Real time, regional assessment
of the lung's ventilatory heterogeneities

Immediate and Continuous feedback
from interventions and ventilatory strategies

Fully compatible with all mechanical ventilators

ENLIGHT 2100

INDIVIDUALIZATION OF RESPIRATORY CARE BY CONTINUOUS REGIONAL MONITORING

TIMPEL
PRECISION VENTILATION

Technology – Electrical Impedance Tomography (EIT)

Brochure Navigation

For easier navigation and understanding of this brochure, we implemented icons that correspond with different tools and pages aswel as QR codes to instantly play educational videos complimenting the information.

Technology · Complete Care · Accessories · Cases · Ventilation Tool · Trends Tool · PEEP Titration Tool · Points of Interest

QR codes for educational videos

Take Home Messages

ENLIGHT 2100 is a bedside continous lung monitor that provides:

- real time functional images of the lungs for adult, pediatric and neonatal patients in the same device
- regional information about ventilation distribution

Clinical tools for:

- regional ventilatory assessment
- quantification of hyperdistension and collapse in each PEEP level
- analysis and comparison of the last 48 hours of the patient's ventilatory history

How does ENLIGHT work?

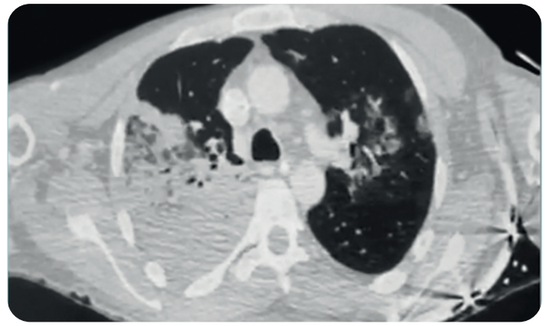
ENLIGHT creates a resistive map of the lungs that helps the caregiver optimize ventilation at the bedside.

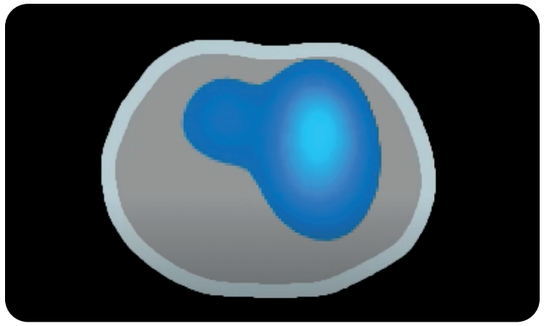
Patient belt with 32 sensors is positioned around the patient´s thorax.

The system measures the change of electrical impedance creating 50 real images per second. The color scale goes from the dark blue (less ventilated regions) to white (more ventilated regions).

CT versus EIT comparison

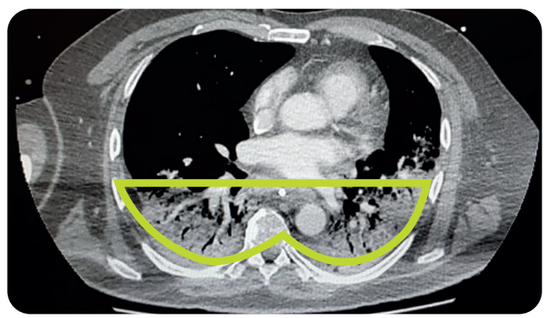
Example of CT and EIT images

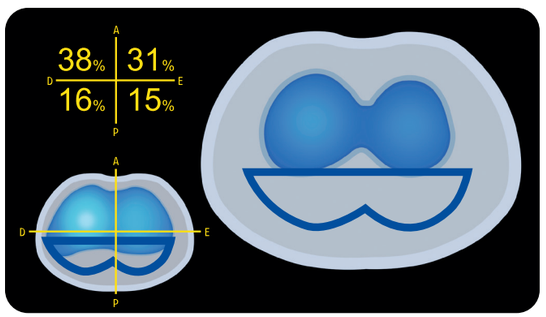




Standard imaging – CT	EIT
Diagnostic Tool	Monitoring Tool
Snapshot in time	Continuous real time video
High spatial resolution (anatomical)	High temporal resolution (functional)
Patient Transport	Bedside
Radiation	Radiation free

Example of asymmetrical ventilation distribution on ENLIGHT and the patient's CT image.
The area represented in blue is equivalent to the one in green: since there is collapse on the CT, there is no ventilation (impedance) variation on the same region on ENLIGHT images.

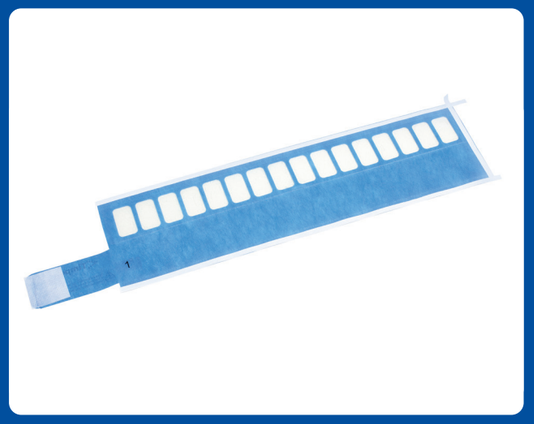




ENLIGHT 2100 & Accessories

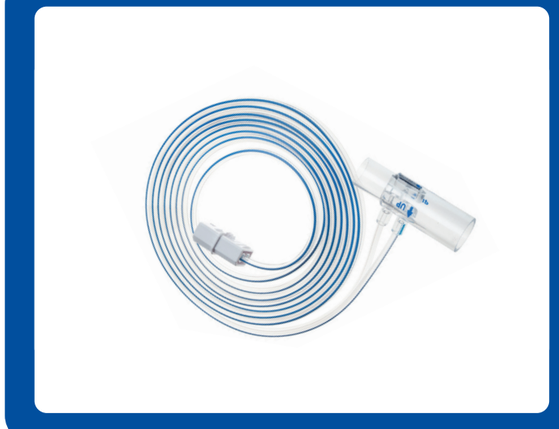
Sensoring Reusable Belt

- No chest compression, comfortable for the skin
- Left & Right (two) separated parts for easy application
- 32 electrodes provide the highest resolution with the most dense image quality available



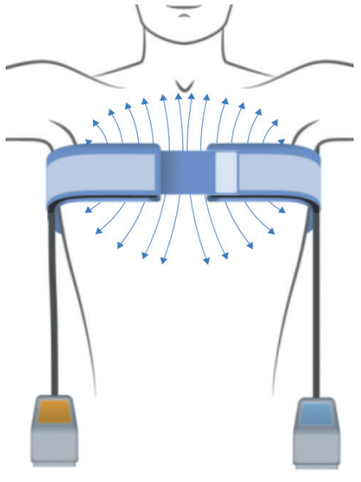
Addere

- Breathable, textile non woven fabric
- Single patient use to minimize the chances of cross infection
- Highly conductive biocompatible gel, for gentle contact on the patient's skin, avoiding belt misplacement
- Provides excellent signal quality
- Up to 48 hours of continuous monitoring with one Addere



Proximal Flow Sensor

- Automatically calculates alveolar parameters, including real time Alveolar Driving Pressure
- Precise measurements, compatible with all mechanical ventilators



Belt is applied between the 4th and 5th intercostal space, providing visualization of a 15 cm slice, representing approximately 60% of the lung.

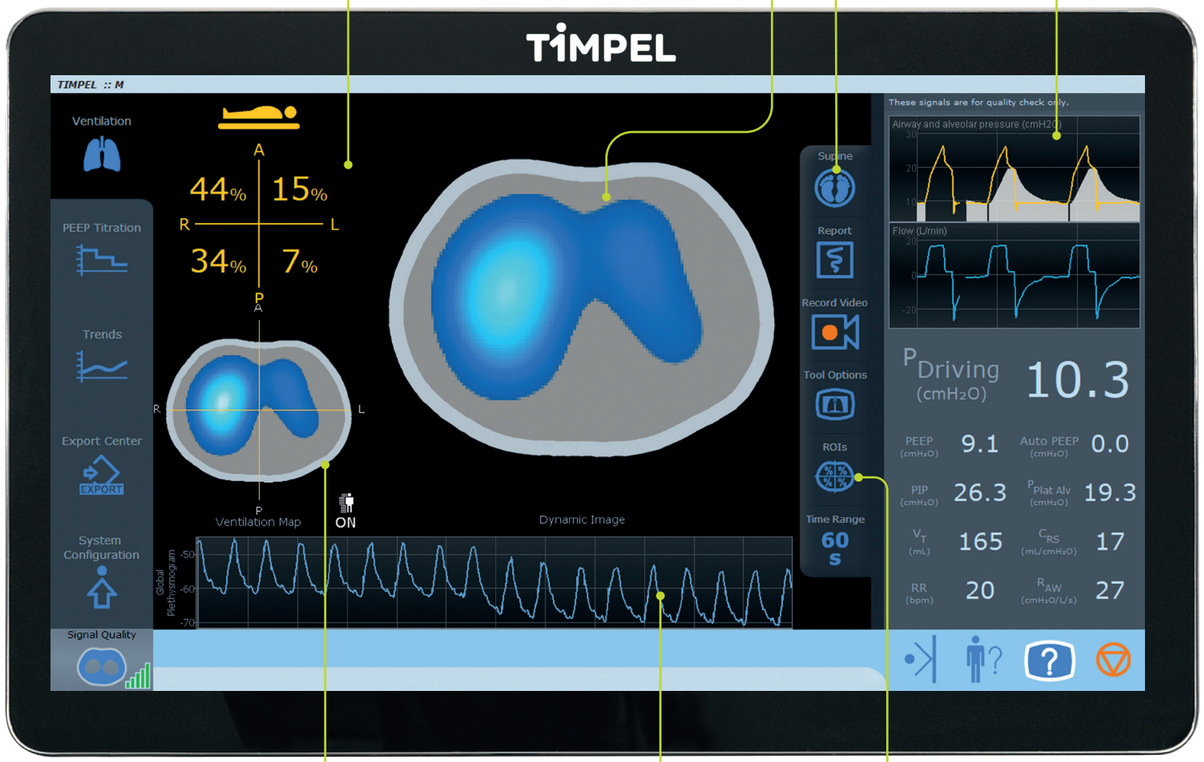
The Main Tools: Ventilaton Screen

Ventilation Distribution Ratios
Displays the percentages of tidal volume that each region of the lungs is receiving, unveiling ventilation heterogeneities.

Dynamic Image
Real-time monitoring of the patient's breathing with high temporal resolution (real 50 images per second).

Supine / Prone
Can change the position of the image to reflect the position of the patient.

Ventilatory Parameters
Precise ventilatory parameters, breath by breath, synchronized with EIT information.



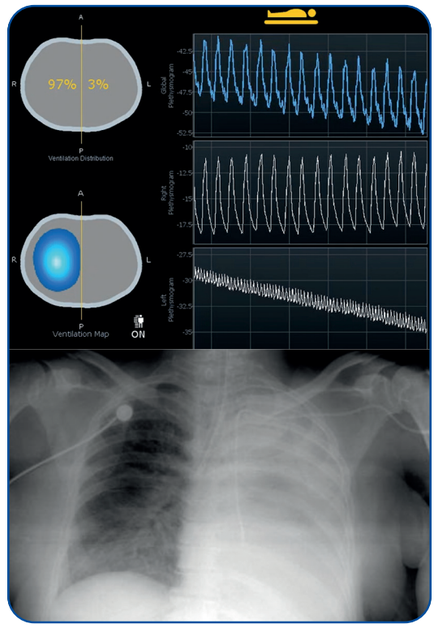
Ventilation Distribution Map
See how the air is being distributed inside the lungs and detect ventilation heterogenities.

Plethysmogram
Plethysmogram signal shows the sum of impedance variation globally or in a region of interest over time.

- Wave amplitude corresponds to Tidal Volume (Vt)
- Position changes or ventilatory adjustments may cause changes to the baseline of the plethysmogram which corresponds to End Expiratory Lung Volume (EELV).

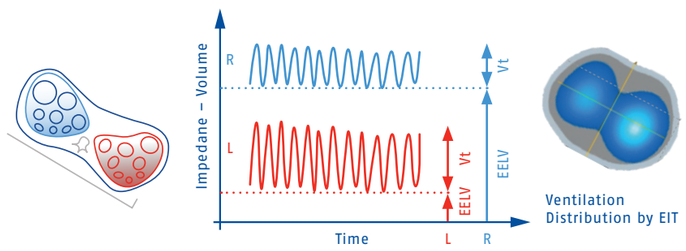
Regions of interest (ROIs)
To further analyze regional lung ventilation volumes and real time responses in different layouts: A/P, R/L, Quadrants and 4 horizontal layers.

An illustrative example of the benefits of having regional information.



After ET tube displacement we see:
1. Drop of the baseline of global plethysmogram (blue) – reduction of air volume
2. Right lung plethysmogram shows high amplitude – ventilation goes exclusively to the right lung. Left lung plethysmogram – minimal amplitude with drop of base line – no ventilation with decreasing of air volume in left lung

Take home message
- ENLIGHT continuously shows real time ventilation distribution.
- Changes are immediately detected, even before clinical manifestations.
- Provides also immediate feedback to clinical management.

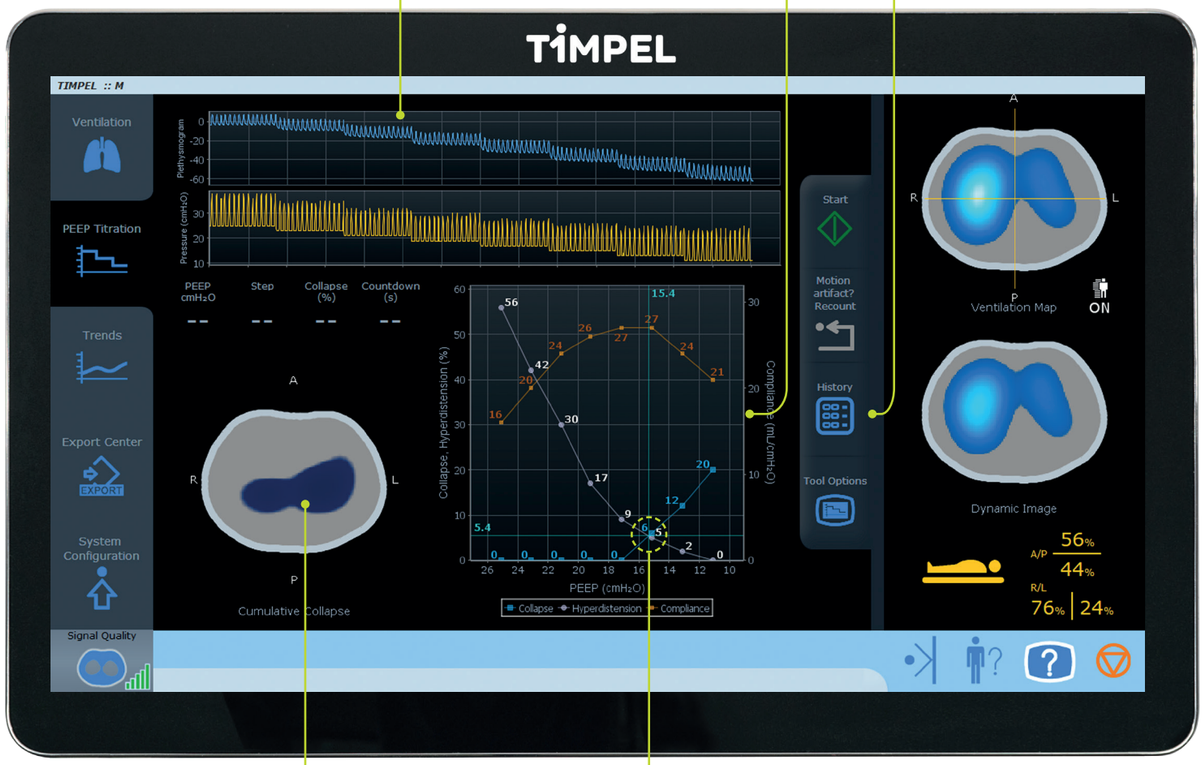


The Main Tools: PEEP Titration

Plethysmogram and Pressure Curves
Observe the automatic detection of PEEP changes.

Graphics
Real time calculation of compliance, hyperdistension and collapse. Monitor how these parameters behave step by step.

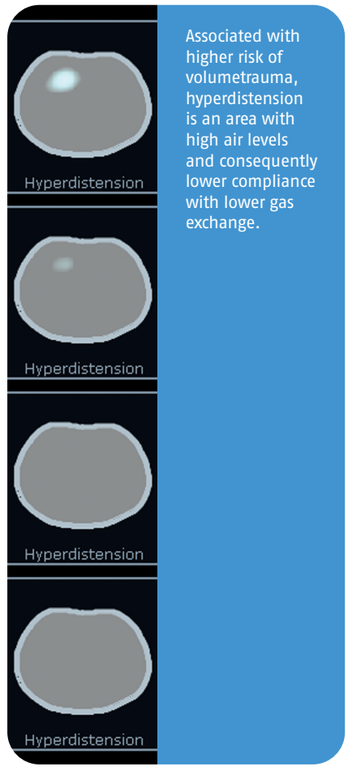
History
Display of regional hyperdistension (white) and collapse (dark blue) in each PEEP step, identifying lung's heterogeneous behaviors for same PEEP values.



Cumulative Collapse
Updates after each reduction in PEEP and illustrates when and where the collapse is beginning to appear.

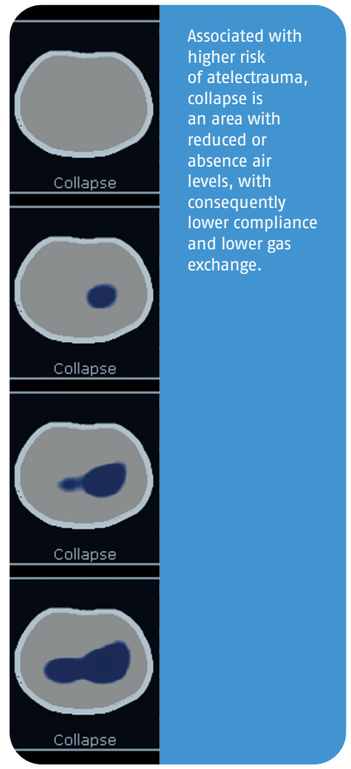
Crossing Point
The PEEP value with best compromise of lung hyperdistension and collapse at the same time. Global compliance curve shows the relevant value for the crossing point.

Hyperdistension (white)



Associated with higher risk of volumetrauma, hyperdistension is an area with high air levels and consequently lower compliance with lower gas exchange.

Collapse (dark blue)



Associated with higher risk of atelectrauma, collapse is an area with reduced or absence air levels, with consequently lower compliance and lower gas exchange.

Parameters

PEEP 17.1 cmH₂O
Hyperdistension 9 %
Collapse 0 %
Compliance 27 mL/cmH₂O

PEEP 15.2 cmH₂O
Hyperdistension 5 %
Collapse 6 %
Compliance 27 mL/cmH₂O

PEEP 13.1 cmH₂O
Hyperdistension 2 %
Collapse 12 %
Compliance 24 mL/cmH₂O

PEEP 11.1 cmH₂O
Hyperdistension 0 %
Collapse 20 %
Compliance 21 mL/cmH₂O

Values of PEEP hyperdistension, collapse and compliance for each step.

Take home message
Real time, interactive guiding tool to titrate individualized PEEP. Provides the location and amounts of hyperdistension and collapse for each PEEP level.

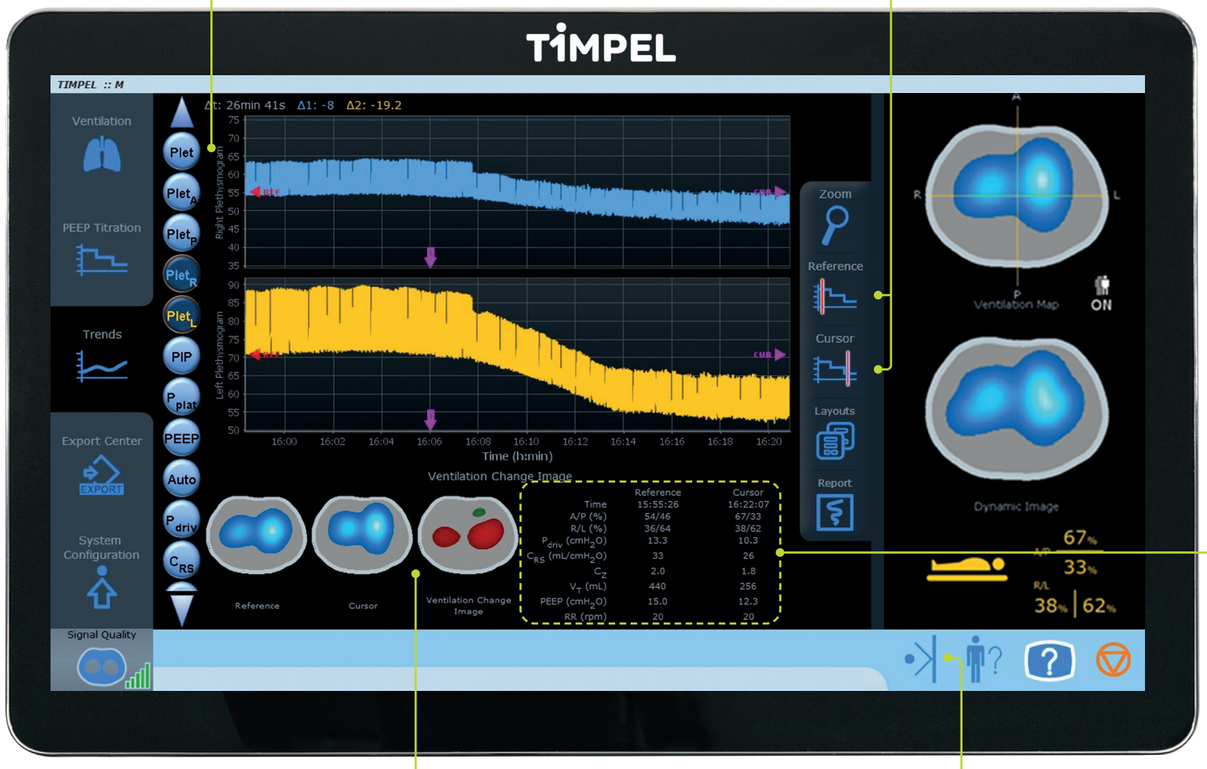
*only for adult patients with no spontaneus respiratory effort and under controlled ventilatory modes

The Main Tools: Trends

Drag and Drop Graphics
Configure and compare different parameters for detailed data analysis.

Reference and Cursor
Select and compare two moments from the last 48 hours to see what has changed.

Comparison Parameters
Understand what changed in each parameter between Reference and Cursor moments.



	Reference	Cursor
Time	15:55:26	16:22:07
A/P (%)	54/46	67/33
R/L (%)	36/64	38/62
P_{driv} (cmH_2O)	13.3	10.3
C_{RS} (mL/cmH_2O)	33	26
C_z	2.0	1.8
V_T (mL)	440	256
PEEP (cmH_2O)	15.0	12.3
RR (rpm)	20	20

Compliance or Ventilation Change Images
Comparative images of two different moments in time, showing regional changes in ventilation or compliance.

Events Marking
Mark events to know exactly what happened and when, and understand the effects. They are stored and displayed on the Trends screen and in the Reports.

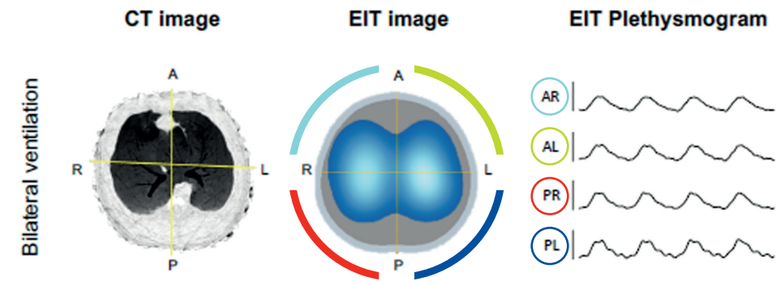
Take home message
The last 48 hours of the patient's records to analyze and guide the decision making process.

Regions of Interest – Regional Monitoring

Illustrative examples of the behavior of the plethysmogram in different ROIs according to different lung situations.

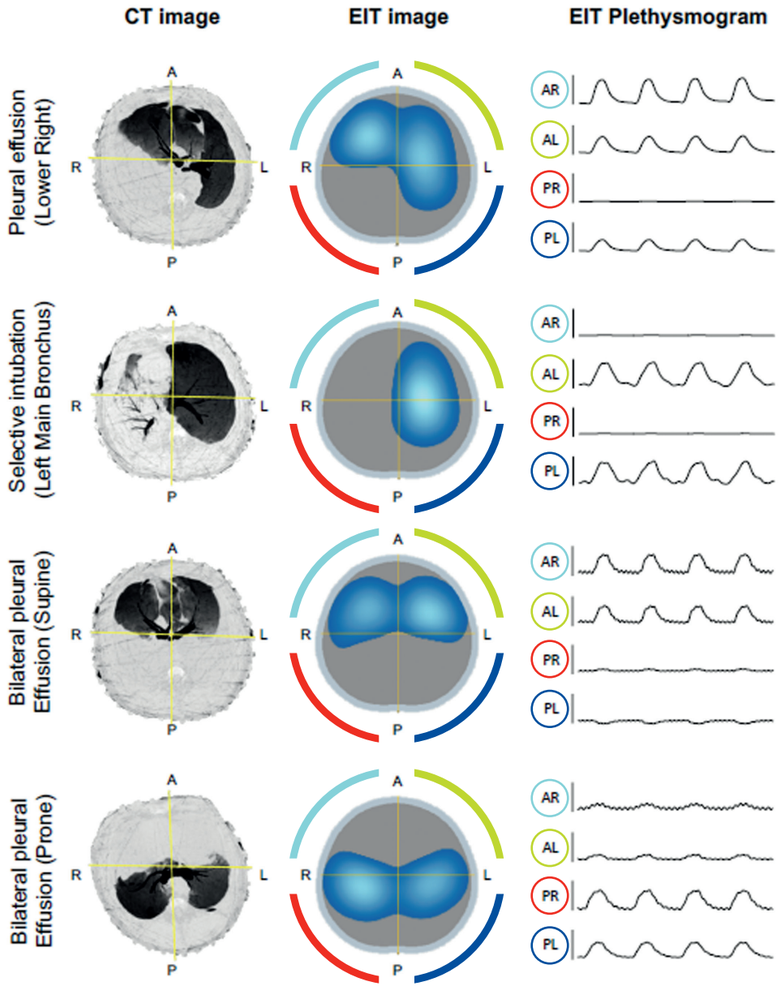
Symmetrical ventilation

Similar wave amplitude, indicating symmetrical ventilation in all monitored segments.



Asymmetrical ventilation

Smaller or absence of the wave amplitude indicates lack or absence in ventilation in specific segment.



Complete Care

Hemodynamic quick assessment:

Contractility and size of RV and LV?

Evaluation of signs of hypovolemia

No signs of pericardial effusion

No signs of RV failure

LUS - Lung Ultrasound:

No signs of PNO

No signs of pleural effusion

Airway care:

Suction

Bronchoscopy – clear bronchial tree

Imaging
Chest Xray:

CT

Ventilation optimization:

ENLIGHT monitoring
Respiratory Care
Positioning

Cases – R/L Asymmetrical lung injury & the lateral positioning

Introduction

Case briefing

- Patient 60-yo, BMI 35, DM II., Metabolic syndrome
- 2 days progression of respiratory insuficiences
- Saturation before admission 70%
- Admission: NIV PEEP 8 + 8 PS / Spo2 90% on Fio2 1.0
- Progression of respiratory failure – NIV intolerance, exhaustion
- ET tube after 2 hours, start of MV-PCV, PEEP10+20PC, Spo2 95% on Fio2 1.0
- Initial Pao2/Fio2 60

Complete Care

- Haemodynamic fast assesment – no pathology, no RV failure
- USG – no PNO, no effusion
- FOB – clear bronchial tree
- CXR – Figure 1

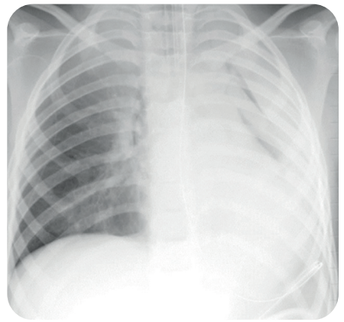
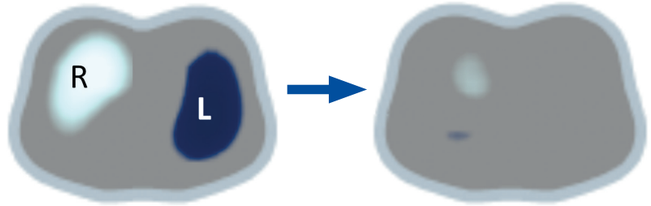


Figure 1: Chest X-ray of admission.

Results

*consolidated images comparing hyperdistension and collapse with PEEP 12 before and after 15 hours of lateral repositioning



Less Hyperdistension - 70 %
Less Collapse - 51 %

a) First PEEP Titration performed with ENLIGHT

PEEP	Hyperdistension visualised	Hyperdistension in percentage	Collapse visualised	Collapse in percentage	Compliance
16		15.5 %		0 %	42.4
14		14.2 %		1.4 %	41.8
12		14.8 %		8.8 %	40.7
10		13.2 %		10.7 %	38.5
8		12.9 %		17.3 %	37.7

Second PEEP Titraion after 15 hours of PEEP 12

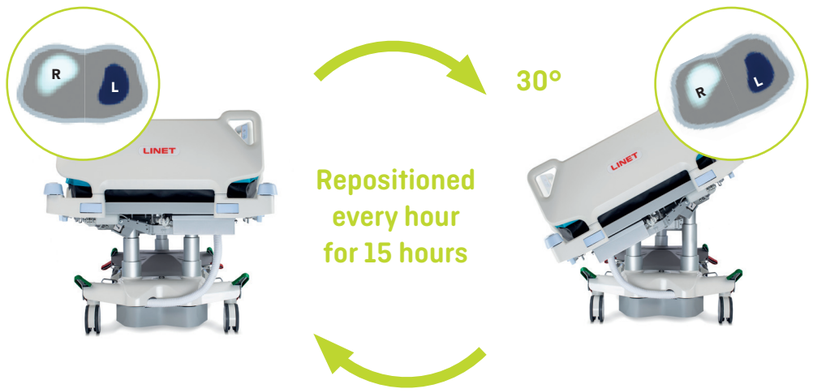
PEEP	Hyperdistension visualised	Hyperdistension in percentage	Collapse visualised	Collapse in percentage	Compliance
16		12.2 %		0.5 %	42.7
14		9.6 %		1.9 %	40.6
12		4.4 %		4.3 %	41.4
10		4.1 %		6.5 %	40.3
8		0.1 %		13.2 %	41.4

Intervention

b) Positioning strategy

The right lung facing down reduces hyperdistension, thus improving compliance.

Collapsed left lung facing up leads to the oppening of collapsed units, improving compliance.



Take home message

"By EIT we monitor ventilation asymmetry and we identify the ideal position (lateral right) to reduce hyperdistension and collapse at the same time."

Michal Otáhal, MD., PhD.
ICU, General University Hospital Prague

Cases – Ventilation optimization:
ENLIGHT PEEP Titration tool vs. ARDSnet table

Introduction

Case briefing

- 24-yo obese patient (BMI 36 Kg/m2) with ARDS due to COVID-19
- Progression of respiratory failure despite HFNC and NIV → Mechanical Ventilation with PEEP = 10 cmH20 according to the low PEEP ARDSNet protocol.

Complete Care

- Bronchoscopy – clear bronchial tree
- Chest X-ray (Figure 1)
- Monitoring with ENLIGHT showed asymmetric ventilation (Figure 2)

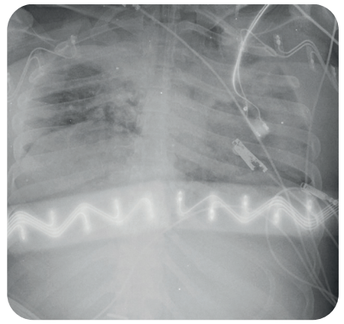


Figure 1: Chest X-ray showing diffuse alveolar infiltrates more intense on the left lung.

Ventilation optimization
– ENLIGHT monitoring

Figure 2

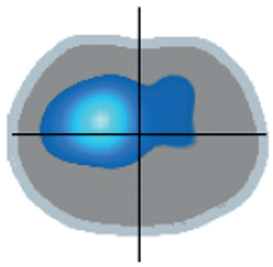


Figure 2:
Asymmetric ventilation with 78% directed towards the right lung and 64% towards the ventral region.

Intervention

a) The effect of ventilation optimization with ENLIGHT PEEP titration tool

- Decremental PEEP titration 2 cmH_2O every 30s (Figure 3)
- Ideal PEEP was identified as the intersection between colapse and hyperdistension

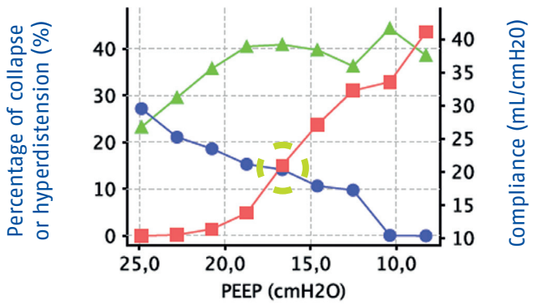


Figure 3:
A decremental PEEP titration guided by EIT (PEEP titration tool) identified an ideal PEEP of 17 cmH_2O ($PEEP_{EIT}$).

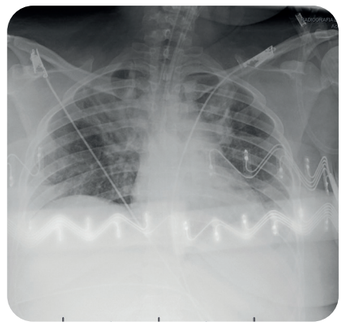


Figure 4: Follow-up chest X-ray on Day 2 showed significant improvement of alveolar infiltrates.

Results

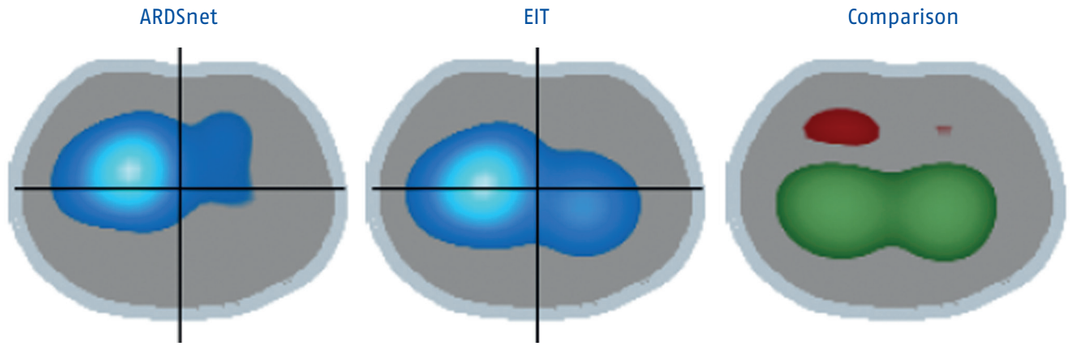


Figure 5:
Differential image between PEEP ARDSnet and PEEP EIT, showing an improvement of compliance on the dependent region.

Table 1

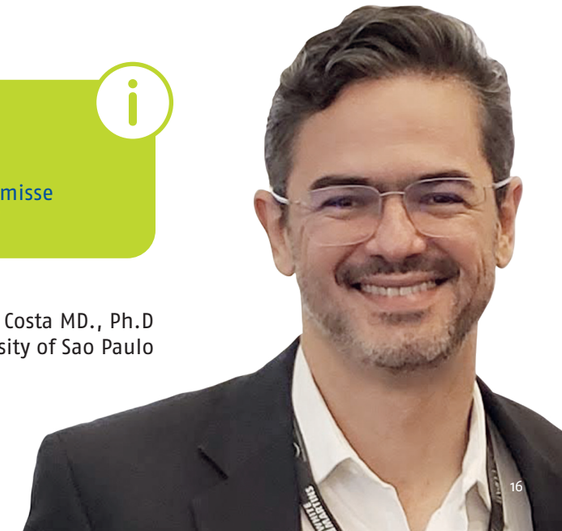
Show the PEEP ARDSnet vs PEEP EIT with improve in asymmetry (A/P/R/L), reduction in driving pressure, improve in compliance and P/F ratio

	PEEP (cmH_2O)	A/P (%)	R/L (%)	Driving Pressure (cmH_2O)	C_{RS} (mL/cmH_2O)	P/F ratio (mmHg)
$PEEP_{ARDSNet}$	10	64/36	78/22	14.9	26	93
$PEEP_{EIT}$	17	40/60	68/32	11.5	38	224

Take home message

"Monitoring PEEP titration with EIT,
it is possible to identify the best compromisse
between hyperdistension and collapse."

Prof. Eduardo Costa MD., Ph.D
Respiratory ICU, University of Sao Paulo



Cases – Ventilation optimization with ENLIGHT PEEP titration tool in prone position

Introduction

Case briefing
- 61-yo BMI 36 Kg/m2 with ARDS due to COVID-19
- Progression of respiratory failure → Mechanical Ventilation with PEEP = 14
- Initial P/F ratio 60 mmHg

Complete Care
- Bronchoscopy – clear bronchial tree
- Monitoring with ENLIGHT showed asymmetric ventilation (Figure 1)

Ventilation optimization – ENLIGHT monitoring

Figure 1

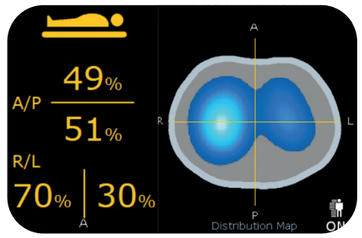


Figure 1:
Asymmetric ventilation in right / left lung in supine position

Intervention

a) The first PEEP titration in supine position

- Decremental PEEP titration 2 cmH_2O every 30s. Ideal PEEP was identified on the crossing point between collapse and hyperdistension in both supine and prone positions (figure 2 and 5)
- Hypoxemia with P/F 132

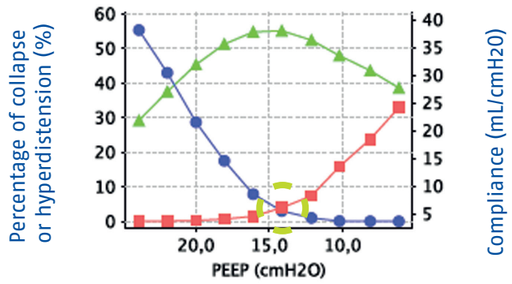


Figure 2
A decremental PEEP titration guided by ENLIGHT (PEEP titration tool) identified an ideal PEEP of 14 cmH_2O in supine position.

b) The effect of proning on ventilation with the same PEEP found in supine position

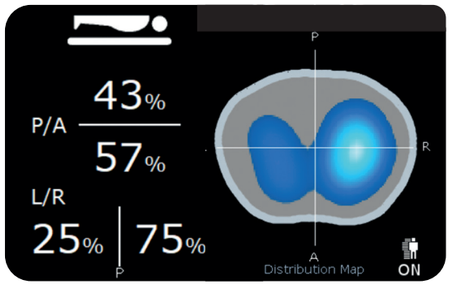


Figure 3
Less ventilation in non dependent region in prone position.

c) After 10 hours patient returns to supine position

Ventral ventilation predominant (figure 4)

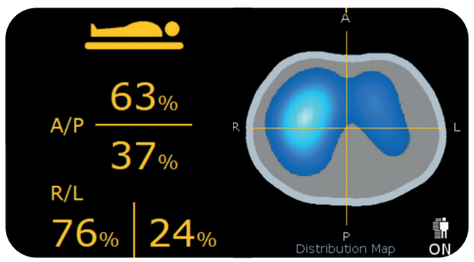


Figure 4
After the first prone

d) Decided to prone the patient again because of persistent of ventilation asymmetry.

PEEP titration was performed in prone position. It was found that the ideal PEEP was 6cmH_2O higher (20cm H_2O)

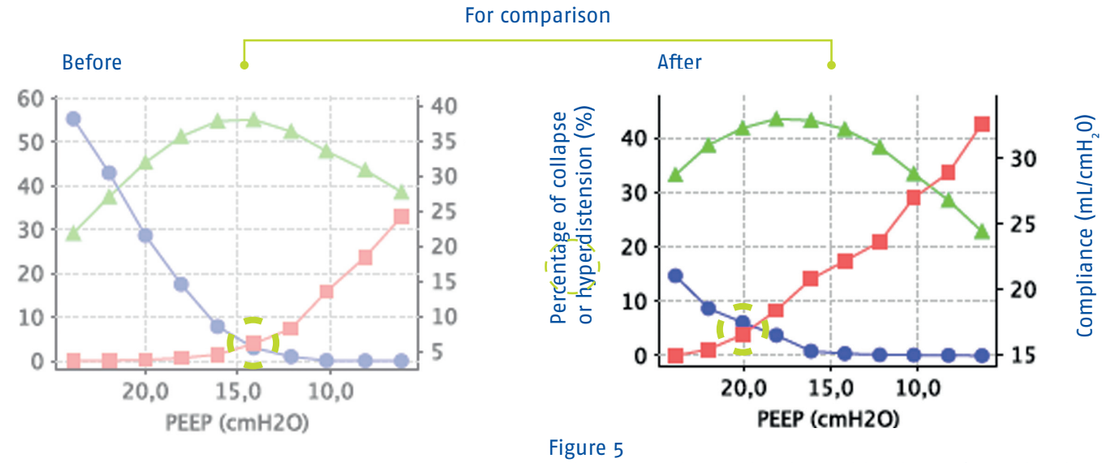


Figure 5
A decremental PEEP titration guided by EIT (PEEP titration tool) identified an ideal PEEP of 20cmH_2O.

Results

After 10 hours patient returns to supine position

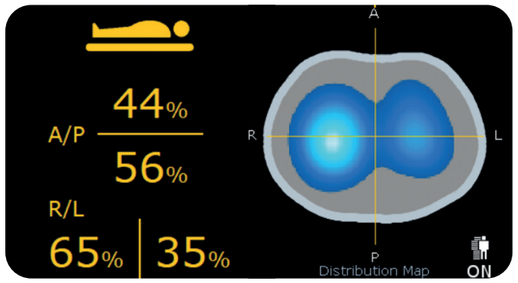


Figure 6
After the second prone, ventilation became more homogeneous

Take home message

"We realized there are many benefits from a new PEEP titration during prone positioning, improving mechanics and ventilation distribution while still in the prone position. EIT helped us to understand why some patients do not improve in the prone position and some are even worse after a full session in prone."

Prof. Marcelo Amato MD., Ph.D
Respiratory ICU University of Sao Paulo

References

- Costa, E.L.V., et al, Bedside estimation of recruitable alveolar collapse and hyperdistension by electrical impedance tomography. Intensive Care Med (2009) 35:1132–1137
- Pereira, S.M., et al; Individual Positive End-expiratory Pressure Settings Optimize Intraoperative Mechanical Ventilation and Reduce Postoperative Atelectasis. Anesthesiology 2018; 129:1070–1081
- Florio, G. et al; A lung rescue team improves survival in obesity with acute respiratory distress syndrome. Critical Care 2020; 24:4
- Mlček, M., et al. Targeted lateral positioning decreases lung collapse and overdistension in COVID-19-associated ARDS. BMC Pulm Med (2021) 21:133

TIMPEL

PRECISION VENTILATION

*The clinical cases are only illustrative examples of the use of ENLIGHT.
They do not serve as a clinical guideline or recommendation of standard operating procedures.

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