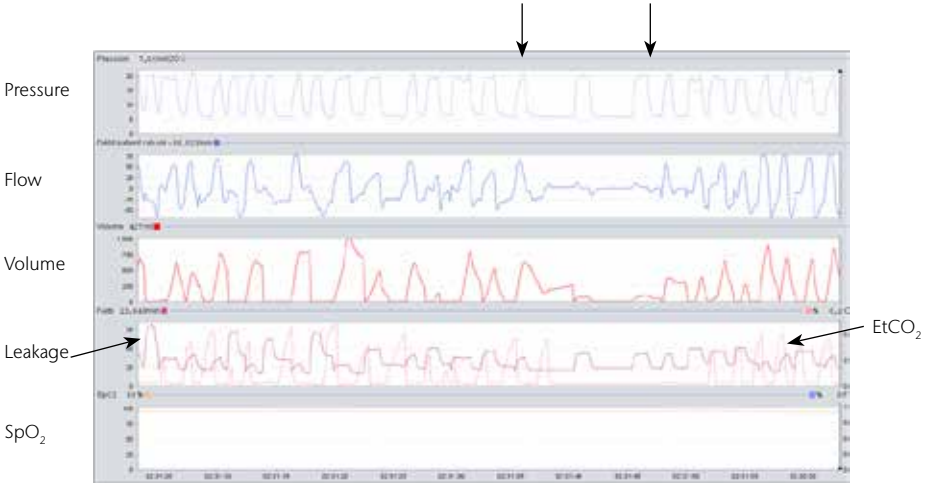


Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.31	8.8	10.8	33.9	95

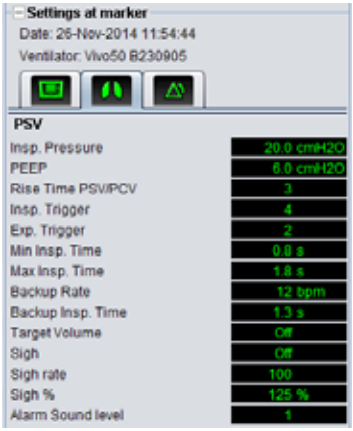
Zoom on night-time periods



Apnea



Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D3 under NIV	7.39	7.1	11.1	32.1	96

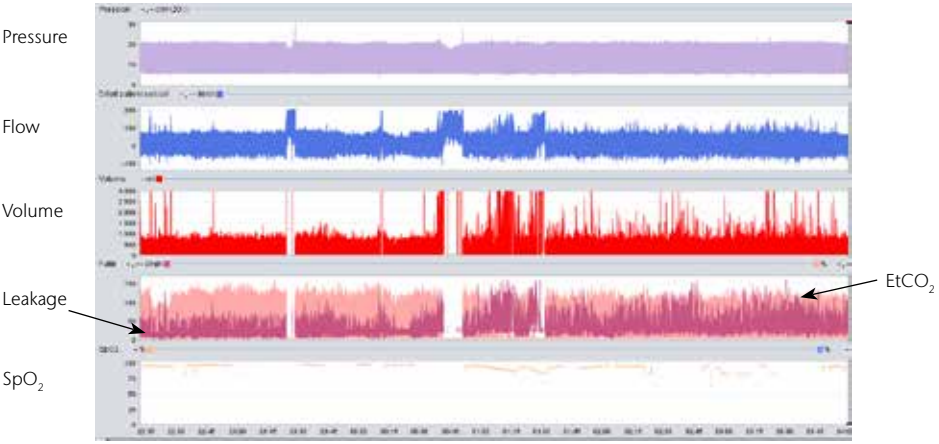


Ventilator parameters

Clinical and paraclinical improvement with medical treatment, non-invasive ventilation and supplemental oxygen.

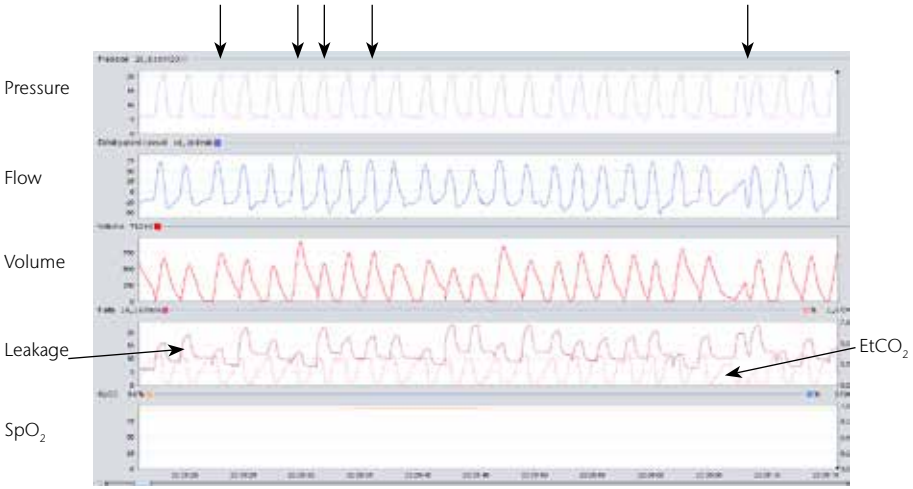
Ventilator parameters unchanged but reduction in leakages.

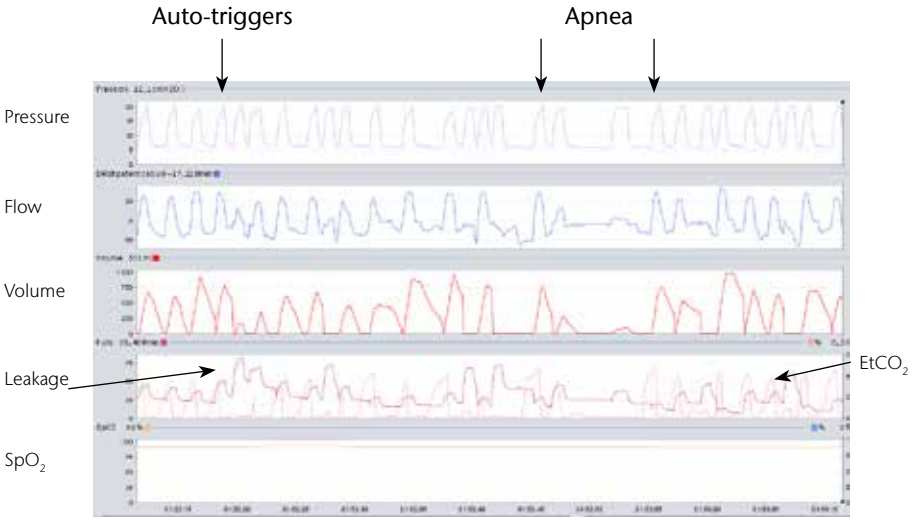
Presentation of overall results for the following night



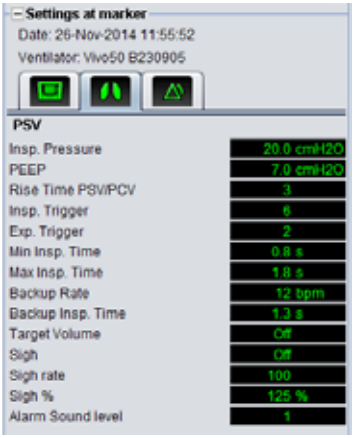
Zoom on periods during night

Asynchrony at the end of inspiration and double-trigger





Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D4 under NIV	7.45	6.8	11.3	35.4	97

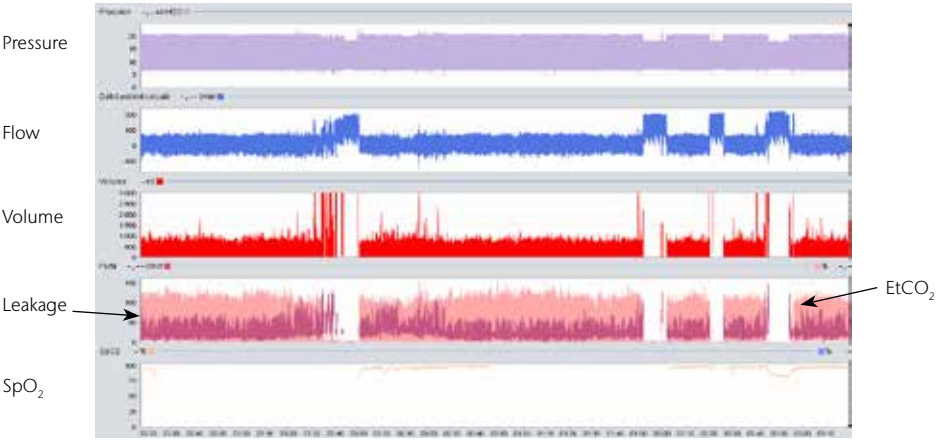


Ventilator parameters

Ventilator parameters changed.
Reduction in leakages.

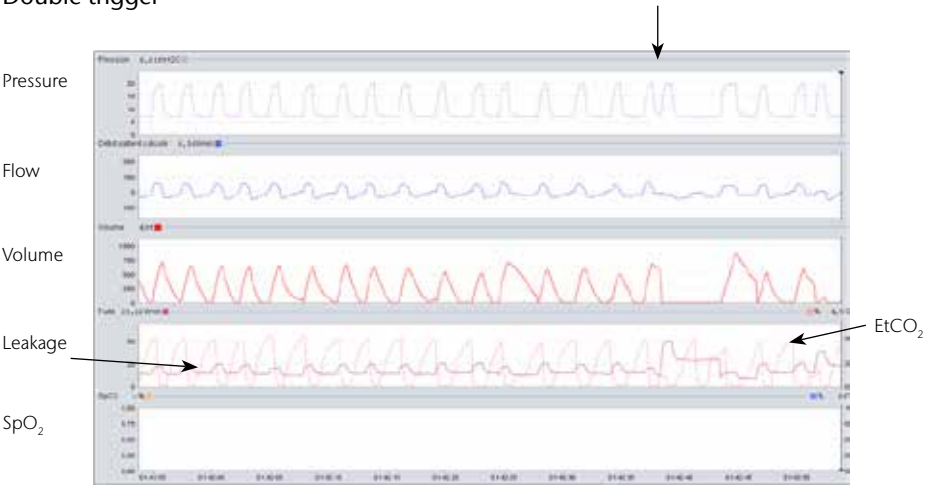
Clinical and paraclinical improvement.

Presentation of overall night results



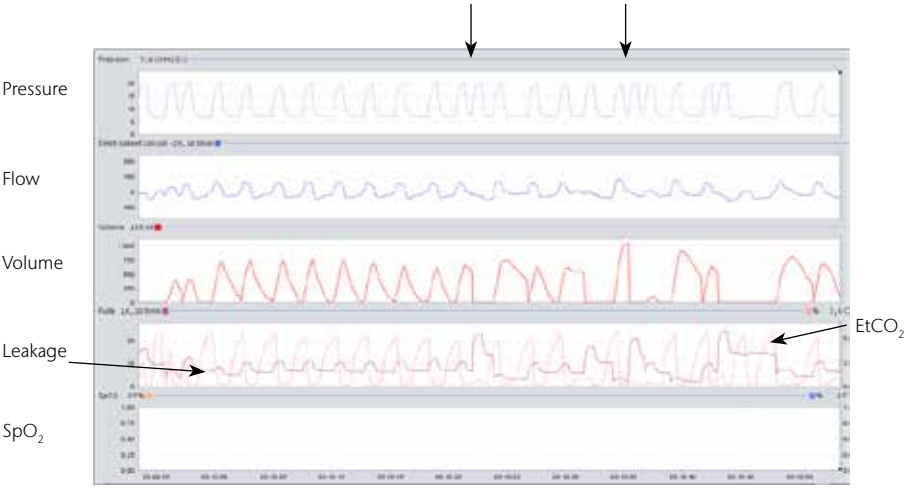
Zoom on night-time periods

Double trigger



Improvement but events persist

Auto-triggers



Case 4

Female, 74 years old, admitted to respiratory intensive care unit (RICU) for acute respiratory failure in addition to a bronchial superinfection and trouble swallowing.

History of ischaemic cardiopathy, carcinoma in situ at carina level being treated with cryotherapy, COPD.

Height 160 cm; Weight 85 kg; Heart rate 90/min; BP 165/85 mm Hg; RR 18/min. Diffuse basal sibilant and crackling rales, regular cardiac sounds without any murmur, oedema of the lower limbs. Trouble swallowing.

RFT FVC 1.48 L FEV 0.52 L TLC 7.29 L FEV/FVC 35% DLCO/VA 55%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 under O2	7.31	10.5	8.82	38.1	92.5

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode Leakage circuit.

Mask selected

Non-vented facial mask.

Inspiratory and expiratory pressure selected

Started with Insp pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend according to the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Inspiratory trigger selected

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Expiratory trigger selected

Expiratory trigger 3.

Rise time setting

Setting 4.

Adjust according to how comfortable the patient is.
Does the air reach you quickly or not quickly enough?

Min. and max. inspiratory times selected

(0.8- 2)

Backup rate setting

12

Target Volume

No.

Oxygen flow

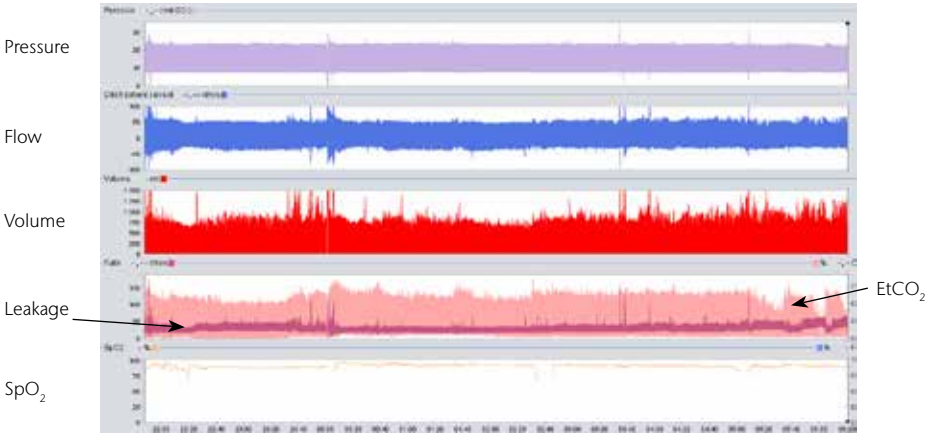
O_2 required to obtain an $SpO_2 \geq 90\%$.

Selected parameters

PSV mode
Insp Pressure 23; PEEP 8; RR 12; Inspiratory trigger 4; Expiratory trigger 3; Inspiratory time 1.3; Rise time 4; Min. insp. time 0.8; Max. insp. time 2; sigh + Oxygen 2 l/min.
Duration 3h 3h 8 hours
Simple supplemental oxygen 3 l/min. outside the NIV ranges.

Monitoring and adjusting parameters

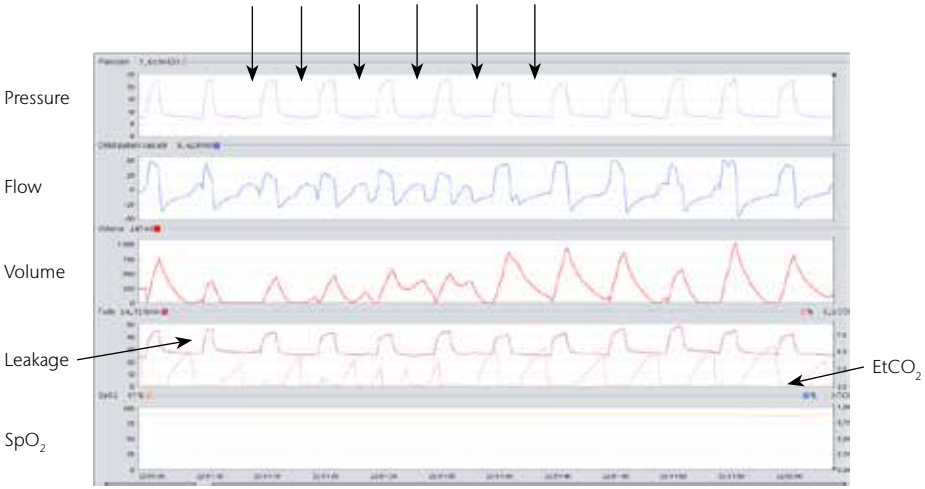
Presentation of overall night results



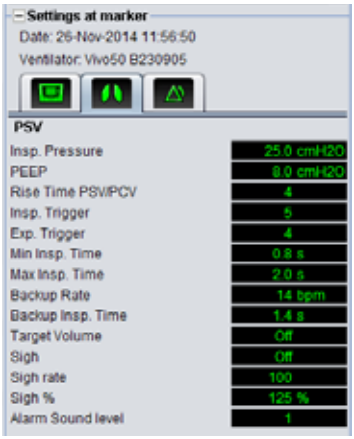
Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.45	9.1	8	40.3	91

Zoom on night-time periods

Ineffective efforts



Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D3 under NIV	7.41	10	13.2	45.5	98



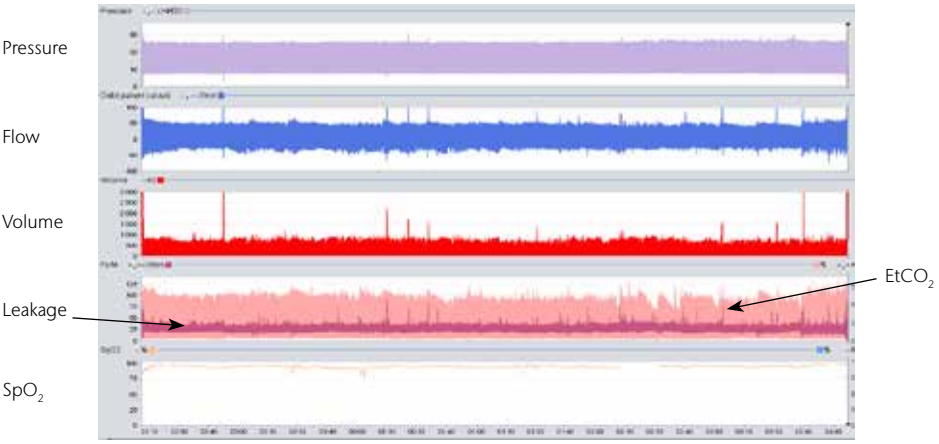
Night ventilator parameters

Clinical and paraclinical improvement with medical treatment, non-invasive ventilation and supplemental oxygen.

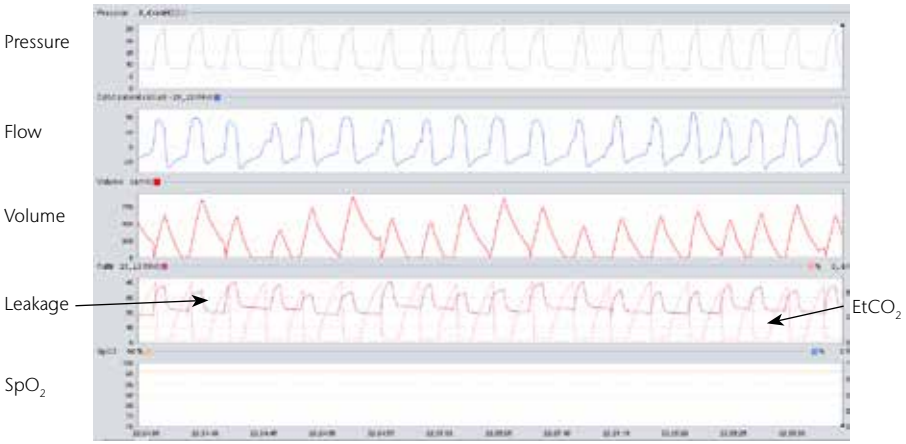
Ventilator parameters changed.

The improvement is linked to the reduction in auto-PEEP as a result of the medical treatment.

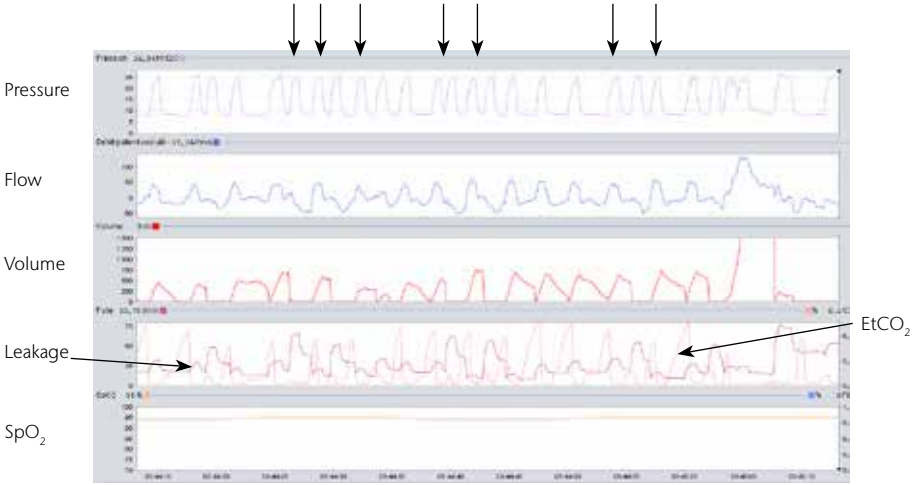
Presentation of overall results for the following night



Zoom on night-time periods



Improvement, but some persist. Auto-triggers



Action was taken on the leakages. The screenshot indicates some events which occurred during a very small part of the night.

Case 5

Male, 70 years old, admitted to respiratory intensive care unit (RICU) for acute respiratory failure in addition to spastic exacerbation.

History of ischaemic cardiopathy, overlap syndrome.

Height 170 cm; Weight 76 kg; Heart rate 98/min; BP 140/95 mm Hg; RR 16/min. Outbreak of left basal crepitations, irregular cardiac sounds without any murmur, oedema of the lower limbs.

RFT FVC 2.03 L FEV 1.18 L TLC 6.92 L FEV/FVC 58% DLCO/VA 60%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 under O2	7.33	7.2	11.5	28.7	96

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode Leakage circuit.

Mask selected

Non-vented facial mask.

Inspiratory and expiratory pressure selected

Started with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend according to the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Inspiratory trigger selected

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Expiratory trigger selected

Expiratory trigger 3.

Rise time setting

Setting 3.

Adjust according to how comfortable the patient is.

- Does the air reach you quickly or not quickly enough?

Min. and max. inspiratory times selected

(0.8- 2)

Backup rate setting

12

Target Volume.

No.

Oxygen flow

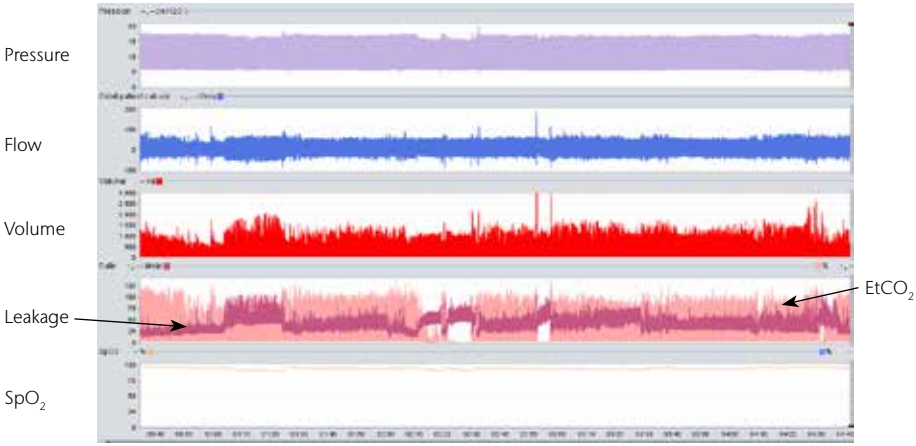
O_2 required to obtain an $SpO_2 \geq 90\%$.

Selected parameters

PSV mode
Insp Pressure 17; PEEP 6; RR 12; Inspiratory trigger 4; Expiratory trigger 3; Inspiratory time 1.3; Rise time 3; Min. insp. time 0.8; Max. insp. time 2; sigh + Oxygen 3 l/min.
Duration 3h 3h 8 hours
Simple supplemental oxygen 3 l/min. outside the NIV ranges.

Monitoring and adjusting parameters

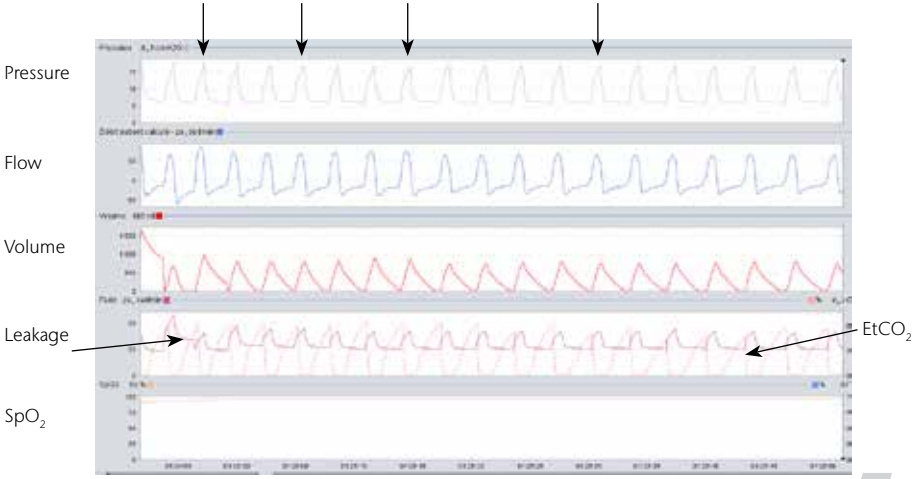
Presentation of overall night results

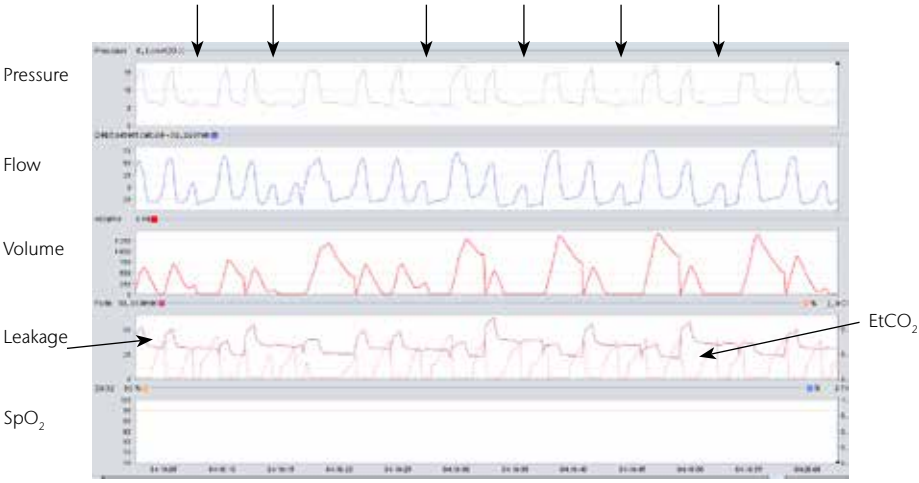


Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.38	6.9	12	30.8	97

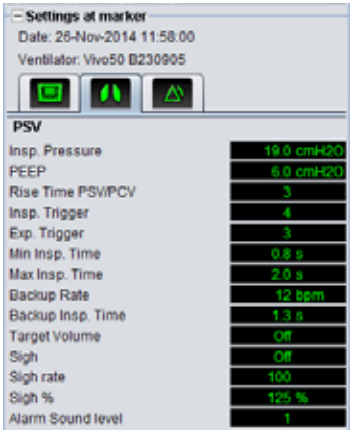
Zoom on night-time periods

Asynchrony at the end of inspiration





Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D3 under NIV	7.41	6.5	12.4	32.2	97



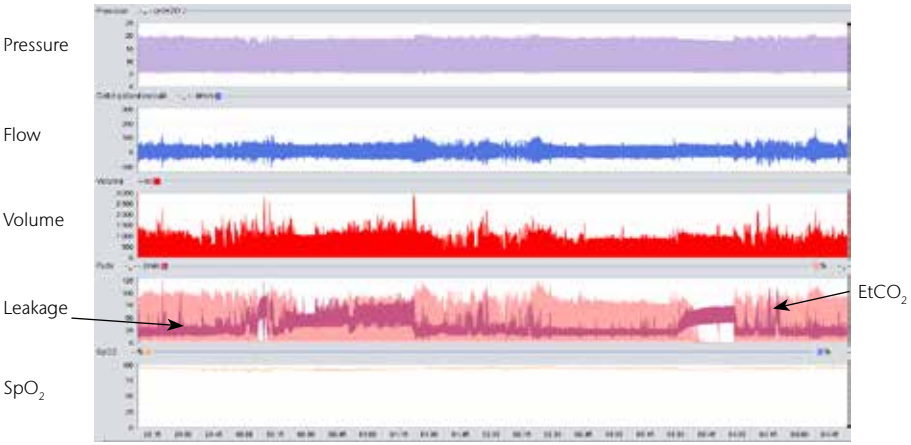
Night ventilator parameters

Clinical and paraclinical improvement with medical treatment, non-invasive ventilation and supplemental oxygen.

Ventilator parameters changed.

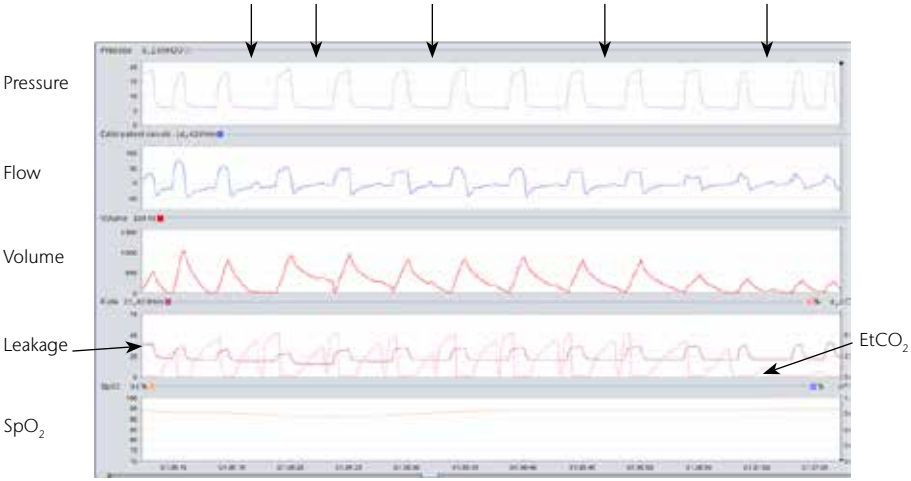
The interface was adjusted to reduce leakages. The medication used in treatment was adjusted to reduce auto-PEEP and we also increased the Insp Pressure.
Aim: to reduce leakages, and auto-PEEP and to improve the tolerance of NIV.

Presentation of overall night results



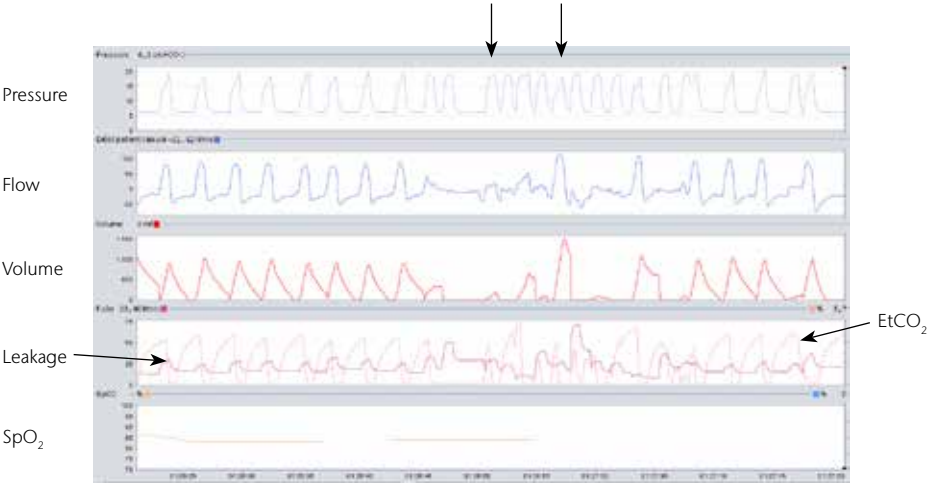
Zoom on periods during night

Ineffective efforts



Improvement but events persist

Auto-triggers



Case 6

Male, 79 years old, admitted to respiratory intensive care unit (RICU) for acute respiratory failure in addition to global cardiac decompensation.

History of post-smoking COPD, radiation pneumonitis in addition to LLL pulmonary neoplasia, cured epidermoid cancer of vocal cords, moderate sleep apnoea syndrome (AHI 20/h), complete arrhythmia due to atrial fibrillation.

Height 170 cm; Weight 98 kg; Heart rate 80/min; BP 130/80 mm Hg; RR 18/min. Diffuse hypoventilation without superimposed noise, irregular cardiac sounds without any murmur, oedema of the lower limbs.

RFT FVC 2.03 L FEV 1.23 L FEV/FVC 60% DLCO/VA 60%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 Room Air	7.32	8	7.1	27	87
D1 O2	7.33	7.8	10.5	28	94
D1 under NIV	7.43	6	10	28	95

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode with a circuit with exhalation valve.

Mask selected

Non-vented facial mask.

Inspiratory and expiratory pressure selected

Started with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.
Amend according to the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Inspiratory trigger selected

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Expiratory trigger selected

Expiratory trigger 2.

Rise time setting

Setting 2.

Adjust according to how comfortable the patient is.

- Does the air reach you quickly or not quickly enough?

Min. and max. inspiratory times selected

(0.8 – 2)

Backup rate setting

12

Target Volume

No.

Oxygen flow

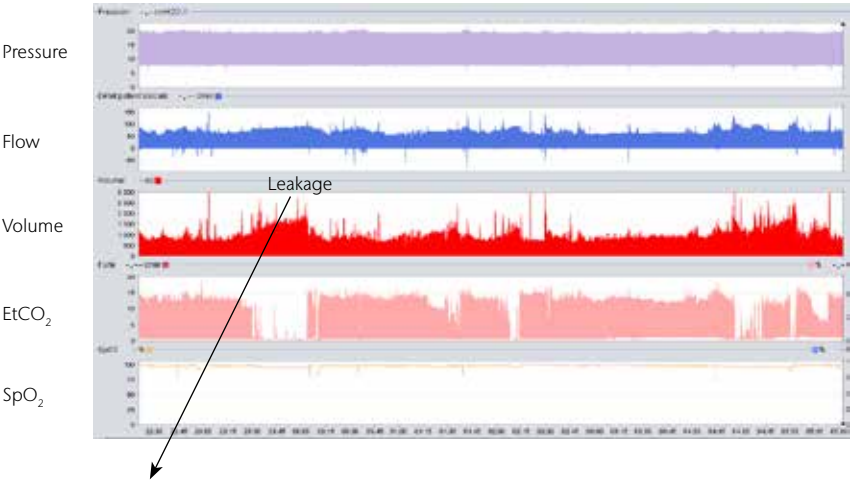
O_2 required to obtain an $SpO_2 \geq 90\%$.

Selected parameters

PSV mode
Insp Pressure 19; PEEP 8; RR 12; Inspiratory trigger 4; Expiratory trigger 2; Inspiratory time 1.3; Gradient 2; Min. insp. time 0.8; Max. insp. time 2; sigh + Oxygen 3 l/min.
Duration 3h 3h 8 hours
Simple supplemental oxygen 2 l/min. outside the NIV ranges.

Monitoring and adjusting parameters

Presentation of overall night results

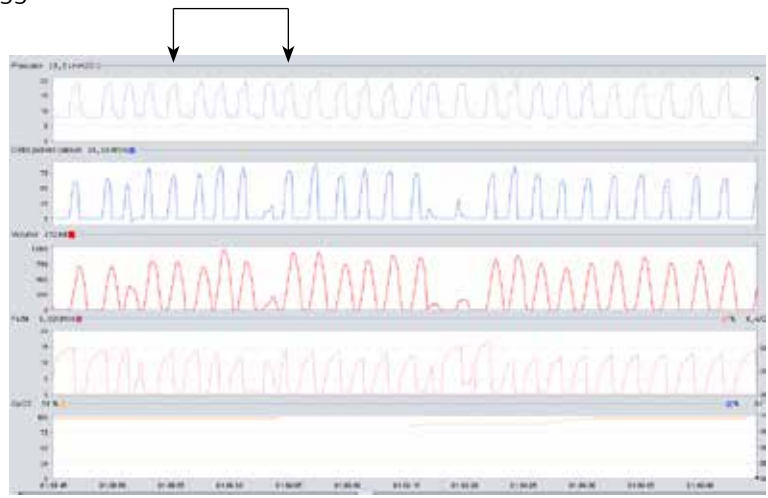


Leakage curve not accessible with valve circuit.
Indirect approach to leakages with $EtCO_2$, flow and volume curves.

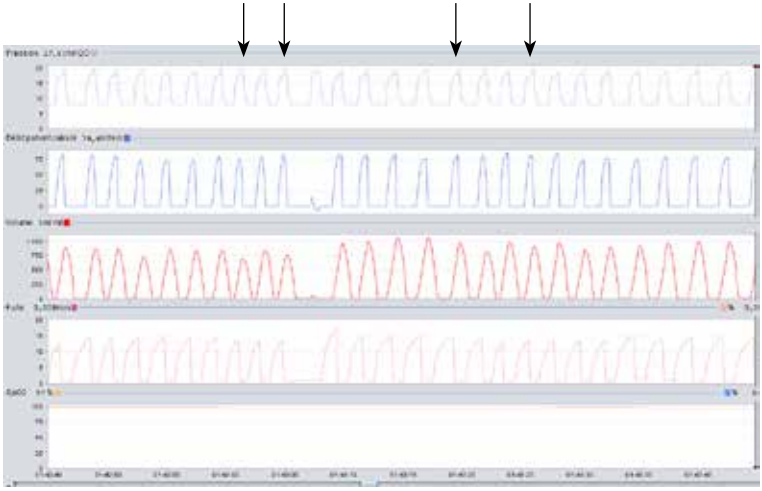
Using the exhalation valve prevents leakages from being measured. They can be tackled using variations of $EtCO_2$, flow and volume curves. Leakages are identified as soon as an $EtCO_2$ curve is smoothed out or dipped against a volume and flow curve with a large amplitude.

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.44	5.9	12.8	29.9	97

Auto-triggers

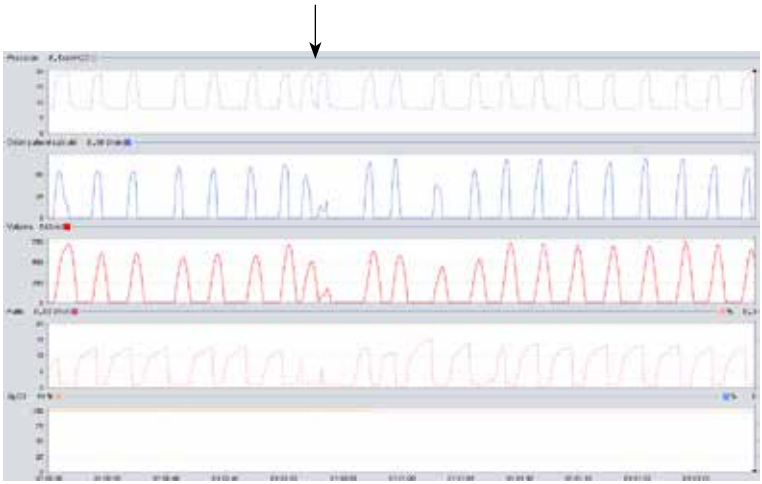


Asynchrony at the end of inspiration



Zoom on a period during the night

Double trigger



Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D3 under NIV	7.43	5.6	14.3	28.5	97
D4 under NIV	7.44	5.6	12.3	28	97

Night ventilator parameters

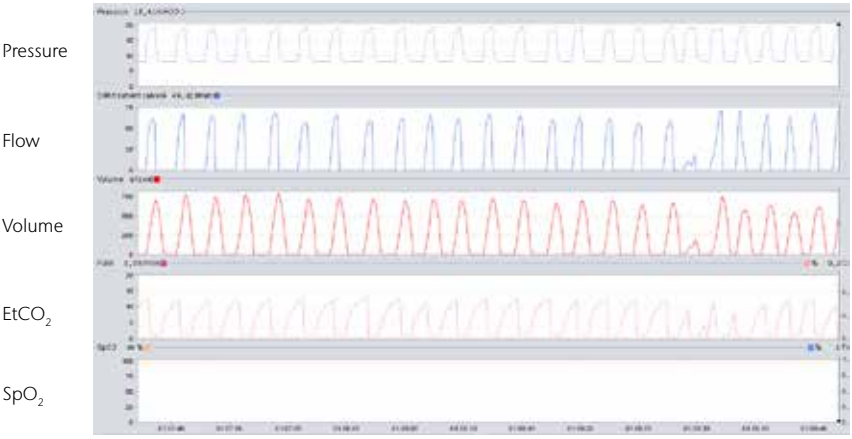
Clinical and paraclinical improvement with medical treatment, non-invasive ventilation and supplemental oxygen.

Ventilator parameters unchanged but improvement in leakages around the mask.

Presentation of overall results for the following night

Improved tracing

Zoom on a period during the night



Case 7

Male, 75 years old, admitted to respiratory intensive care unit (RICU) for acute respiratory failure.

History of obesity, untreated non-apnoeic alveolar hypoventilation, complete arrhythmia due to atrial fibrillation, gastric ulcer.

Height 172 cm; Weight 110 kg; Heart rate 130/min; BP 120/80 mm Hg; RR 25/min. Diffuse hypoventilation without superimposed noise, regular cardiac sounds without any murmur, no oedema of the lower limbs. Restlessness.

RFT FVC 1.28 L FEV 1.02 L FEV/FVC 79% DLCO/VA 132%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 Room Air	7.30	9	7.1	32	86
D1 O2	7.33	9.2	10	31	93

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode.

Mask selected

Non-vented facial mask and circuit with exhalation valve.

Inspiratory and expiratory pressure selected

Started with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend according to the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Inspiratory trigger selected

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Expiratory trigger selected

Expiratory trigger 3.

Rise time setting

Setting 1. On the patient's request.

Adjust according to how comfortable the patient is.
Does the air reach you quickly or not quickly enough?

Min. and max. inspiratory times selected

(0.8 – 2)

Backup rate setting

12

Target Volume.

No.

Oxygen flow

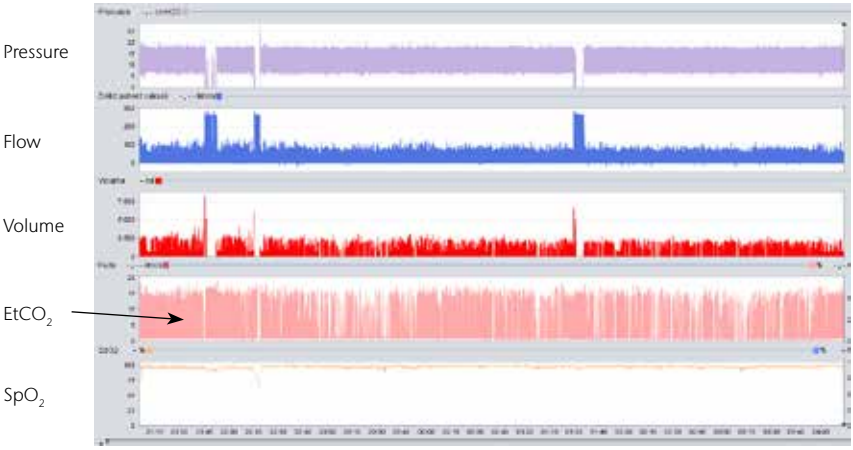
O_2 required to obtain an $SpO_2 \geq 90\%$.

Selected parameters

PSV mode
Insp Pressure 17; PEEP 7; RR 12; Inspiratory trigger 4; Expiratory trigger 3; Inspiratory time 1.3; Gradient Rise Time 1; Min. insp. time 0.8; Max. insp. time 2; sigh + Oxygen 4 l/min.
Duration 3h 3h 8 hours
Simple supplemental oxygen 2 l/min. outside the NIV ranges.

Monitoring and adjusting parameters

Presentation of overall night results

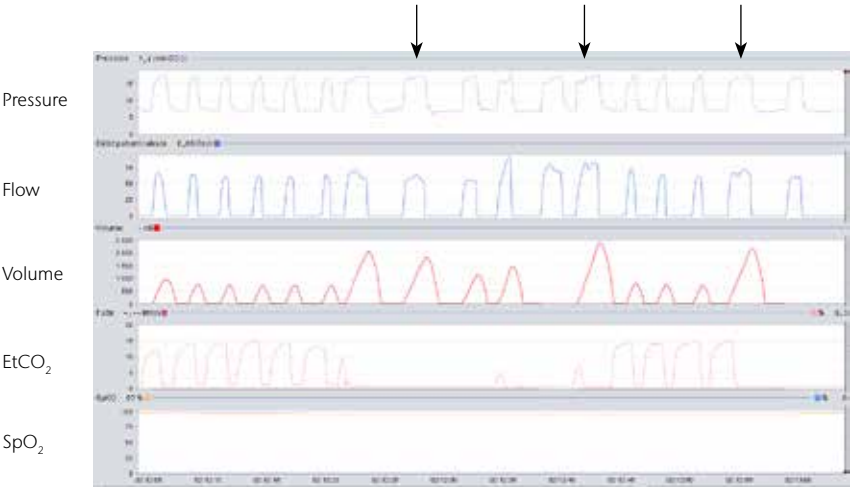


Leakage curve not accessible with valve circuit.
Indirect approach to leakages with $EtCO_2$, flow and volume curves.

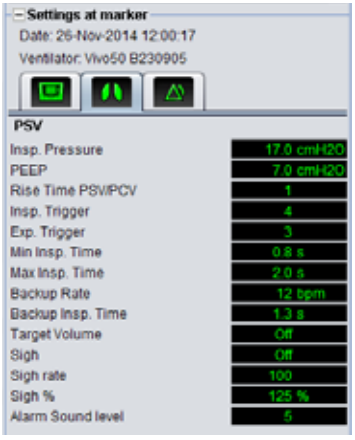
Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.42	6.5	13.6	31.8	98

Zoom on night-time periods

Leakage



Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D3 under NIV	7.49	5.7	18	30.5	99

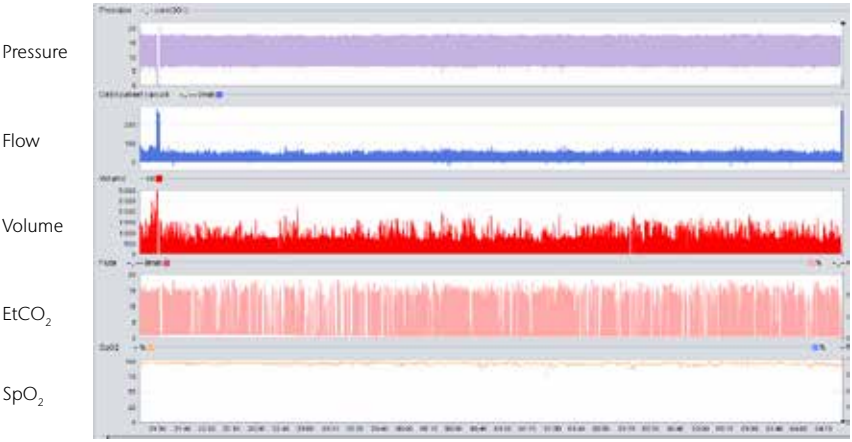


Night ventilator parameters

Clinical and paraclinical improvement with medical treatment, non-invasive ventilation and supplemental oxygen.

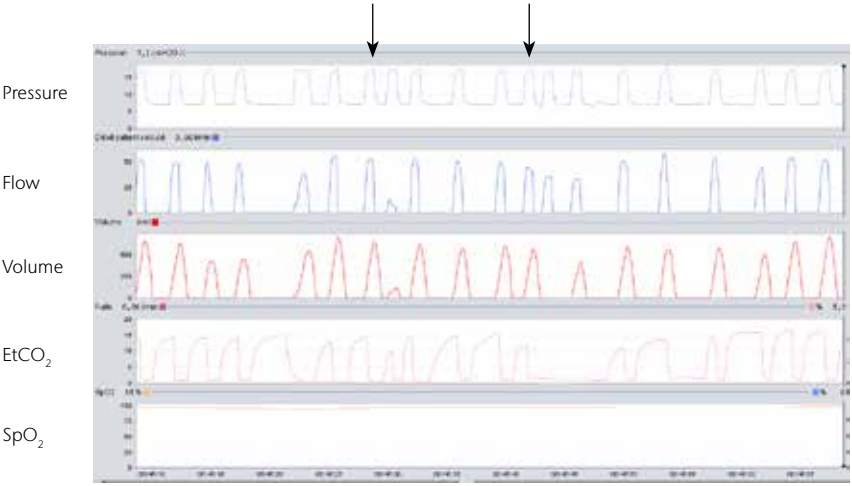
Ventilator parameters unchanged but improvement in patient's restlessness.

Presentation of overall results for the following night

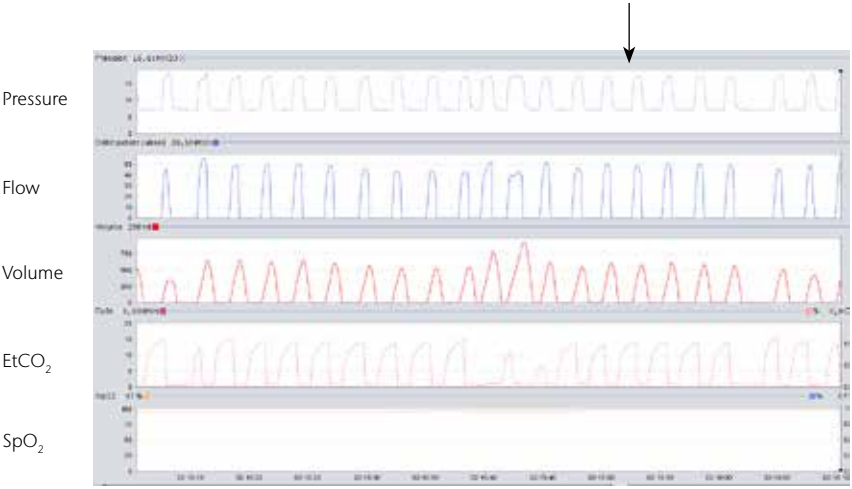


Zoom on night-time periods

Double trigger



Reduction in leaks



Case 8

Female, 54 years old, admitted to respiratory intensive care unit (RICU) for acute respiratory failure on top of bronchospasm.

History of post-smoking CRF with COPD, PH group 3, PAD.

Height 150 cm; Weight 35 kg; Heart rate 88/min; BP 110/60 mm Hg; RR 16/min. Diffuse hypoventilation without superimposed noise, regular cardiac sounds without any murmur, no oedema of the lower limbs.

RFT FVC 1.00 L FEV 0.3 L TLC 3.52 FEV/FVC 30%

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D1 O2	7.30	8.2	10	28	94

Non-invasive ventilation initiated with the Vivo 50 ventilator

Ventilatory mode selected

Pressure mode.

Mask selected

Non-vented facial mask, circuit with exhalation valve.

Inspiratory and expiratory pressure selected

Started with Insp Pressure at 13 cm H_2O and PEEP at 3 cm H_2O.

Amend according to the following questions:
Are you receiving too much air or not enough?

- Too much: reduce the insufflation pressure.
- Not enough: increase the insufflation pressure.

Inspiratory trigger selected

Inspiratory trigger 4.

Amend according to the following questions:
Can you comfortably make the effort to trigger the ventilator?

- Too sensitive: make the inspiratory trigger less sensitive.
- Too hard: make the inspiratory trigger more sensitive.

Expiratory trigger selected

Expiratory trigger 4.

Rise time setting

Setting 1.

Adjust according to how comfortable the patient is.
Does the air reach you quickly or not quickly enough?

Min. and max. inspiratory times selected

(0.8 – 2)

Backup rate setting

12

Target Volume.

No.

Oxygen flow

O_2 required to obtain an $SpO_2 \geq 90\%$.

Selected parameters

PSV mode
Insp pressure 22. PEEP 6. RR 12. Inspiratory trigger 4. Expiratory trigger 4.
Inspiratory time 1.2. Rise Time 1. Min. insp. time 0.8. Max. insp. time 2, sigh
+ oxygen 2 l/min.
Duration 3h 3h 8 hours
Simple supplemental oxygen 2 l/min. outside the NIV ranges.

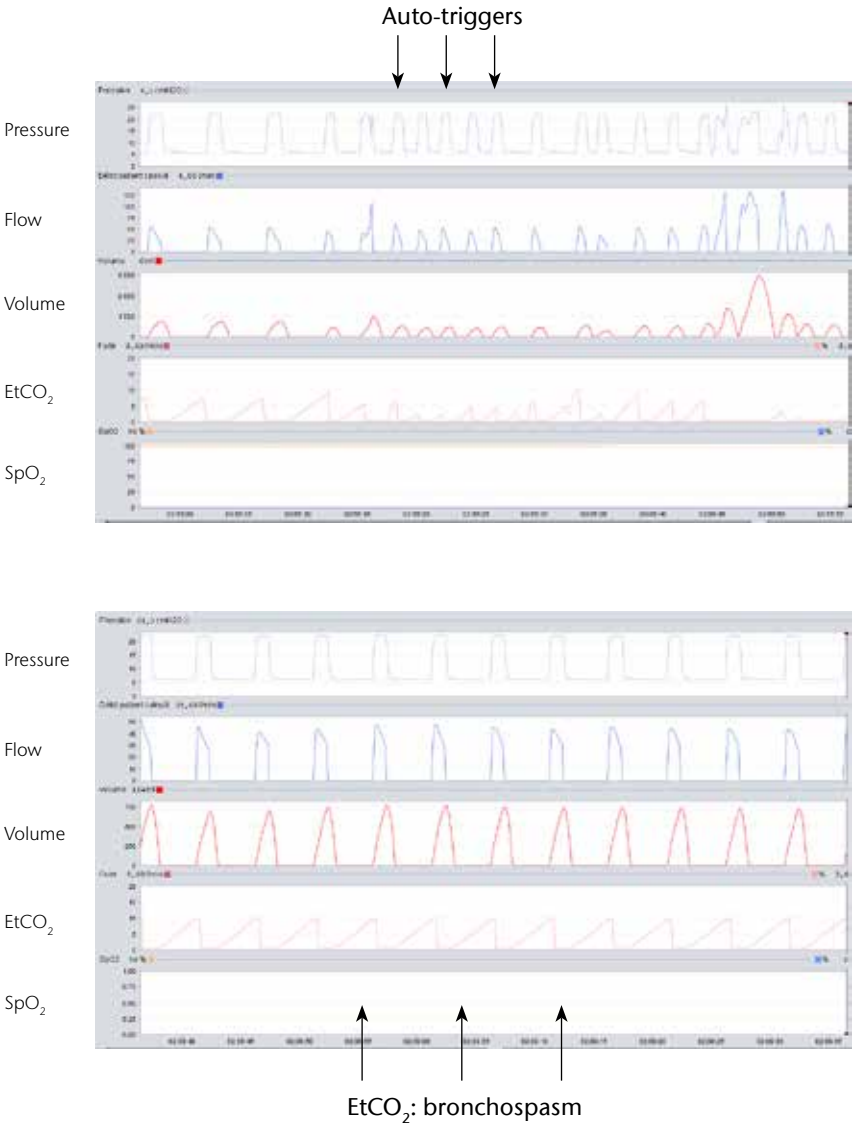
Monitoring and adjusting parameters

Presentation of overall night results

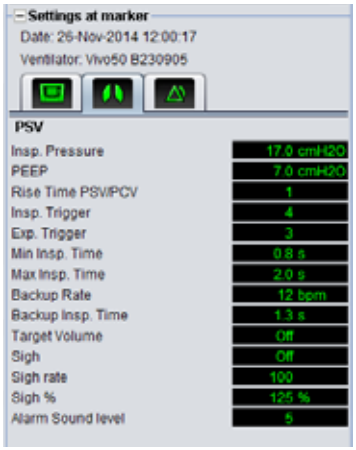
Leakage curve not accessible with valve circuit.
Indirect approach to leakages with $EtCO_2$, flow and volume curves.

Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D2 under NIV	7.38	7.2	13.2	33.3	97

Zoom on night-time periods



Blood gas	pH	$PaCO_2$ (kPa)	PaO_2 (kPa)	HCO_3 (mmol/L)	SaO_2 (%)
D3 under NIV	7.49	5.7	18	30.5	99



Night ventilator parameters

Clinical and paraclinical improvement with medical treatment, non-invasive ventilation and supplemental oxygen.
Ventilator parameters unchanged but improvement in bronchospasm.

Presentation of overall results for the following night

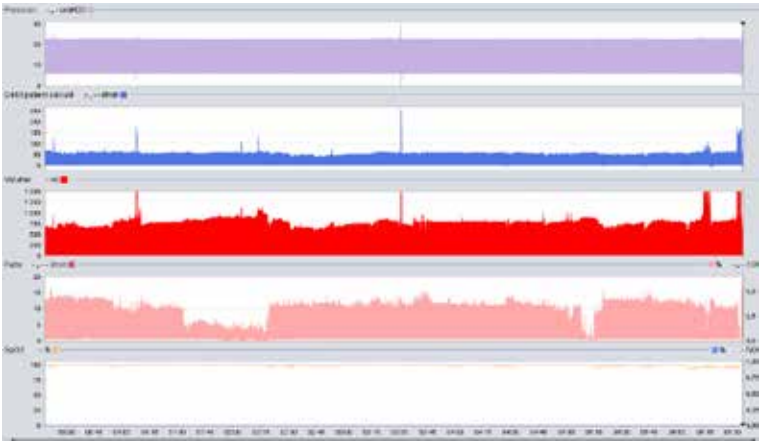
Pressure

Flow

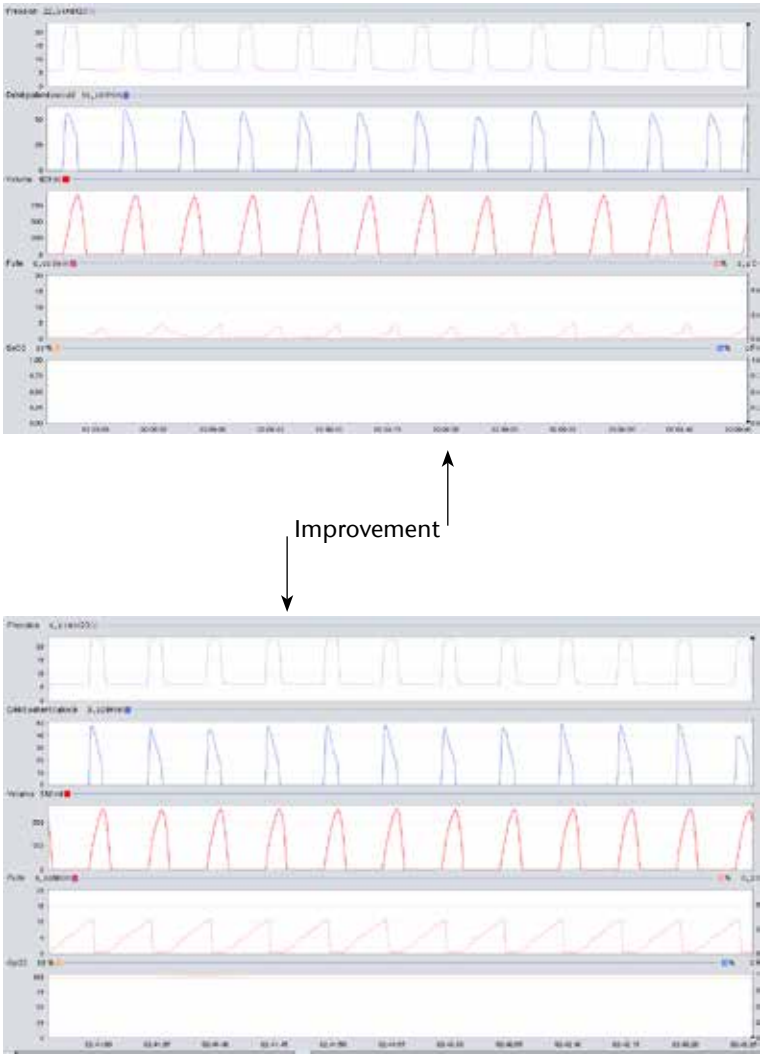
Volume

$EtCO_2$

SpO_2



Zoom on night-time periods



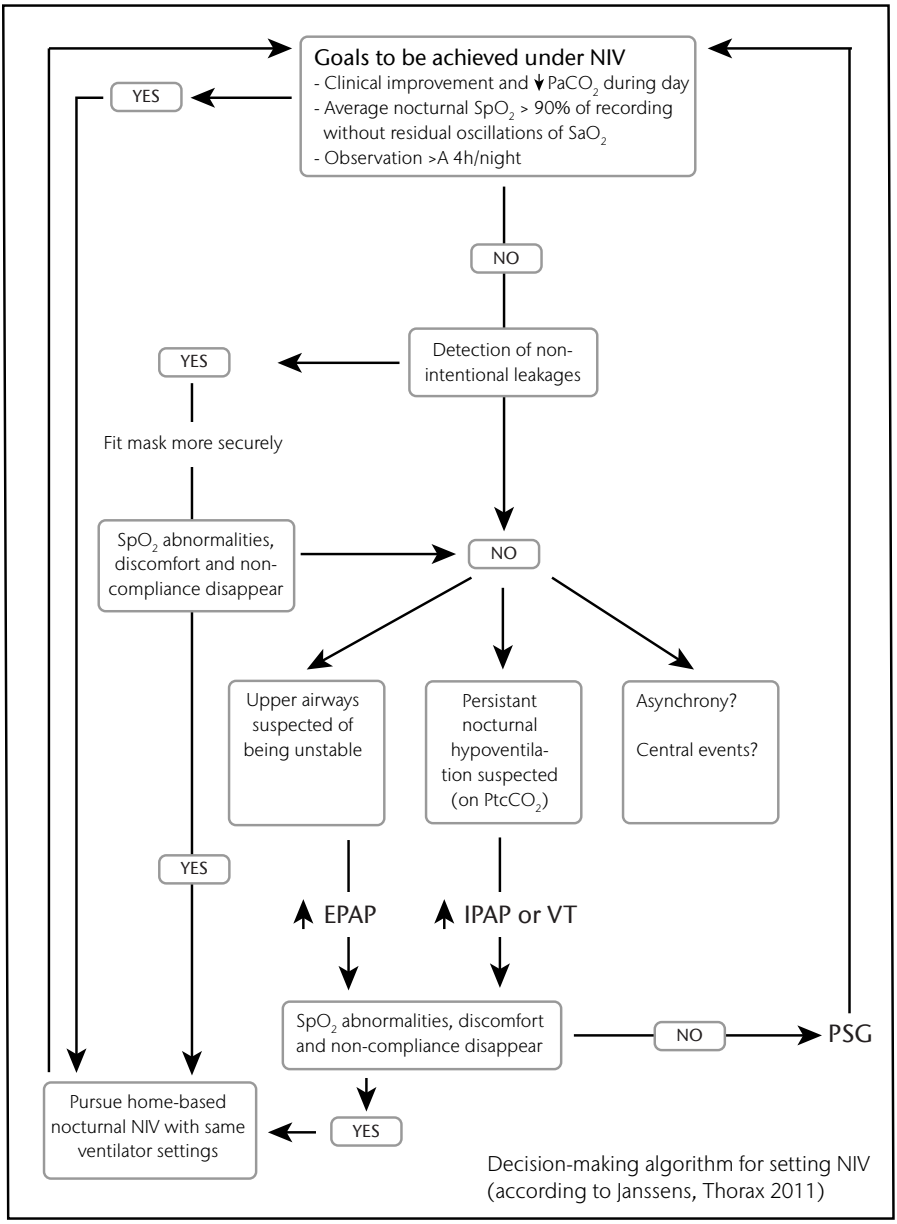
Conclusion

Setting up and adjusting non-invasive ventilation is designed to be carried out using monitoring software, which allows the various anomalies to be rectified in real-time in relation to the patient's respiratory dynamics and the ventilator settings.

An important role in dealing with these ventilatory anomalies is played by the effectiveness of the aetiological treatment of the patient's disorder, as well as by ensuring that the correct interface and ventilation parameters are used.

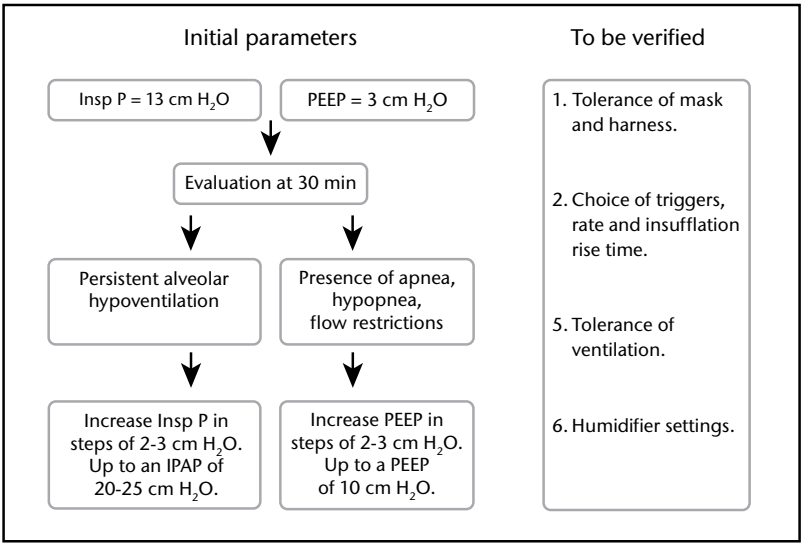
Thanks to the Vivo 50 ventilator the various ventilatory asynchronous events can be identified and treated while setting up and monitoring treatment via non-invasive ventilation.

Algorithms

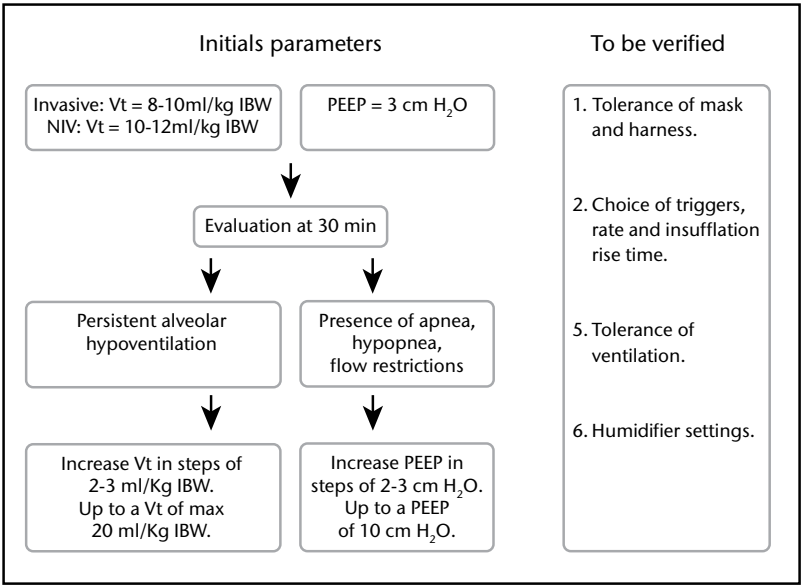


Decision-making algorithm for setting NIV (according to Janssens, Thorax 2011)

Algorithm - Pressure-controlled mode



Algorithm - Volume-controlled mode



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For more information

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Asynchronies patient—machine en aide inspiratoire: intérêt des courbes affichées par le respirateur, J. Roeseler, J.-B. Michotte, T. Sottiaux, Réanimation (2010) 19, 62—65.

Interactions patient–ventilateur, A.-W. Thille, L. Brochard, Réanimation 16 (2007) 13–19.

Parameters to be set

Pressure-controlled ventilation modes

Pressure Support	
Inspiratory Pressure	4 – 50 cm H_2O
PEEP	2 – 30 cm H_2O
Rise time	1 – 9 (longest)
Inspiratory trigger	1 – 9 (most difficult)
Expiratory trigger	1 – 9 (slowest)
Minimum inspiratory time	off – 3 seconds
Maximum inspiratory time	off – 3 seconds
Backup rate	4 – 40 breaths per minute
Backup inspiratory time	0.3 – 5.0 seconds
Target Volume	off – 2500 ml
Maximum Pressure	50 cm H_2O
Minimum Pressure	4 – 50 cm H_2O
Sigh	off – on
Sigh rate	50 – 250
Sigh %	125 – 200%

Pressure Controlled Ventilation	
Inspiratory Pressure	4 – 50 cm H_2O
PEEP	2 – 30 cm H_2O
Breath rate	4 – 40 breaths per minute
Inspiratory time	0.3 – 5 seconds
Rise time	1 – 9 (longest)
Inspiratory trigger	1 – 9 (most difficult)
Target Volume	off – 2500 ml
Maximum Pressure	50 cm H_2O
Minimum Pressure	4 – 50 cm H_2O
Sigh	off – on
Sigh rate	50 – 250
Sigh %	125 – 200%

Volume-controlled ventilation mode

Volume Controlled Ventilation	
Tidal Volume	100 – 2500 ml
PEEP	2 – 30 cm H_2O
Breath rate	4 – 40 breaths per minute
Inspiratory time	0.3 – 5 seconds
Rise time	1 – 9 (longest)
Inspiratory trigger	1 – 9 (most difficult)
Flow Pattern	square – decelerating
Sigh	off – on
Sigh rate	50 – 250
Sigh %	125 – 200%

Ventilation mode

CPAP	
CPAP	4 – 20 cm H_2O

Alarm settings for pressure- or volume-controlled mode	
High pressure	5 – 60 cm H_2O
Low pressure	1 – 50 cm H_2O
High Vt	off – 3000 ml
Low Vt	off – 1200 ml
High Breath rate	off – 70 b/min.
Low Breath rate	off – 30 b/min.
High MV	off – 40 litres
Low MV	off – 30 litres
Apnea	off – 60 seconds
Disconnection	on – off
Rebreathing	on – off
High PEEP	on – off
Low PEEP	on – off
High SpO_2	off – 100%
Low SpO_2	off – 100%
High pulse rate	off – 250 b/min.
Low pulse rate	off – 250 b/min.
High FiO_2	off – 100%
Low FiO_2	off – 100%
High $EtCO_2$	off – 74 mm Hg
Low $EtCO_2$	off – 74 mm Hg
High $InspCO_2$	off – 74 mm Hg

Timin, Timax, rapport I/E

Patient resp

Inspiratory time (seconds)

	10	11	12	13	14	15	16	17	18	19
0,3										
0,4										
0,5										
0,6										
0,7									1/3,8	1/3,5
0,8							1/3,7	1/3,4	**1/3,2**	**1/3**
0,9					1/3,8	1/3,4	**1/3,2**	**1/2,9**	1/2,7	1/2,6
1			1/4	1/3,6	**1/3,3**	**1/3**	1/2,8	1/2,5	1/2,3	1/2,2
1,1		1/4	**1/3,5**	**1/3,2**	1/2,9	1/2,6	1/2,4	1/2,2	1/2	1/1,9
1,2	1/4	**1/3,5**	1/3,2	1/2,8	1/2,6	1/2,3	1/2,1	1/1,9	1/1,8	1/1,8
1,3	**1/3,6**	1/3,2	1/2,8	1/2,6	1/2,3	1/2,1	1/1,9	1/1,7	1/1,6	1/1,4
1,4	1/3,3	1/2,9	1/2,6	1/2,3	1/2,1	1/1,9	1/1,7	1/1,5	1/1,4	1/1,3
1,5	1/3	1/2,6	1/2,3	1/2,1	1/1,9	1/1,7	1/1,5	1/1,4	1/1,2	1/1,1
1,6	1/2,8	1/2,4	1/2,1	1/1,9	1/1,7	1/1,5	1/1,3	1/1,2	1/1,1	**1/1,0**
1,7	1/2,5	1/2,2	1/1,9	1/1,8	1/1,5	1/1,4	1/1,2	1/1,1	**1/1,0**	
1,8	1/2,3	1/2	1/1,8	1/1,6	1/1,4	1/1,2	1/1,1	**1/1,0**		
1,9	1/2,2	1/1,9	1/1,6	1/1,5	1/1,3	1/1,1	**1/1,0**			
2	1/2	1/1,7	1/1,5	1/1,4	1/1,1	**1/1,0**				
2,1	1/1,9	1/1,6	1/1,4	1/1,3	**1/1,0**					
2,2	1/1,7	1/1,5	1/1,3	1/1,2						
2,3	1/1,6	1/1,4	1/1,2	**1/1,0**						
2,4	1/1,5	1/1,3	1/1,1							
2,5	1/1,4	1/1,2	**1/1,0**							
2,6	1/1,3	1/1,1								
2,7	1/1,2	**1/1,0**								
2,8	1/1,1									
2,9	1/1,1									
3	**1/1,0**									
3,1										

piratory rate (cycle per minute)

	20	21	22	23	24	25	26	27	28	29	30
									1/4,4	1/4,2	1/4
					1/4	1/3,8	1/3,6	1/3,4	**1/3,3**	**1/3,1**	**1/3**
		1/3,8	1/3,6	1/3,4	**1/3,2**	**1/3**	**1/2,9**	**1/2,7**	1/2,6	1/2,5	1/2,3
5	1/3,3	**1/3,1**	**1/2,9**	**1/2,7**	1/2,6	1/2,4	1/2,3	1/2,2	1/2,1	1/2	1/1,9
8	**1/2,8**	1/2,6	1/2,4	1/2,3	1/2,1	1/2	1/1,9	1/1,8	1/1,7	1/1,6	1/1,5
6	1/2,3	1/2,2	1/2	1/1,9	1/1,8	1/1,7	1/1,6	1/1,5	1/1,4	1/1,3	1/1,2
2	1/2	1/1,9	1/1,7	1/1,6	1/1,5	1/1,4	1/1,3	1/1,2	**1/1,2**	**1/1,1**	**1/1,1**
9	1/1,7	1/1,6	1/1,5	1/1,4	1/1,3	1/1,2	**1/1,1**	**1/1,0**			
6	1/1,5	1/1,4	1/1,3	1/1,2	**1/1,1**	**1/1,0**					
4	1/1,3	1/1,2	**1/1,1**	**1/1,1**							
3	1/1,2	**1/1,0**									
1	**1/1,0**										
0											

Ti Max	Setting of Ti for COPD patients (Ti min OFF)
Ti Min Ti Max	Setting of Ti for restrictive patients
	Inversed I:E ratio

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