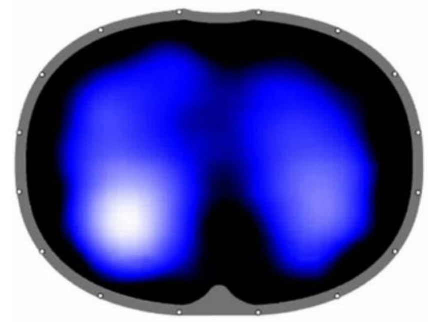
Société de Kinésithérapie de Réanimation

CENTRE HOSPITALIER UNIVERSITAIRE BORDEAUX

DU MKREA 2024

Tomographie par Impédance Electrique

Principe, Mise en place et Applications Cliniques pour le MKREA



Alexandre GARCIA MKDE

CHU de Bordeaux - Magellan

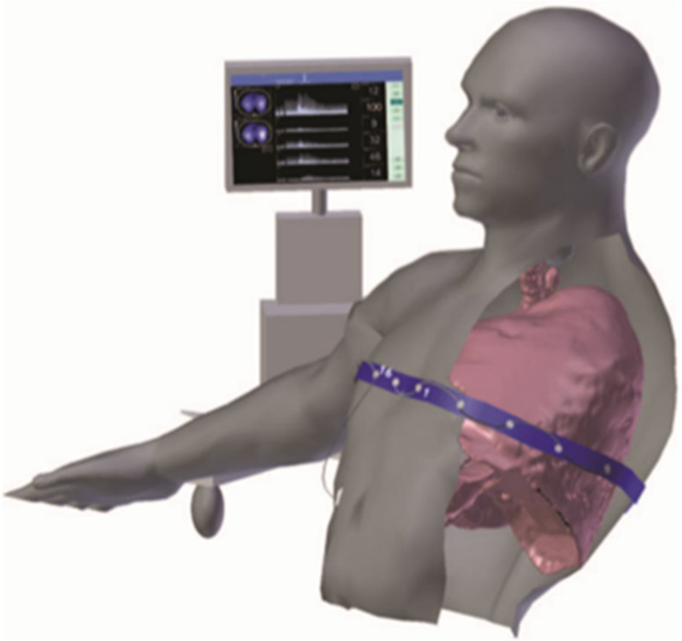
Réanimation Chirurgicale

Thoracique & Digestive

Pas de Conflits d'Intérêts

TIE
Tomographie par impédance électrique

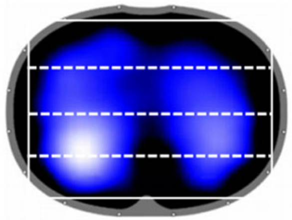
Monitorage de la fonction pulmonaire
impédancemétrie



Rowley et al. 2019

- **Non invasive**
- **Au lit du patient**
- **Dynamique**
- **Validé**

Distribution de l'impédance
=
Distribution de l'air



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mid-ventral	38%
mid-dorsal	40%
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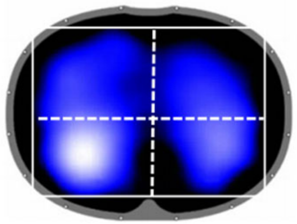


right upper	25%
right lower	30%
left upper	22%
left lower	23%

Shono et Kotani 2019

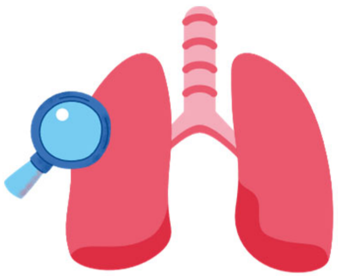
TIE & MKDE

Tomographie par impédance électrique

Evaluation des pratiques

Recherche

Pratique Clinique



Individualisation du soin

TIE

OBJECTIFS PEDAGOGIQUES

- S'approprier les bases de fonctionnement TIE
- Connaître les étapes de mise en place TIE
- Interpréter les mesures TIE et connaître leurs limites

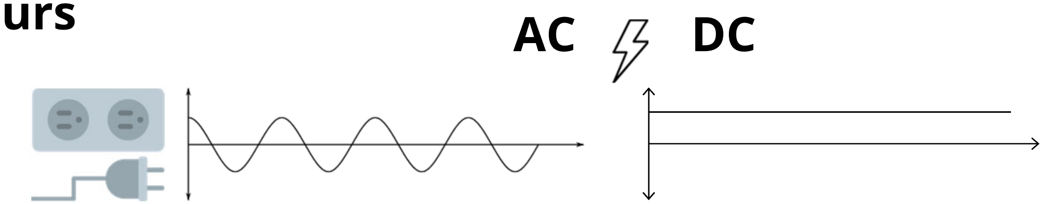
- Place du TIE dans la pratique clinique du MKREA ?
- Retour d'expérience

Principe de Fonctionnement

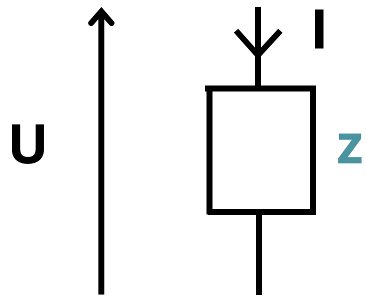
TIE

L'Impédance Z

Circuit électrique basique - **3 grandeurs**



- **Courant - I** (*Ampère*)
- **Tension - U** (*Volt*)
- **Impédance - Z** (*Ohm*)



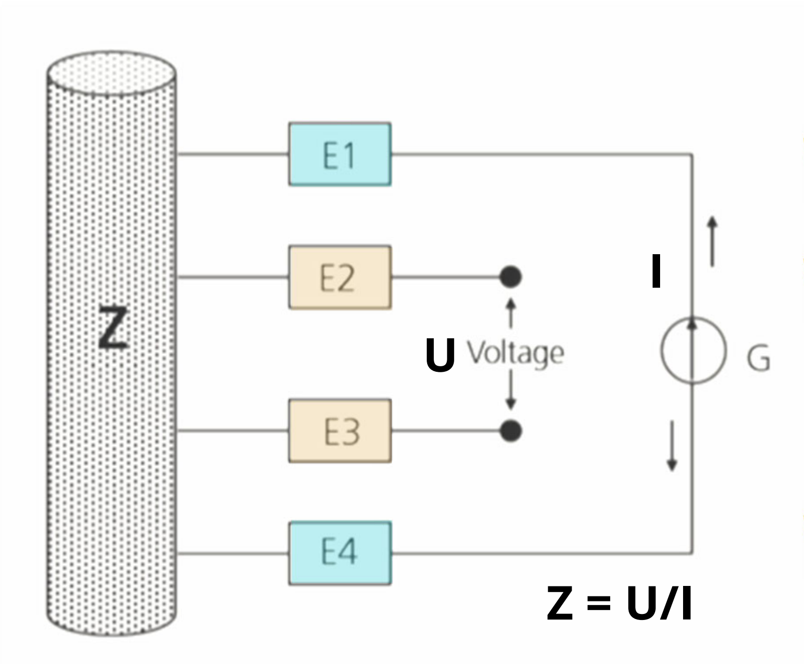
L'impédance est la propriété d'un système **à resister** au passage d'un **courant électrique alternatif**.

Loi d'Ohm - [U (volt) = Z (Ohm) * I (Ampère)]

TIE

Bio-impédance

La Bioimpédance (Ohm.m) : propriété d'un **tissu biologique à résister** au passage d'un **courant électrique alternatif**.



Sánchez-Iglesias, Fernández-Lucas, et Teruel 2012

Tissu biologique

- **Quantité de fluides**
- **Proportions d'électrolytes conducteurs (ions)**

Conditions de mesure

- **Fréquence & Direction du courant injecté**

TIE : historique

***Tomo-* "coupure" / *-graphe* "image"**

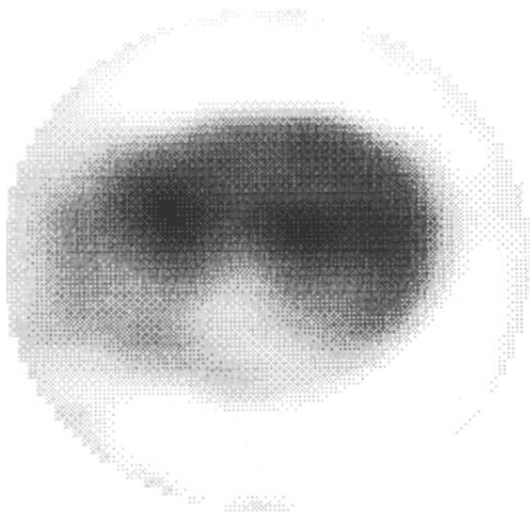


Figure 3. An applied potential tomography image of a forearm constructed from a 16-electrode circular array. The arm was placed into an 80 mm diameter saline-filled tank whose outline is visible on the image.

D C Barber & H B Brown

Distribution spatiale de l'**impédance** de tissus biologiques suivant une **coupe transversale**

TIE décrit pour la première fois en **1984**
D C Barber & H B Brown

Coupe Transversale d'un avant-bras

TIE

TIE du Thorax

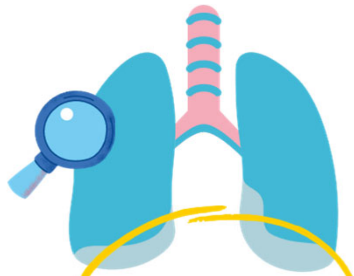
Table 1. Electrical resistivity of thoracic tissues.

Tissue	Resistivity (Ω·cm)
Blood	150
Lungs, inspiration	2400
Lungs, expiration	700
Heart muscle, longitudinal	125
Heart muscle, transversal	1800
Skeletal muscle, longitudinal	160–575
Skeletal muscle, transversal	420–5200
Fat	2000–2700
Bone	16,600

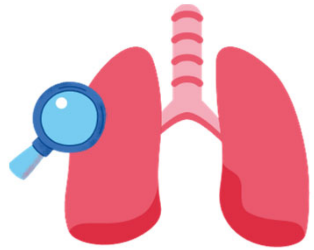
Putensen et al. 2019

Phénomènes Physiologiques

Variations d'Impédance



Ventilation



Perfusion

TIE

TIE du Thorax

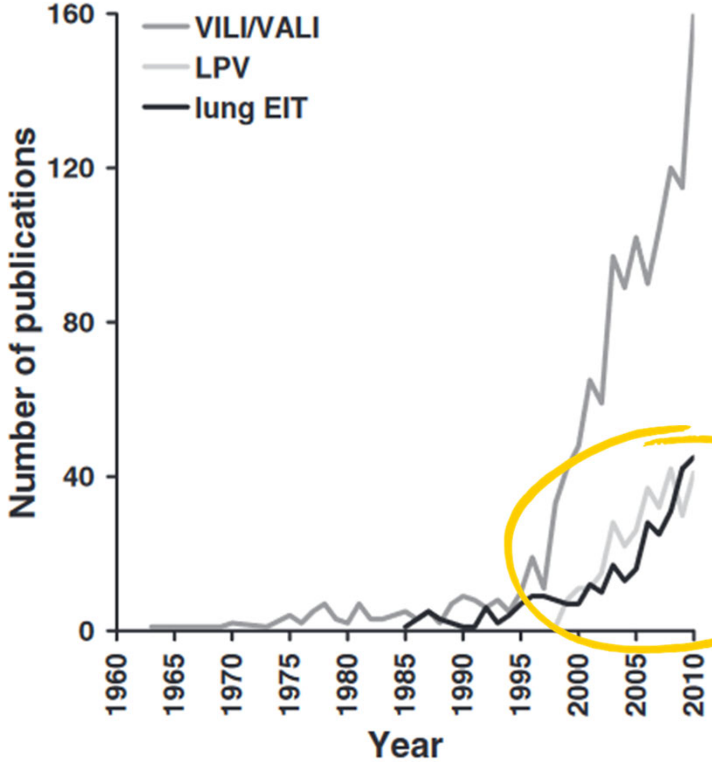


Figure 1. Number of publications on VILI/VALI, LPV and lung EIT published in peer-reviewed journals. (Source: ISI Web of Knowledge, Thomson Reuters, New York, USA.)

Adler et al. 2012

1995 Etude croissante des **VILI**

2000 Emergence de la **Ventilation Protectice**

Besoin de **caractériser la réponse régionale du poumon** à la **ventilation mécanique**

Developpement des **outils** de **monitorage**

Guider les stratégies de soin

TIE

Dispositifs

Images issues de https://www.draeger.com/fr_fr/Products/PulmoVista-500

TIE

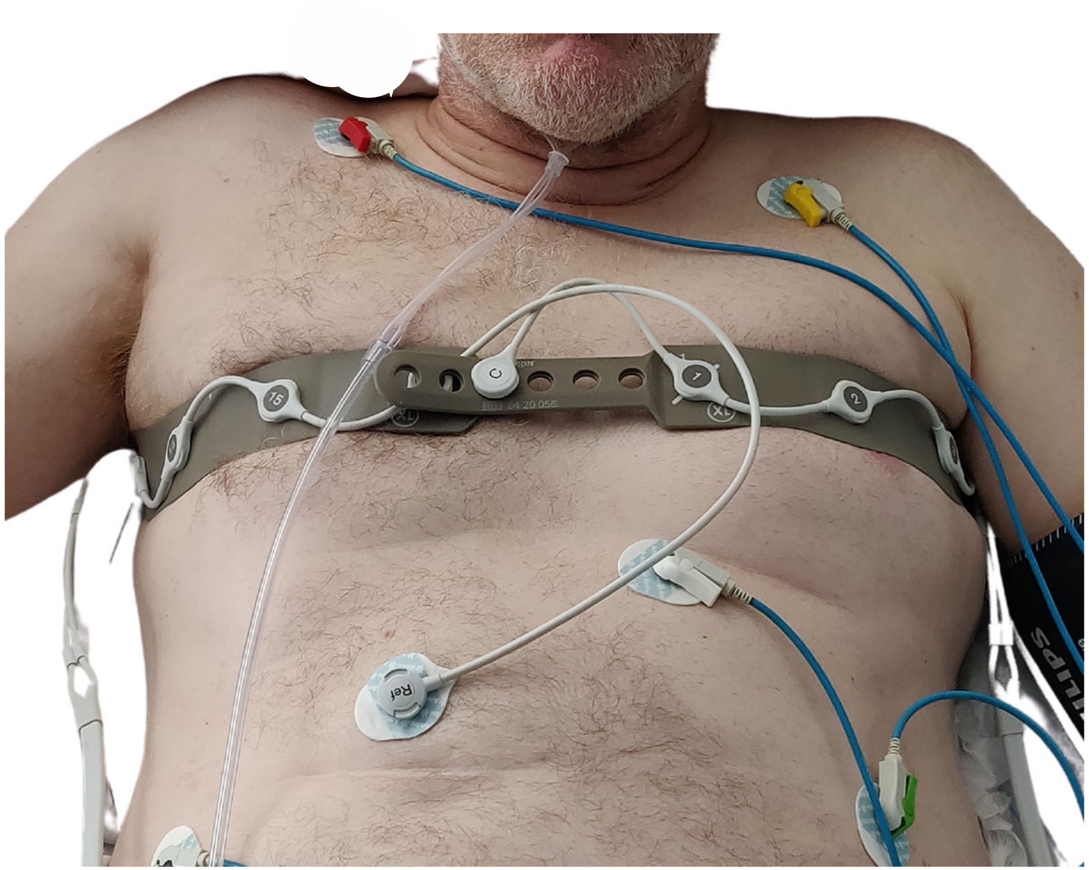
Dispositifs

Table 2. Commercially available electrical impedance tomography (EIT) devices.

Manufacturer	EIT System	Electrodes		Image Reconstruction Algorithm	Measurement and Data Acquisition
		Number	Configuration		
Swisstom AG	BB²	32	electrode belt	Graz consensus reconstruction algorithm for EIT (GREIT) algorithm for EIT (GREIT)	pair drive (adjustable skip) serial measurement
Timpel SA	Enlight	32	electrode stripes	Finite Element Method-based Newton-Raphson method	pair drive (3-electrode skip) parallel measurement
CareFusion	Goe-MF II	16	individual electrodes	Sheffield back-projection	pair drive (adjacent) serial measurement
Dräger Medical	PulmoVista 500	16	electrode belt	Finite Element Method-based Newton-Raphson method	pair drive (adjacent) serial measurement
Maltron Inc	Mark 1	16	individual electrodes	Sheffield back-projection	pair drive (adjacent)
	Mark 3.5	8	individual electrodes		serial measurement

Putensen et al. 2019

TIE
Mesure & Acquisition des données



Positionnement de la ceinture

Karsten J et al. 2016

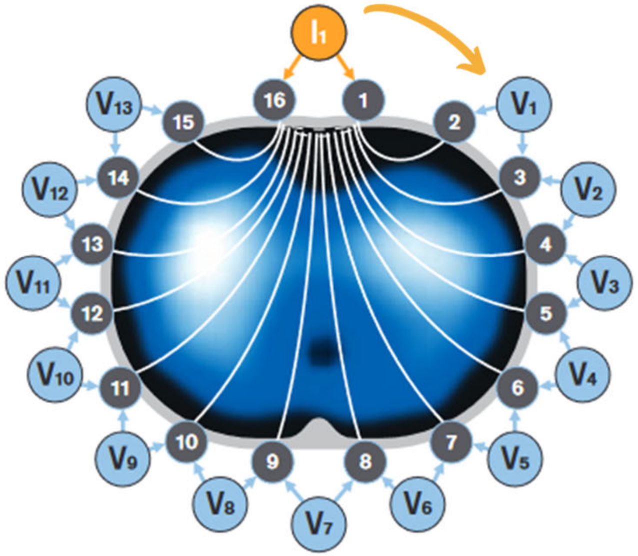
- → **4 - 6ème** espace intercostal
- → **Ligne parasternale**
- → **Contact peau**

Perturbation des mesures

- → Pansements, fils de sutures,
- → **Mouvements, paroles**

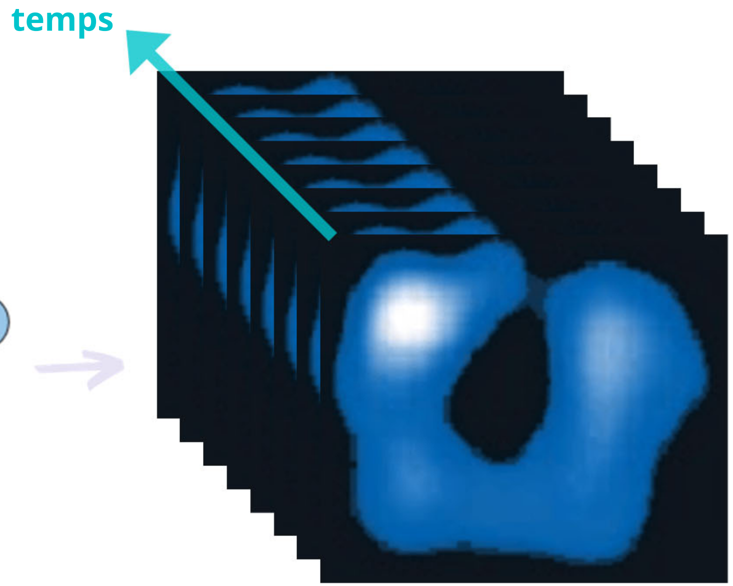
TIE

Mesure & Acquisition des données



Teschner, Imhoff, et Leonhardt, s. d.

Acquisition
Z=V/I

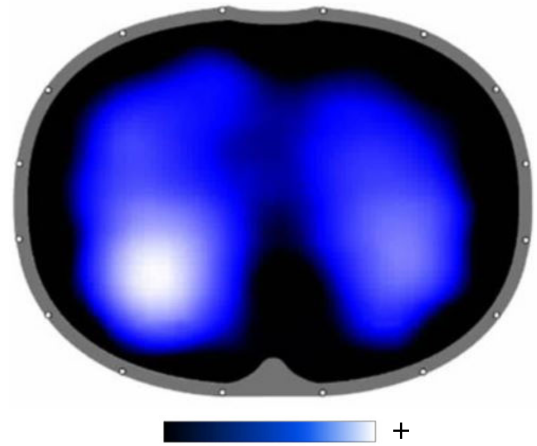


Teschner, Imhoff, et Leonhardt, s. d.

Génération images 2D
32x32 pixels

Imagerie relative

Variation Impédance
fin d'inspiration



Shono et Kotani
2019

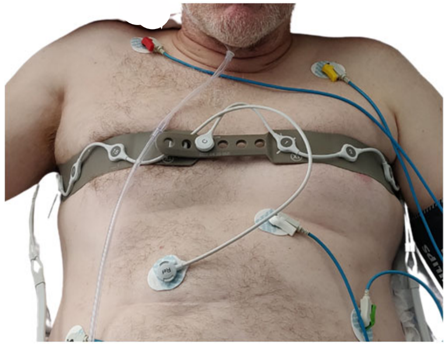
Frame rate 25/sec

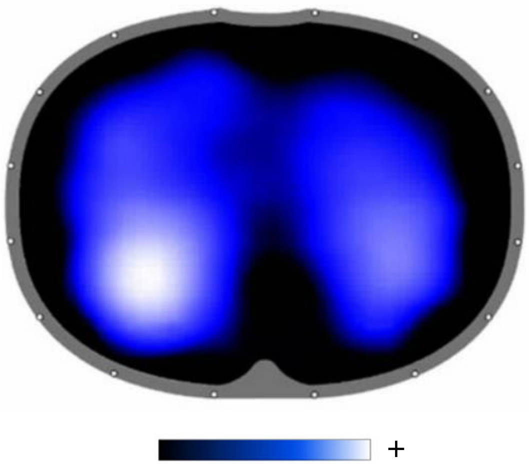
Variation d'impédance = Variation de volume

Van Genderingen et al. 2003

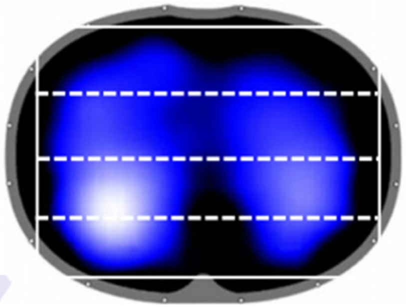
TIE

Analyse Régionale





Shono et Kotani
2019



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mid-dorsal	40%
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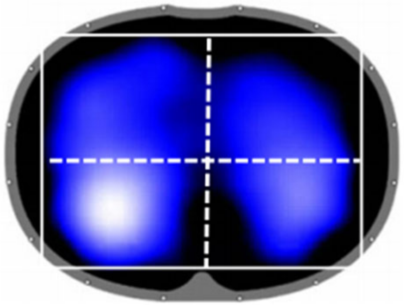

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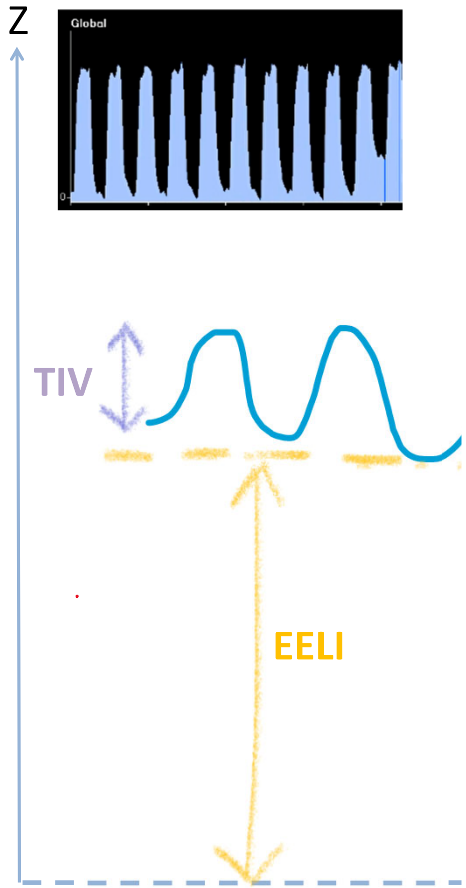
right lower	30%
left upper	22%
left lower	23%

TIE

Données TIE Monitorées



TIV

Tidal Impedance Variation

→ reflet du **Vt**

Van Genderingen et al. 2003

VENTILATION

EELI

End Expiratory Lung Impedance

→ reflet **EELV** : **CRF**

Hinz et al. 2003

AERATION

TIE

Données TIE Monitorées

TIV

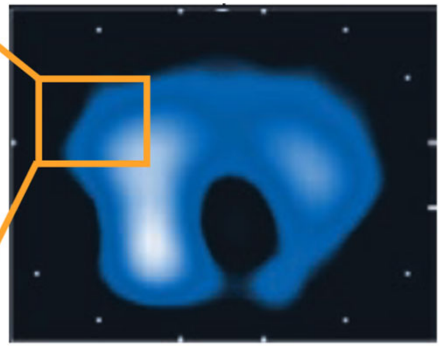
Tidal Impedance Variation

→ reflet du **Vt**

Van Genderingen et al. 2003

VENTILATION

4,7	5,0	5,1	5,8	6,3
5,4	5,9	6,9	7,7	7,2
6,1	7,4	8,6	9,5	11,3
6,8	8,6	9,5	12,8	15,4
7,3	8,9	10,4	14,5	16,1



Teschner, Imhoff, et Leonhardt, s. d.

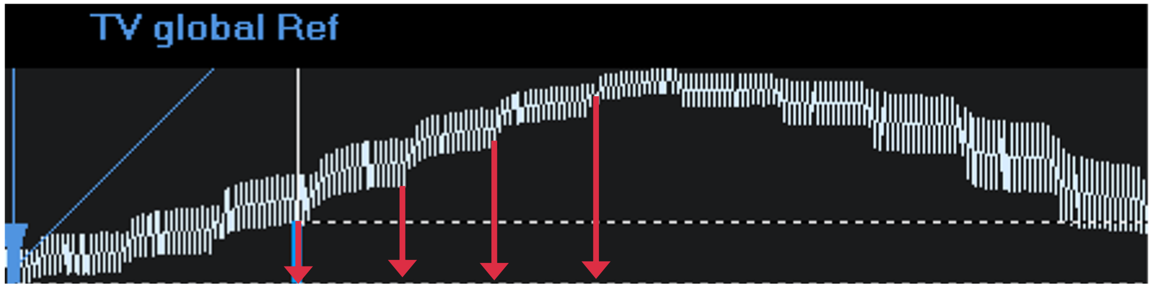
EELI

End Expiratory Lung Impedance

→ reflet **EELV** : **CRF**

Hinz et al. 2003

RECRUTEMENT



TIE

Données TIE Monitorées

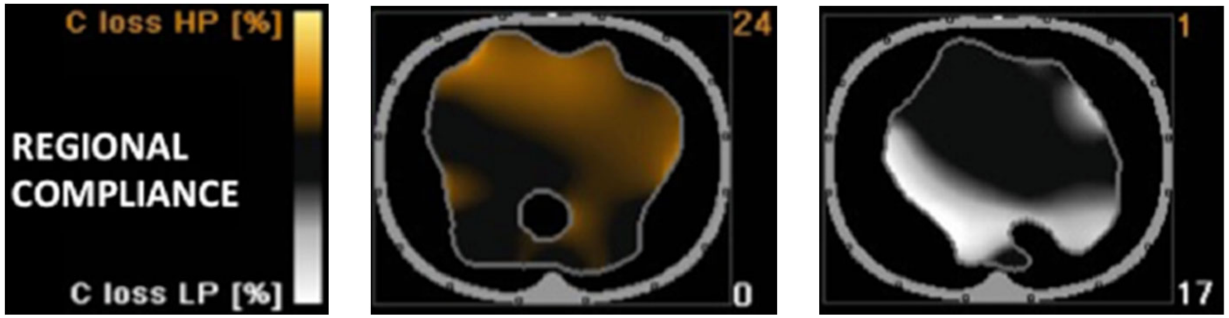
Intubé / Ventilé

Regional Respiratory System Compliance

→ Compliance régionale : <u>TIV pixel / Pression Motrice globale</u>

→ **Estimation des zones Surdistendues / Collabées (atelectasiées)** Costa et al. 2009

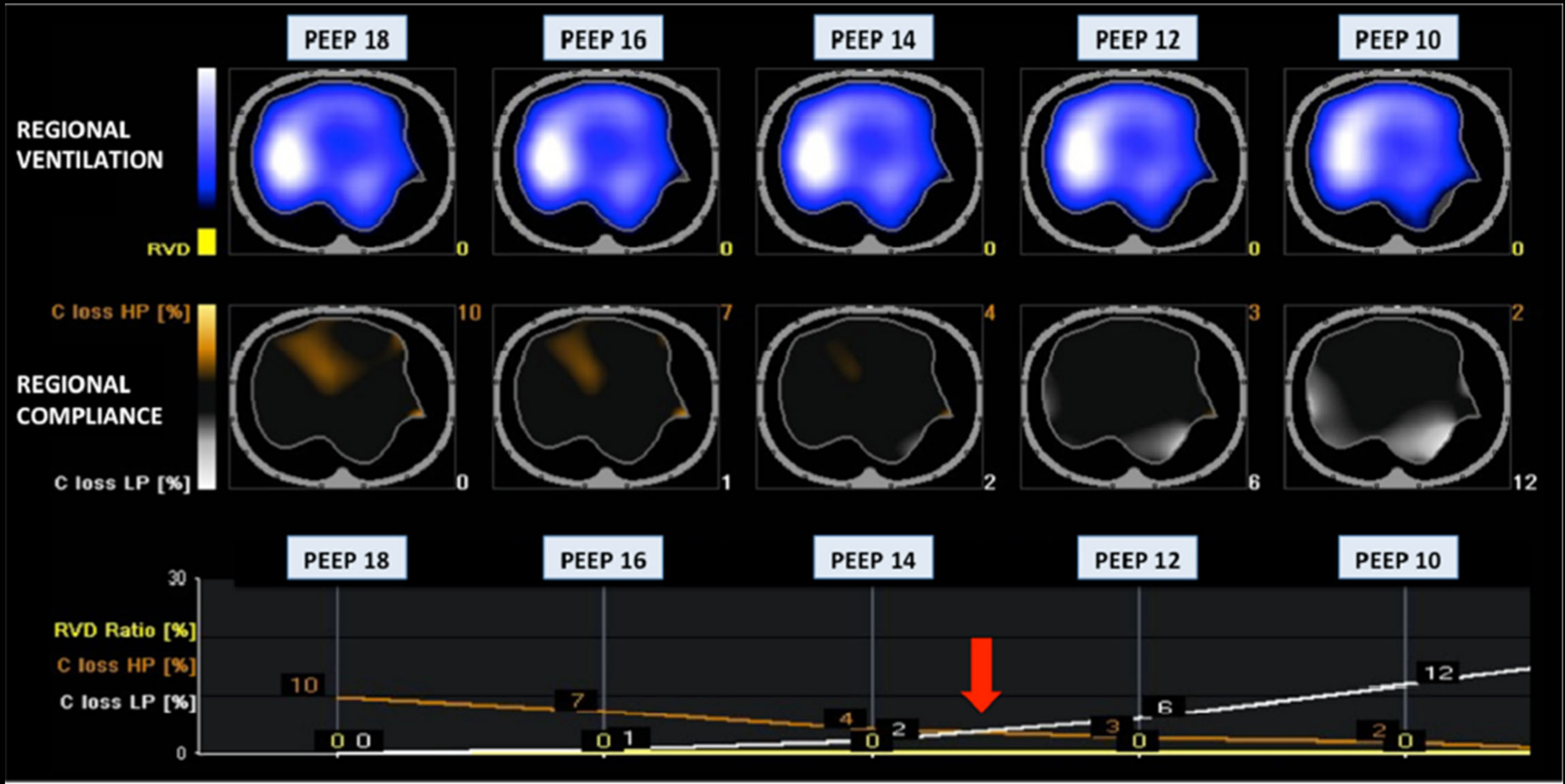
PEEP 18 **PEEP 10**



Surdistention **Atelectasie**

Sella et al. 2020

Titrage PEEP
SDRA
ECMO



Sella et al. 2020

TIE

Données TIE Analysées

G.I

Global Inhomogeneity index Zhao et al. 2009

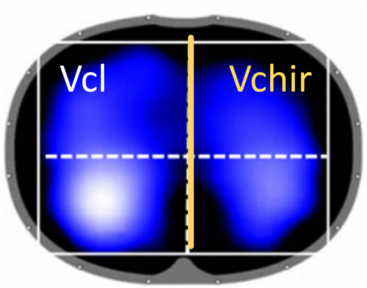
→ Reflet de l'hétérognéité de la distribution du TIV = Vt

Homogénéité de la Ventilation

RV

Ratio de Ventilation

→ Observation de la redistribution de la ventilation suivant des zones d'interêts



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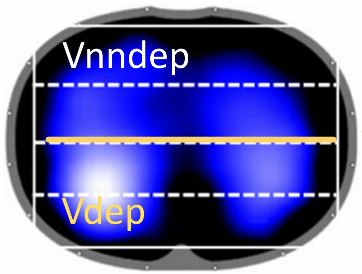


ventral	10%
mid-ventral	38%
mid-dorsal	40%
dorsal	12%

\- Shono et Kotani 2019 +

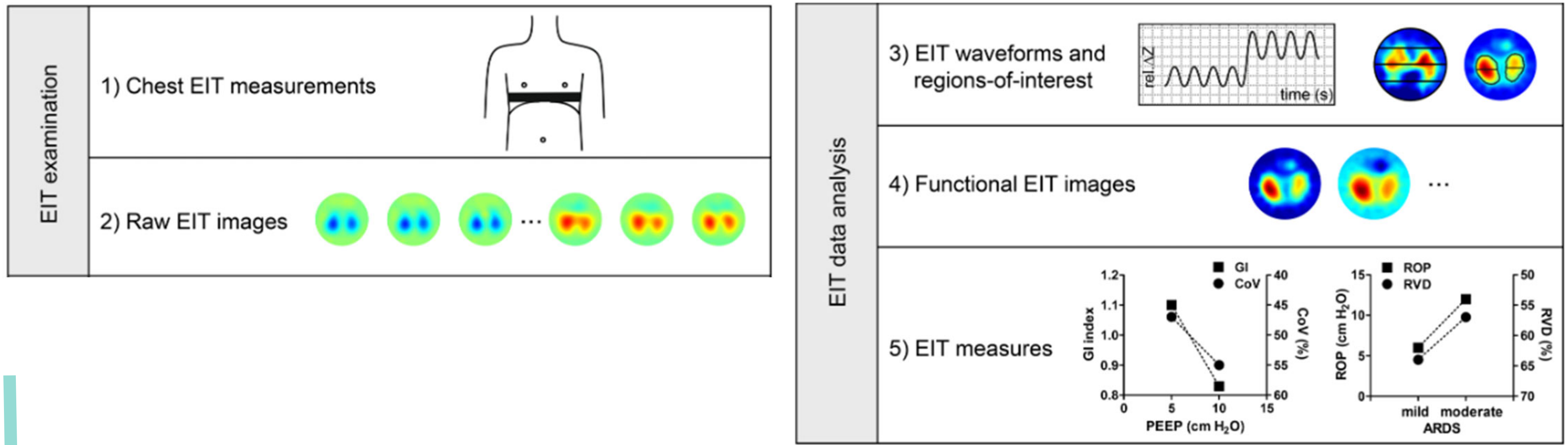
TIE
Monitorage de la fonction Pulmonaire

OPEN ACCESS

Chest electrical impedance tomography examination, data analysis, terminology, clinical use and recommendations: consensus statement of the TRanslational EIT developmeNt stuDy group

Examination du patient

Analyse des données



Frerichs et al. 2017

Mise en Place

TIE

Mise en Place

Taille de la ceinture

Humidification des électrodes

Placement ceinture

Référence

Connexion à la centrale

Mise en route TIE

Contre-Indication ?

- **DM actif** : Pacemaker, défibrillateur
- **Etat cutanée endommagé, pansement sur la zone d'observation**
- **Risque lié à la mise en place de la ceinture** (fracture, lésions spinales, etc.)
- **Mouvement incontrôlables**
- **Electrothérapie en cours**
- Présence d'un champ magnétique (**IRM**)
- **Volume courant < 1 ml/kg**
- **IMC > 50 kg.m-2**

TIE

Mise en Place

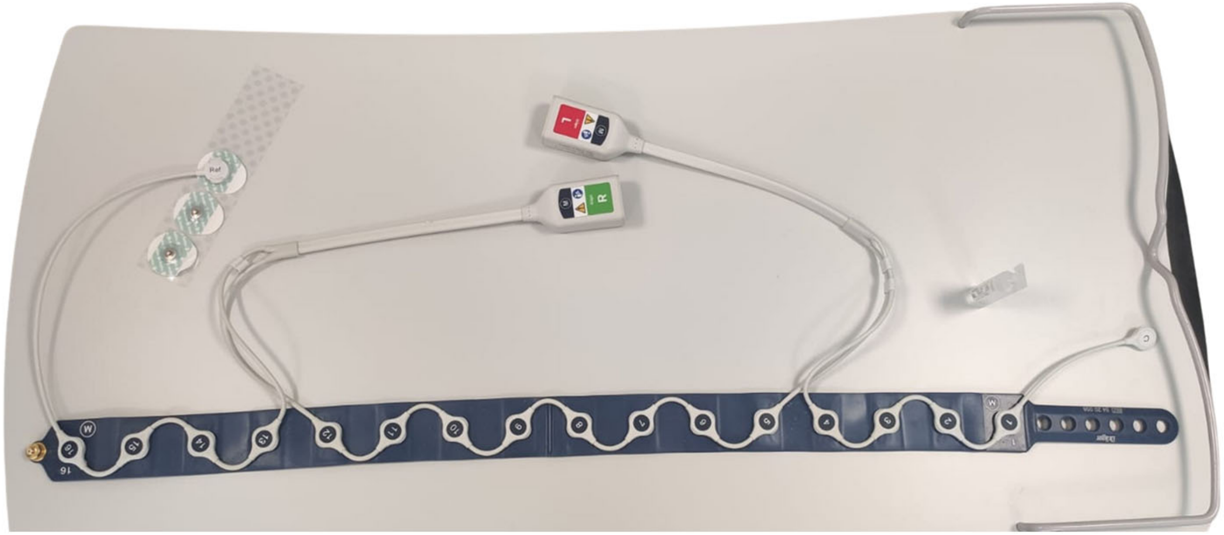
- Taille de la ceinture
- Humidification des électrodes
- Placement ceinture
- Référence
- Connexion à la centrale
- Mise en route TIE

S M L XL XXL

TIE

Mise en Place

- Taille de la ceinture
- Humidification des électrodes
- Placement ceinture
- Référence
- Connexion à la centrale
- Mise en route TIE



TIE

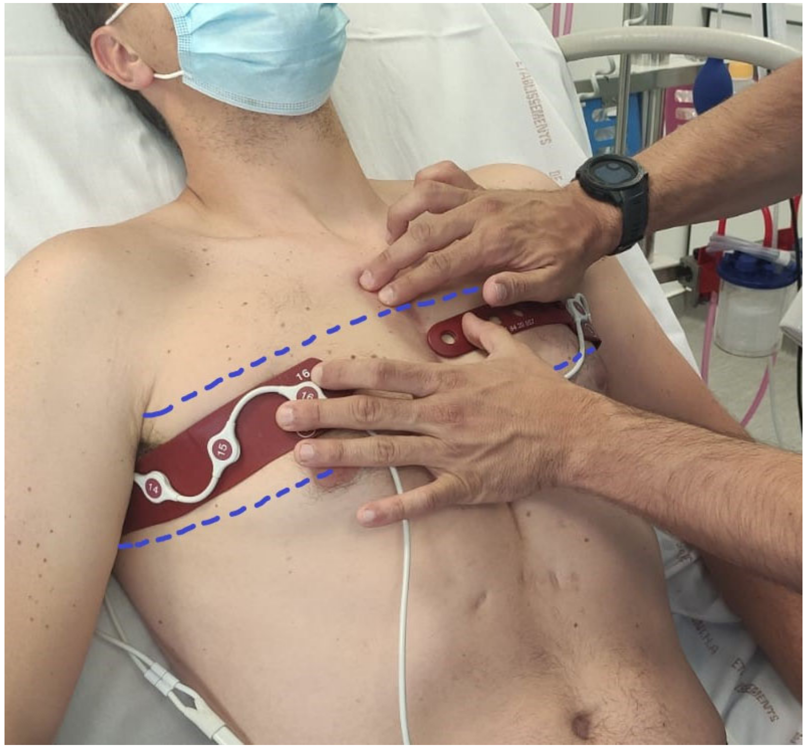
Mise en Place

- Taille de la ceinture ✓
- Humidification des électrodes
- Placement ceinture
- Référence
- Connexion à la centrale
- Mise en route TIE

TIE

Mise en Place

- Taille de la ceinture ✓
- Humidification des électrodes ✓
- Placement ceinture
- Référence
- Connexion à la centrale
- Mise en route TIE



4-6ème espace intercostale

TIE

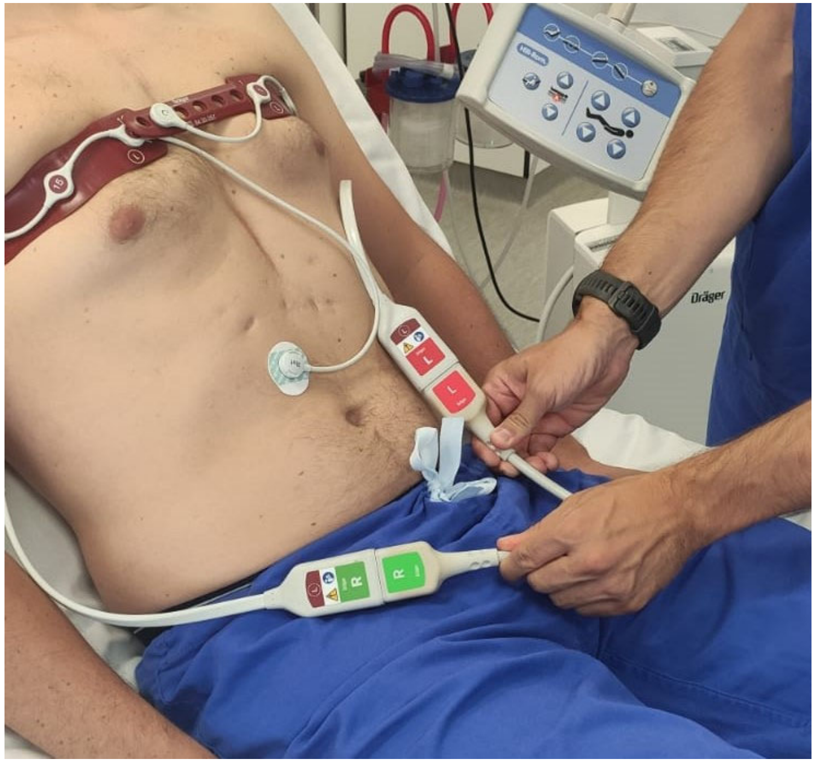
Mise en Place

- Taille de la ceinture ✓
- Humidification des électrodes ✓
- Placement ceinture ✓
- Référence
- Connexion à la centrale
- Mise en route TIE

TIE

Mise en Place

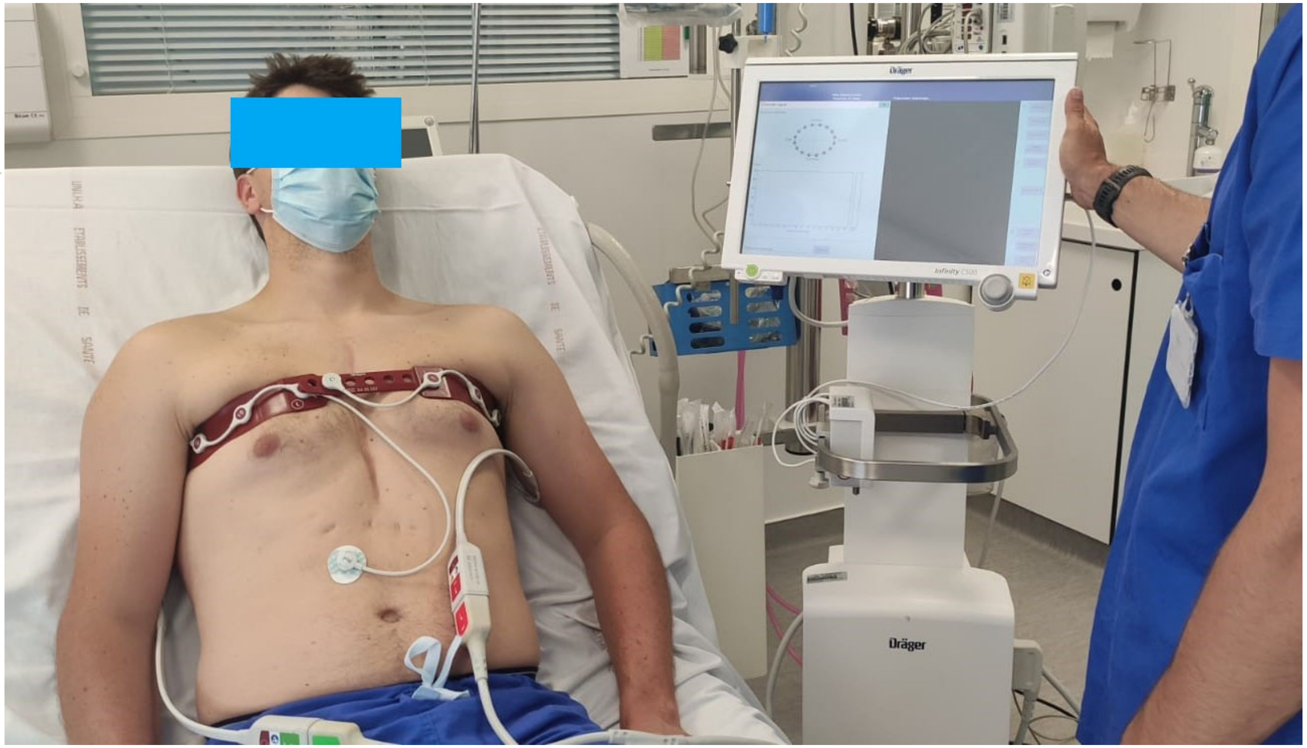
- Taille de la ceinture ✓
- Humidification des électrodes ✓
- Placement ceinture ✓
- Référence ✓
- Connexion à la centrale
- Mise en route TIE

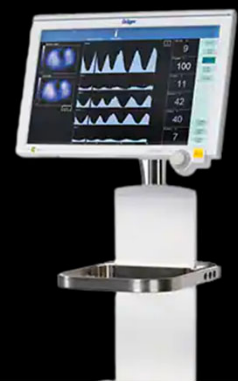


TIE

Mise en Place

- Taille de la ceinture ✓
- Humidification des électrodes ✓
- Placement ceinture ✓
- Référence ✓
- Connexion à la centrale ✓
- Mise en route TIE





TIE

Intérêts pour le MKREA

Recherche

&

Applications Cliniques

TIE

Intérêts pour le MKREA

OUTIL DE MONITORAGE

- Non invasive
- Dynamique
- Au lit du patient
- Validé

OBSERVATION DE LA DISTRIBUTION DE LA VENTILATION EN TEMPS RÉÉL

ANALYSE FONCTIONNELLE DES RÉGIONS PULMONAIRES DISTINCTES
RECRUTEMENT / COMPLIANCE

ANALYSE DE LA RÉPONSE DES RÉGIONS PULMONAIRES À DIFFÉRENTES MESURES THÉRAPEUTIQUES

TIE

Recherche Clinique

Etudes Physiologiques | **Evaluation des pratiques** | **Applications Cliniques**

→ **TIE & Thérapie d'Expansion Pulmonaire**	Reychler et al. 2018 Rowley et al. 2019
→ **TIE & Mobilisation précoce**	Hickmann et al. 2020 Yuan et al. 2021 Eimer et al. 2021
→ **TIE & Positionnement**	Lehman et al. 2018 Riedel et al. 2005
→ **TIE & VNI**	Pérez-Teran et al. 2019 Bordes et al. 2016
→ **TIE & Sevrage Ventilatoire**	Wang et al. 2021 Longhini et al. 2019
→ **TIE & OHDN**	Mauri et al. 2017 Zhang et al. 2020 Yuan et al. 2020
→ **TIE & Pédiatrie**	Thomson et al. 2020

Aspiration EndoTrachéale

Evaluation des pratiques

End-expiratory lung volume recovers more slowly after closed endotracheal suctioning than after open suctioning: A randomized crossover study☆

Amanda Corley RN, BN, GradCertHSci[a,*], Amy J. Spooner RN, BN, GradDipICU[a], Adrian G. Barnett BSc(Hon), PhD[b], Lawrence R. Caruana BPty[a], Naomi E. Hammond RN, BN, MN, MPH[a], John F. Fraser MBChB, PhD[a]

Circuit clos Vs **ouvert**
20 patients
post-chirurgie cardiaque

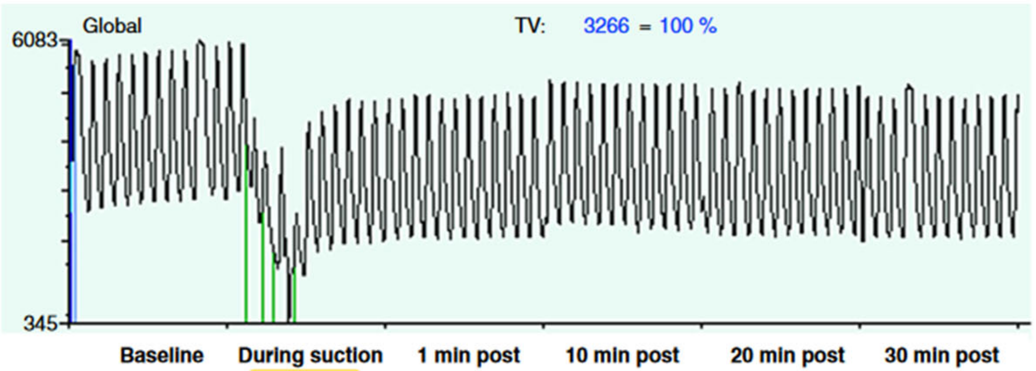


Fig. 3 Representative recording of lung volume loss during CS and recovery postsuction.

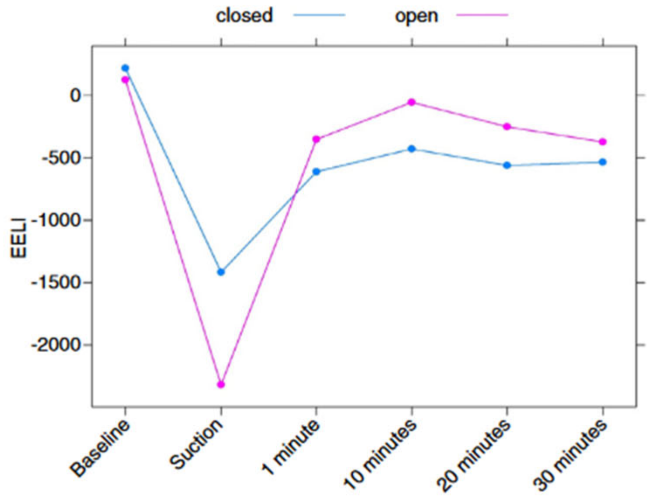


Fig. 4 Mean changes in EELI by suction method demonstrating slower recovery after CS.

→ Propose une manoeuvre de recrutement post-aspi

Oxygénation à Haut Débit Nasal (OHND)

Etude physiologique

Physiologic Effects of High-Flow Nasal Cannula in Acute Hypoxemic Respiratory Failure

Tommaso Mauri[1,2], Cecilia Turrini[1,3], Nilde Eronia[4], Giacomo Grasselli[1], Carlo Alberto Volta[3], Giacomo Bellani[4,5], and Antonio Pesenti[1,2]

15 patients en **IRA Hypoxémique -** P/F < 300

Cross over :
20 min **OHDN 40 L/min**
20 min **masque facial 12L/min**

↘ FR ↘ travail respiratoire ↗ P/F

- **Recrutement (EELI)** = **effet PEEP**
- **Homogénéisation** de la ventilation
- Sans modification du Vt

→ Limitation des zones de distentions au sein du parenchyme

Table 3. Effects of HFNC on Lung Aeration, Homogeneity, and Respiratory Pattern

Variable	Oxygen Facial Mask	High-Flow Nasal Cannula	*P* Value*
$\Delta EELI_{glob}$ (change from facial mask), % of baseline V_T	—	51 ± 57	<0.001
$\Delta EELI_{non\text{-}dep}$ (change from facial mask), % of baseline V_T	—	29 ± 36	≤0.001
$\Delta EELI_{dep}$ (change from facial mask), % of baseline V_T	—	26 ± 33	≤0.01
GI index	0.50 (0.49 to 0.57)	0.47 (0.43 to 0.60)	<0.01
PIF_{glob} (change from facial mask), %	—	−15 ± 23	0.07
PEF_{glob} (change from facial mask), %	—	−27 ± 22	≤0.001
$PIF_{non\text{-}dep}$ (change from facial mask), %	—	−11 ± 29	0.29
PIF_{dep} (change from facial mask), %	—	−20 ± 19	<0.01
$PEF_{non\text{-}dep}$ (change from facial mask), %	—	−19 ± 32	0.07
PEF_{dep} (change from facial mask), %	—	−34 ± 18	<0.001
Ti, s	1.2 ± 0.2	1.2 ± 0.3	0.84
Te, s	1.3 ± 0.2	1.5 ± 0.6	<0.05
Ti/Ttot	0.5 ± 0.0	0.4 ± 0.0	<0.05

Recherche Clinique

Oxygénation à Haut Débit Nasal (OHND)

Application Clinique

Effect of postextubation high-flow nasal cannula therapy on lung recruitment and overdistension in high-risk patient

Rui Zhang[1†], Huaiwu He[1†], Long Yun[1*], Xiang Zhou[1], Xu Wang[1], Yi Chi[1], Siyi Yuan[1] and Zhanqi Zhao[2,3]

24 patients post-extubation (24h) **réa post-chir** (dig, cardio, tho)

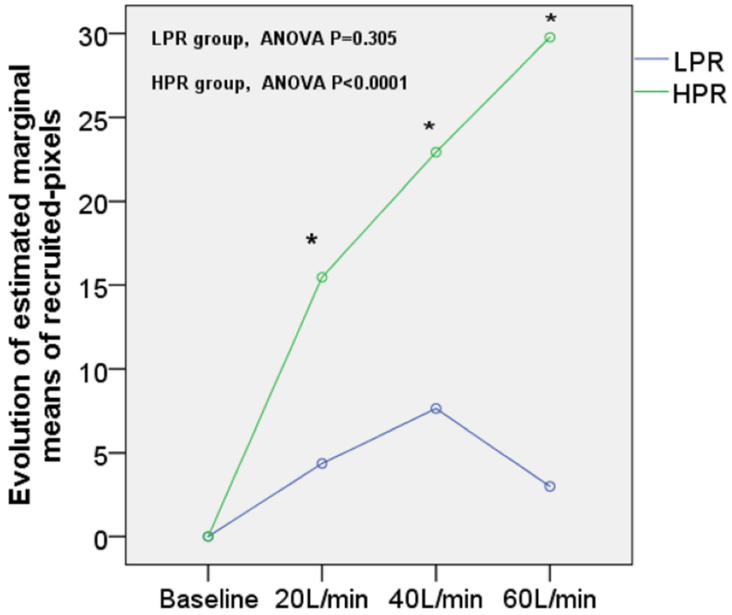
OHDN 0 L/min, 20min **20 L/m**, 20min **40 L/m**, 20min **60 L/m**

Analyse ventro-dorsal (4 ROI) : TIV & EELI

(13) HPR : >10 pixels **Surdistention : > 10 pixels**

(11) LPR : <10 pixels **aéré non ventilé**

Arbitraire Cut-off ?



- **Recrutement (EELI) ROI 3/4**
- Pas de différences P/F, ROX index entre HPR et LPB
- **OHDN surdistention pixels LPR (4/11) > HPR (0/13)**

→ **TIE monitorage OHDN = Individualisation**

Titrage OHDN

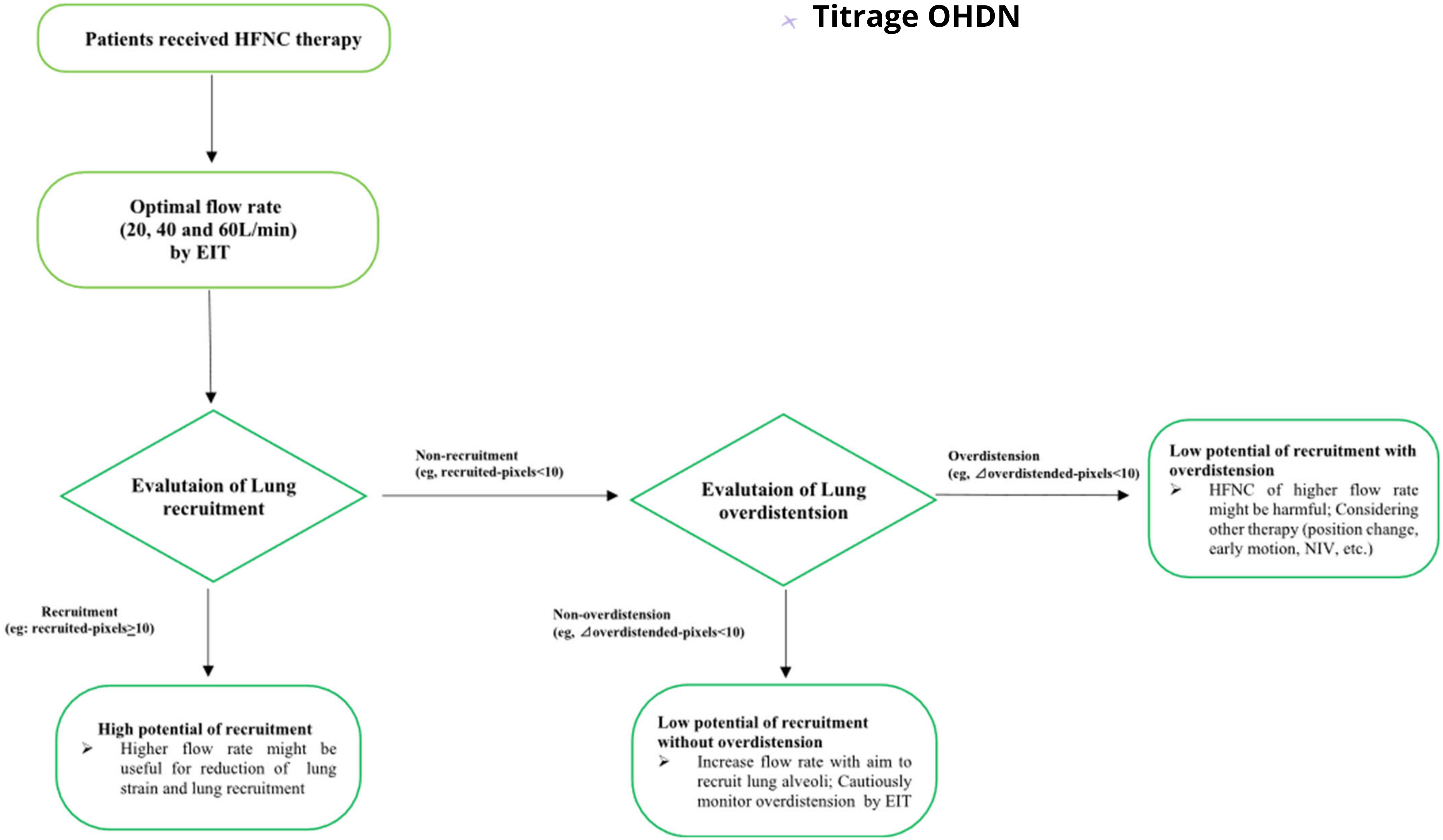


Fig. 3 Conceptual schematic for using EIT to guide HFNC therapy. NIV, non-invasive ventilation

Zhang et al. 2020

Recherche Clinique

Mobilisation Précoce

Etude physiologique

The Effect of Physical Therapy on Regional Lung Function in Critically Ill Patients

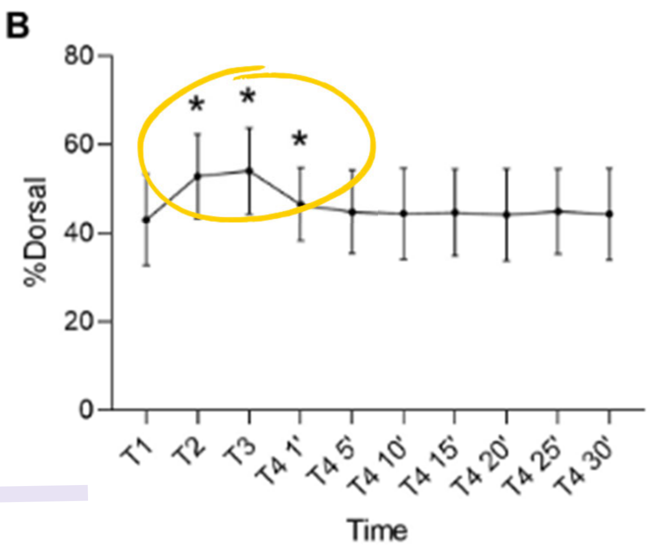
Christine Eimer†, Katharina Freier†, Norbert Weiler, Inéz Frerichs and Tobias Becher*

Department of Anaesthesiology and Intensive Care Medicine, University Medical Centre Schleswig-Holstein, Kiel, Germany

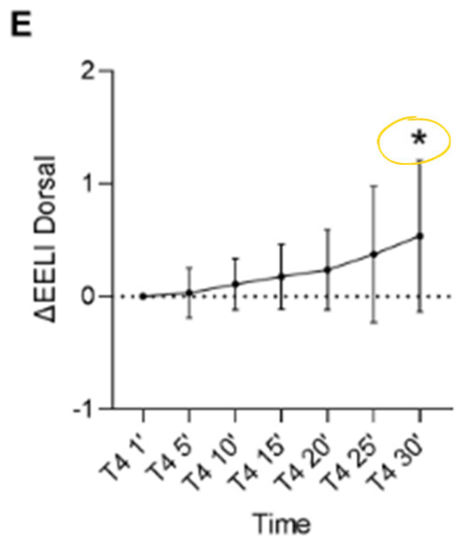
10 patients

réa post-chir (dig, tho, vasculaire) en **RS**

16 minutes d'exercice en moyenne



Redistribution de la **ventilation** dans les **territoires postérieurs Per-exercice**



Recrutement territoires postérieurs Post-exercice

Recherche Clinique

Mobilisation Précoce

Evaluation des pratiques

Acute Effects of Sitting Out of Bed and Exercise on Lung Aeration and Oxygenation in Critically Ill Subjects

Cheryl E Hickmann, Natalia R Montecinos-Munoz, Diego Castanares-Zapatero, Ricardo S Arriagada-Garrido, Ursula Jeria-Blanco, Timour Gizzatullin, Jean Roeseler, Jonathan Dugernier, Xavier Wittebole, and Pierre-François Laterre

Patients **réa dig, med**

fauteuil + AP 15’ **fauteuil seul**

17 **VM** 5 **VM**

23 **RS** 5 **RS**

EELI TIV GI | **P/F** GDS | DLR Perception

AP ↗ **Recrutement (EELI)** **Pendant et 20’ post-exercice**

exo passif

↗ **P/F** **Surtout chez P/F <200**

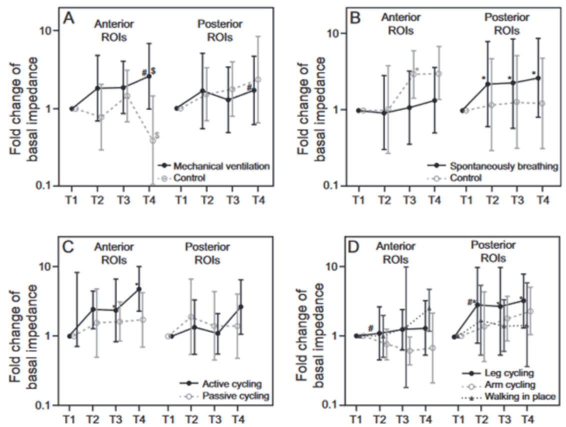


Fig. 2. Lung aeration in anterior and posterior ROIs. A: Mechanically ventilated vs mechanically ventilated control. B: Spontaneously breathing vs spontaneously breathing control. C: Subgroup of mechanically ventilated subjects performing active leg cycling vs mechanically ventilated subjects performing passive leg cycling. D: Subgroups of spontaneously breathing subjects performing three different activities: leg cycling, arm cycling, and walking in place. Values are geometric means (geometric SD) and are fold changes of impedance from basal (T1 = reference) to T2, T3, and T4. T1 = baseline in bed; T2 = sitting in chair; T3 = exercising (resting in chair in control groups); and T4 = resting in chair. *Values are significant vs T1. #Values are significant between anterior and posterior ROIs. $Values are significant between mechanically ventilated subjects and mechanically ventilated controls. ROI = region of interest.

Recherche Clinique

Sevrage Ventilatoire

Etude Physiologique / Application Clinique

Electrical impedance tomography during spontaneous breathing trials and after extubation in critically ill patients at high risk for extubation failure: a multicenter observational study

Federico Longhini[1], Jessica Maugeri[2], Cristina Andreoni[3], Chiara Ronco[1], Andrea Bruni[4], Eugenio Garofalo[4], Corrado Pelaia[4], Camilla Cavicchi[3], Sergio Pintaudi[2] and Paolo Navalesi[4*]

78 patients réa med

I/V > 48h

SBT 30 min - 2PEP 0AI

- Distribution **TIV%** - **EELI** - **GI index**
- FR - Vt - GDS

→ **SBT 0** - **SBT30** ✓ **SB 0** - **SB30**

Extubation

Table 3 EIT data in patients with SBT success and failure

	SBT success ($n=61$)			SBT failure ($n=17$)			Success vs. failure
	Baseline	SBT_0	SBT_30	Baseline	SBT_0	SBT_30	
ΔVt%	0 [0; 0]	−16.4 [−37.0; −2.5]	−12.9 [−35.0; 5.0]	0 [0; 0]	−27.6 [−51.0; −16.0]	−22.9 [−50.6; −13.3]	$p > 0.999^a$ $p = 0.079^b$ $p = 0.054^c$
ΔEELI (ml)	0 [0; 0]	−117 [−240; 21]	−103 [−292; 62]	0 [0; 0]	−456 [−934; −162]	−333 [−1375; −157]	$p > 0.999^a$ $p < 0.001^b$ $p = 0.001^c$
Inhomogeneity index	51 [44; 61]	56 [48; 71]	57 [46; 70]	65 [54; 87]	89 [61; 105]	90 [62; 101]	$p = 0.002^a$ $p = 0.003^b$ $p = 0.005^c$

SBT: Spontaneous Breathing Trial; SBT_0: first 5 min after the beginning of the SBT; SBT_30: last 5 min of the SBT; ΔVt%: change from baseline of the tidal volume in percentage; ΔEELI: change from baseline of the end-expiratory lung impedance

[a] Comparison between groups within baseline

[b] Comparison between groups within SBT_0

[c] Comparison between groups within SBT_30. According to Bonferroni correction, the threshold for statistical significance is $p < 0.017$

→ **Dérecrutement (EELI) et Ventilation Hétérogène**

Longhini et al . 2019

Table 4 EIT data in patients with extubation success and failure

	Baseline	SBT_0	SBT_30	SB_0	SB_30
ΔVt%					
Extubation success ($n=39$)	0 [0; 0]	−12 [−31; 0]	−9 [−29; 7]	−3 [−16; 18]	−12 [−34; 19]
Extubation failure ($n=22$)	0 [0; 0]	−25 [−42; −10]	−29 [−45; −11]	−21 [−39; 1]	−22 [−46; −11]
Extubation success vs. failure	$p>0.999$	$p=0.117$	$p=0.024$	$p=0.014$	$p=0.061$
ΔEELI (ml)					
Extubation success ($n=39$)	0 [0; 0]	−125 [−237; 23]	−78 [−250; 115]	−187 [−488; 82]	−60 [−371; 256]
Extubation failure ($n=22$)	0 [0; 0]	−112 [−316; 17]	−194 [−335; −59]	−236 [−438; 139]	−290 [−537; 152]
Extubation success vs. failure	$p>0.999$	$p=0.671$	$p=0.253$	$p>0.999$	$p=0.132$
Inhomogeneity index					
Extubation success ($n=39$)	46 [42; 63]	53 [44; 68]	56 [44; 70]	52 [45; 66]	53 [45; 69]
Extubation failure ($n=22$)	53 [48; 60]	65 [55; 80]	62 [54; 71]	64 [50; 79]	66 [55; 74]
Extubation success vs. failure	$p=0.166$	$p=0.025$	$p=0.132$	$p=0.049$	$p=0.029$

SBT: Spontaneous Breathing Trial; SBT_0: first 5 min after the beginning of the SBT; SBT_30: last 5 min of the SBT; SB_0: first 5 min of the spontaneous breathing; SB_30: last 5 min of the spontaneous breathing; ΔVt%: change from baseline of the tidal volume in percentage; ΔEELI: change from baseline of the end-expiratory lung impedance

According to Bonferroni correction, the threshold for statistical significance is $p<0.017$

→ **Pas de différences significatives ou de critères prédictifs (TIE et clinique) identifiés**

Longhini et al . 2019

TIE

Applications Cliniques

Intérêt MKREA

Guider les choix thérapeutiques
Evaluation efficacité
Individualisation

Intubé / Ventilé / Sédaté

- **Positionnement**
- **Désencombrement**
- **Réglage PEEP**

Pluridisciplinaire

Vigile / RS

- **Positionnement**
- **Technique de VNI**
- **Désencombrement**
- **BioFeedBack**

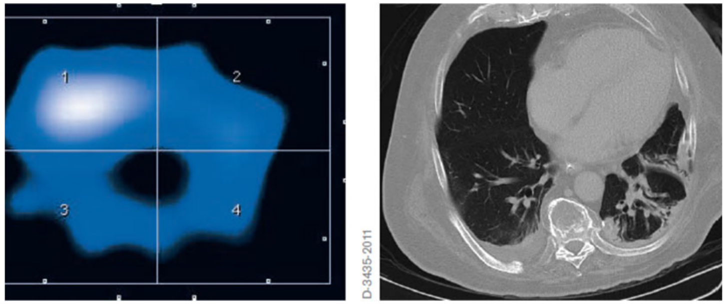
TIE

Limites

Freins à la pratique clinique

LIMITES et Biais Frerichs et al. 2017

- **Analyse d'une section transversale**
- **Temps de mesure : 24h maximum**
- **Perturbations des mesures**
  - Environnement / Pansements
  - Mouvements / Paroles
  - Repositionnement ceinture
- **Basse résolution spatiale**



Teschner, Imhoff, et Leonhardt, s. d.

TIE

Limites

Freins à la pratique clinique

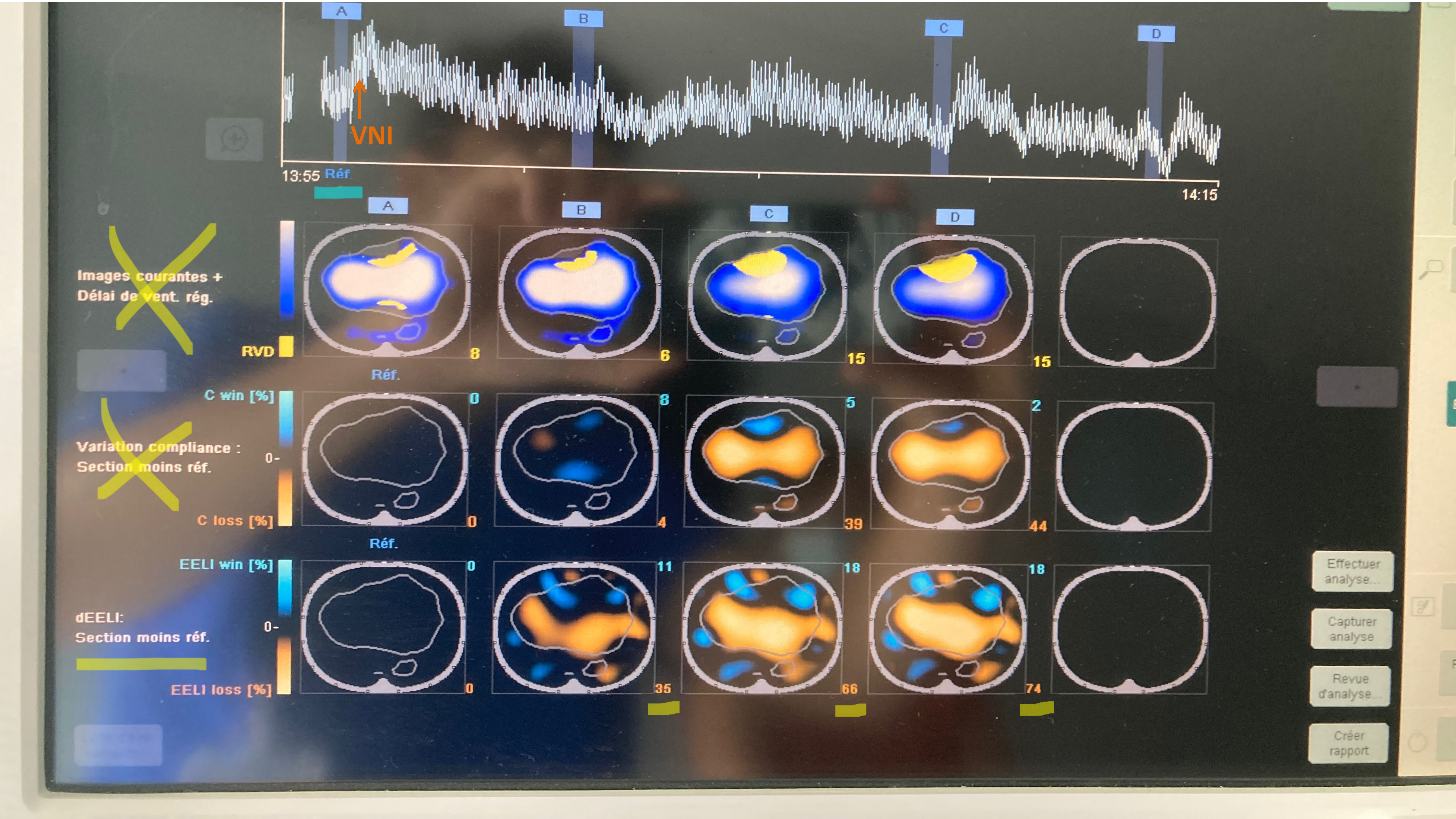
LIMITES et Biais

→ **VS :** analyse de la Compliance impossible **~~Pmusc~~**

Peso ? **Slobod et al. 2022**

→ **Interprétation des mesures :**

- **<u>Pas d'analyse des valeurs ABSOLUES d'impédances : trop grande variabilité inter-individu</u>**
- **Biais importants entre deux positionnements de ceintures**
- **Analyse relative intra-individu sur un même positionnement de ceinture conseillée**


A
B
C
D
VNI
13:55 Réf.
14:15
Images courantes +
Délai de vent. rég.
RVD
8
6
15
15
Réf.
C win [%]
Variation compliance :
Section moins réf.
0-
C loss [%]
0
8
5
2
0
4
39
44
Réf.
EELI win [%]
dEELI:
Section moins réf.
0-
EELI loss [%]
0
11
18
18
0
35
66
74
Effectuer analyse...
Capturer analyse
Revue d'analyse...
Créer rapport

TIE

MKREA

Ventilation Non Invasive

Retour Expérience

TIE

Ventilation Non Invasive

Réglage

AI
PEP
FiO2%
Pente de pressurisation
Trigger inspiratoire
Trigger expiratoire

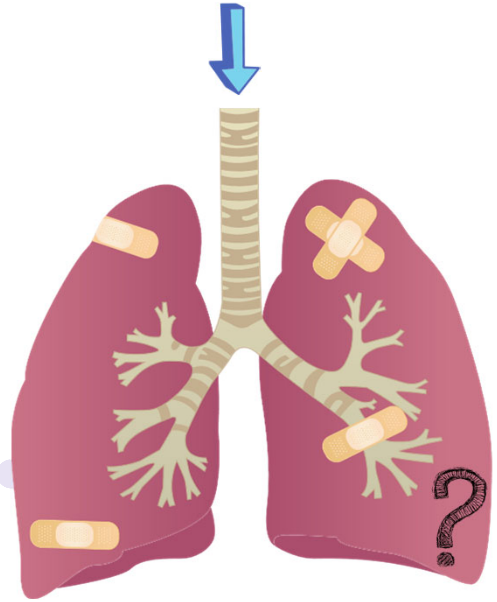
Monitorage

SpO2%

Fréquence Respiratoire

Gazométrie : Pa02 - PaCO2 - pH

Volume courant expiré 6-8 ml par kg de poids théorique

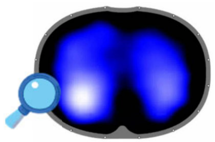


Zones ventilées ?
Répartition du volume courant ?
Objectifs de recrutement atteint ?

Jaber et al.
2010

TIE

Evaluation pratique : VNI et TIE



Distribution volume courant
Recrutement alvéolaire

Patient Mr D - J5 Lobectomie inférieure droite

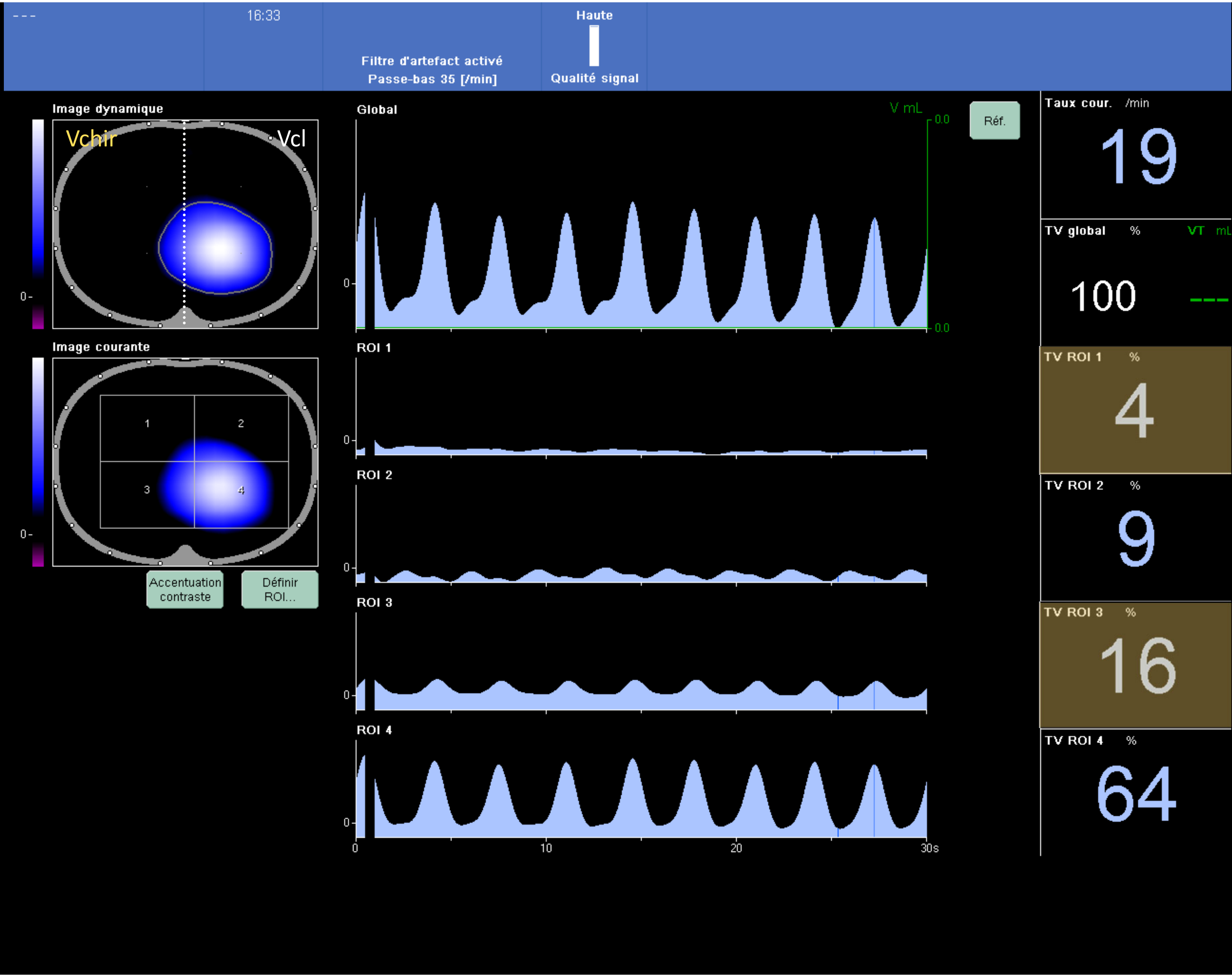
- **J0** : **intervention LID** - thoracotomie - CBNPC
- **J1**: réanimation thoracique
- **J5** : secteur thoracique
  - **Oxygénorequerant : SpO2 91% en AA**
  - Auscultation : sibilants champ droit / **hypoventilation droite**
  - Douleur 2/10 (EN)
  - Drain pleural droit : ablation le 21/11/2020

Prescription PPC

Recrutement alvéolaire poumon droit

- **Patient - J5 LID**
- **PPC prescrite**
- **Pas de contre-indications EIT**
- **Consentant**


Dräger
-0.01
-0.03
-0.03
0.04
0.06
Dräger



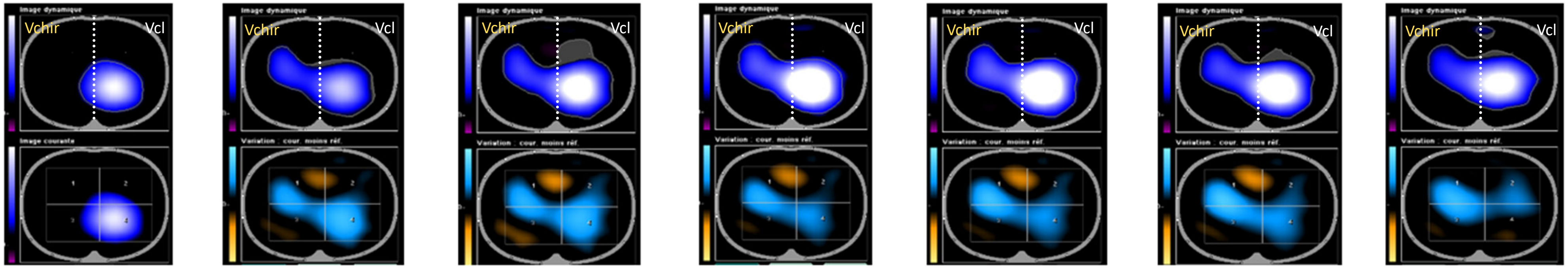
16:33
Filtre d'artefact activé
Passe-bas 35 [/min]
Haute
Qualité signal
Image dynamique
Vchir
Vcl
Image courante
Accentuation contraste
Définir ROI...
Global
V mL
Réf.
ROI 1
ROI 2
ROI 3
ROI 4
0
10
20
30s
Taux cour. /min
19
TV global %
VT mL
100
TV ROI 1 %
4
TV ROI 2 %
9
TV ROI 3 %
16
TV ROI 4 %
64

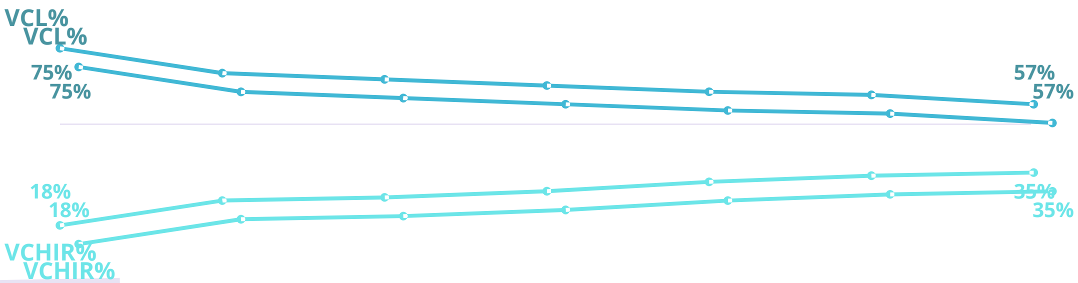
TIE

Evaluation pratique

Mr D - 65 ans - J5 LID - Séance PPC 60' - Vt cible (8ml/kgpp) : 572 ml

RS 2'	PEP4 2'	PEP4 20'	PEP6 20'	PEP8 1'	PEP8 20'	RS 2'
		Vte 668 ml	Vte 685 ml		Vte 669 ml	





- Nouveaux territoires pulmonaires recrutés
- Répartition plus homogène du Vt
- SpO2 98%
- Patient confortable, somnolant

TIE

Evaluation pratique 2 : VNI et TIE

Cas clinique Mr B 45 ans - J3 Décortication pleurale gauche

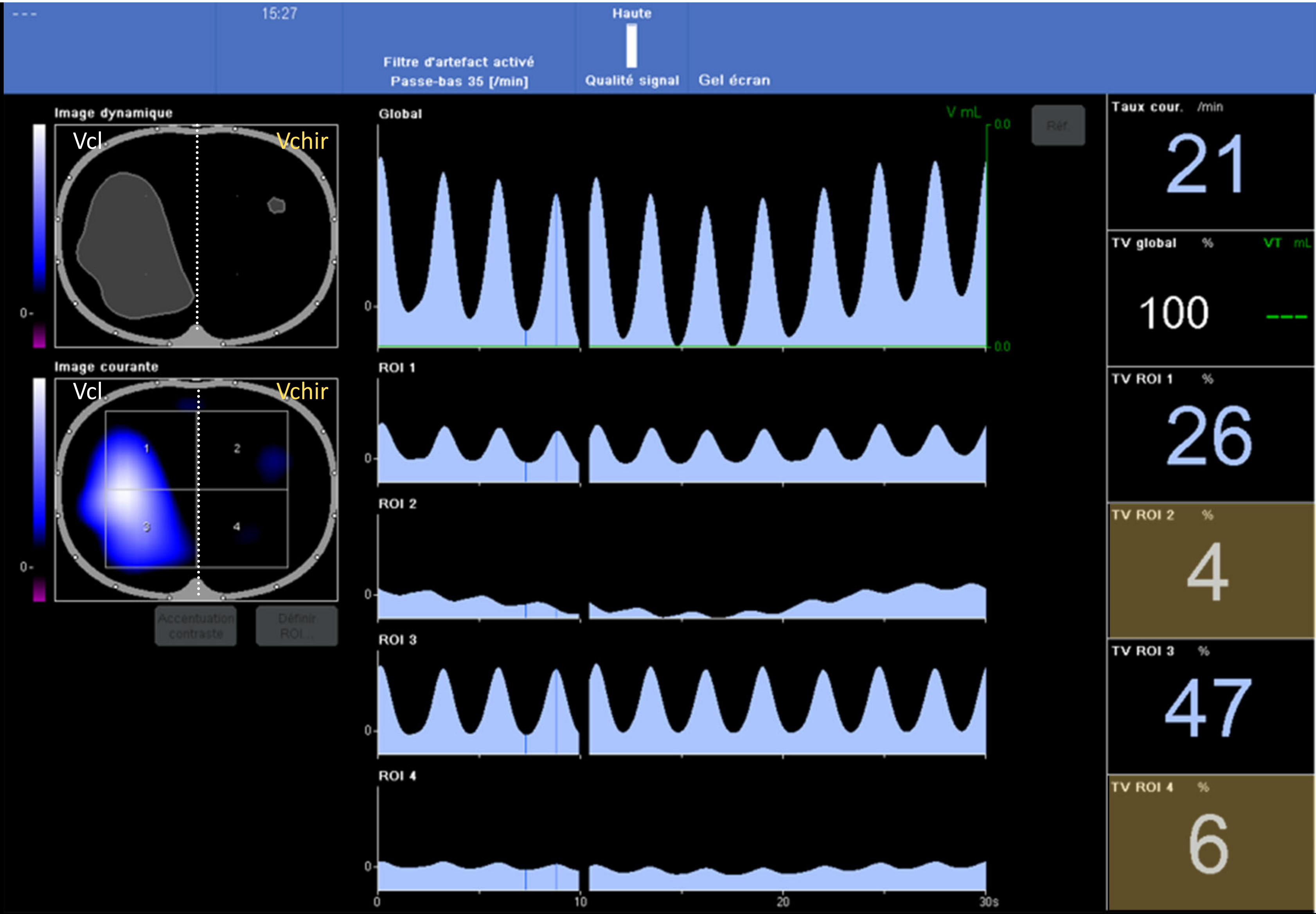
- **HDM** : Pneumopathie Grippe A
  Pleuropneumopathie poumon gauche
- **J0** : **Décortication pleurale poumon gauche**
- **J3** : réanimation thoracique
  - **Oxygénorequerant : SpO2 94% sous 2L O2**
  - **Auscultation** : **hypoventilation poumon gauche**
  - **Rx : atelectasie poumon gauche**
  - Drain pleural gauche : en aspiration, bullage

Prescription PPC intermittente

Reexpansion pulmonaire poumon gauche
Recrutement alvéolaire poumon gauche

- **Patient - J3 Décortication pleurale**
- **PPC prescrite**
- **Pas de contre-indications EIT**
- **Consentant**

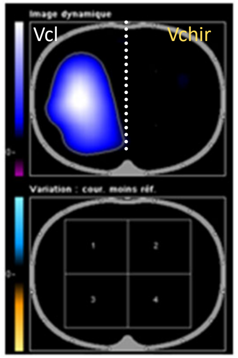
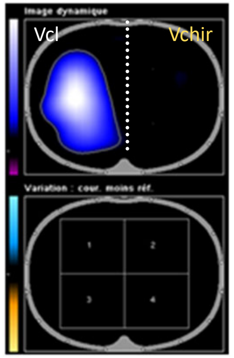
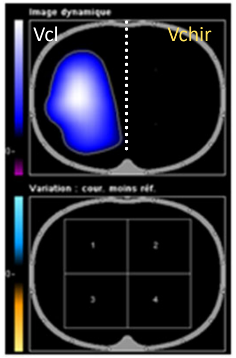
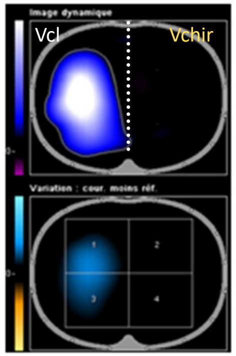
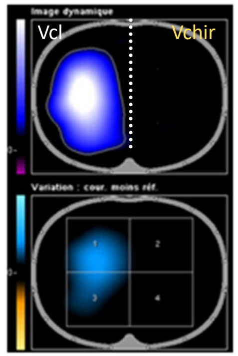

PHILIPS
Dräger


15:27
Haute
Filtre d'artefact activé
Passe-bas 35 [/min]
Qualité signal
Gel écran
Image dynamique
Vcl
Vchir
Image courante
Vcl
Vchir
1
2
3
4
Accentuation contraste
Définir ROI...
Global
V mL
Réf.
ROI 1
ROI 2
ROI 3
ROI 4
0
10
20
30s
Taux cour. /min
21
TV global %
VT mL
100
TV ROI 1 %
26
TV ROI 2 %
4
TV ROI 3 %
47
TV ROI 4 %
6

TIE

Evaluation pratique 2

Mr B - 45 ans - J3 DPG - Séance PPC 30' à 60' - Vt cible (8ml/kgpp) : 600 ml

RS	Vte 532 ml PEP5 5'	Vte 590 ml PEP7 5'	Vte 497 ml PEP10 10'	Vte 737 ml PEP15 10'
				

- Pas de nouveaux territoires pulmonaires recrutés
- Pas d'homogénéisation du Vt
- Patient confortable, somnolant

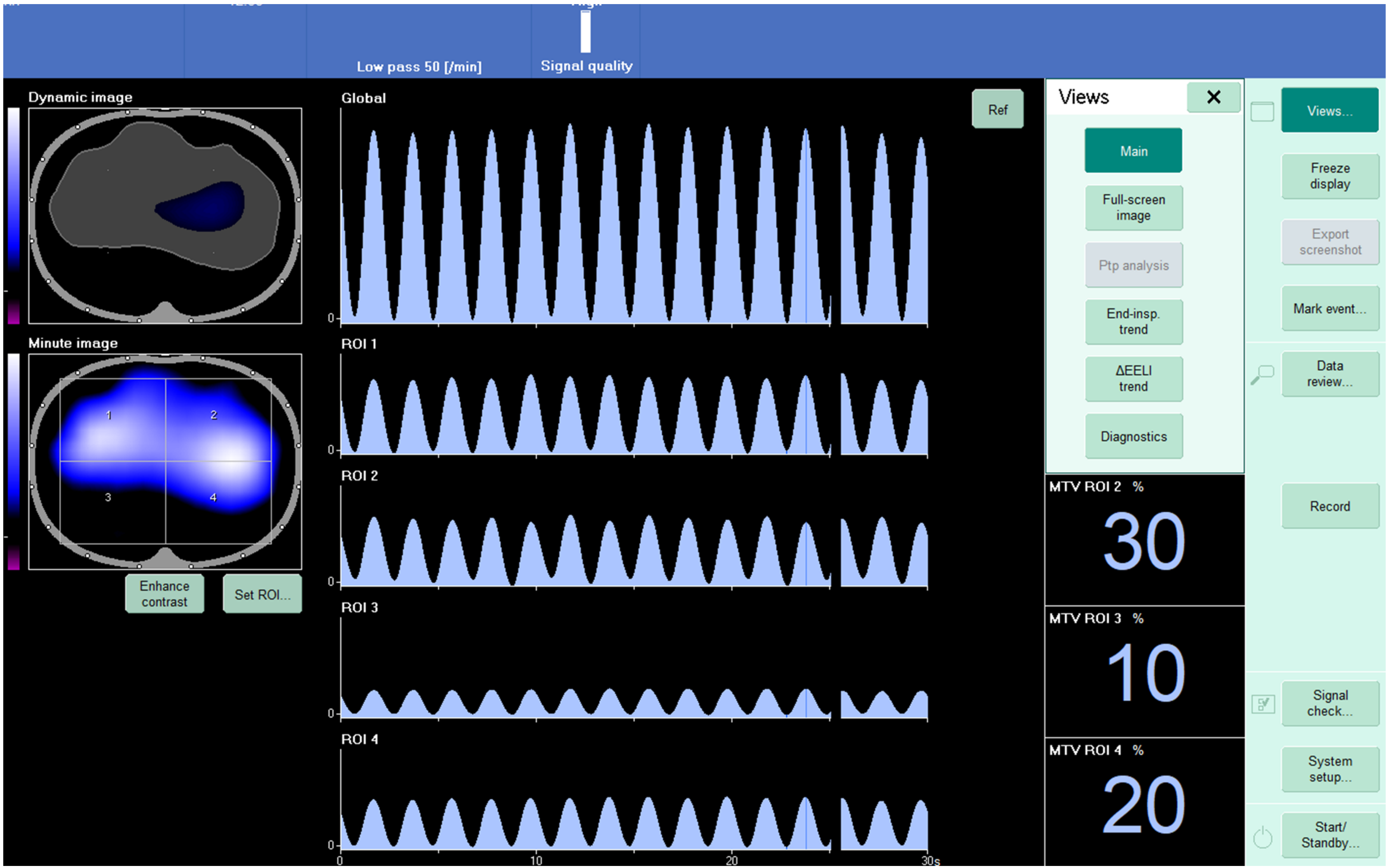
TIE

Applications Cliniques

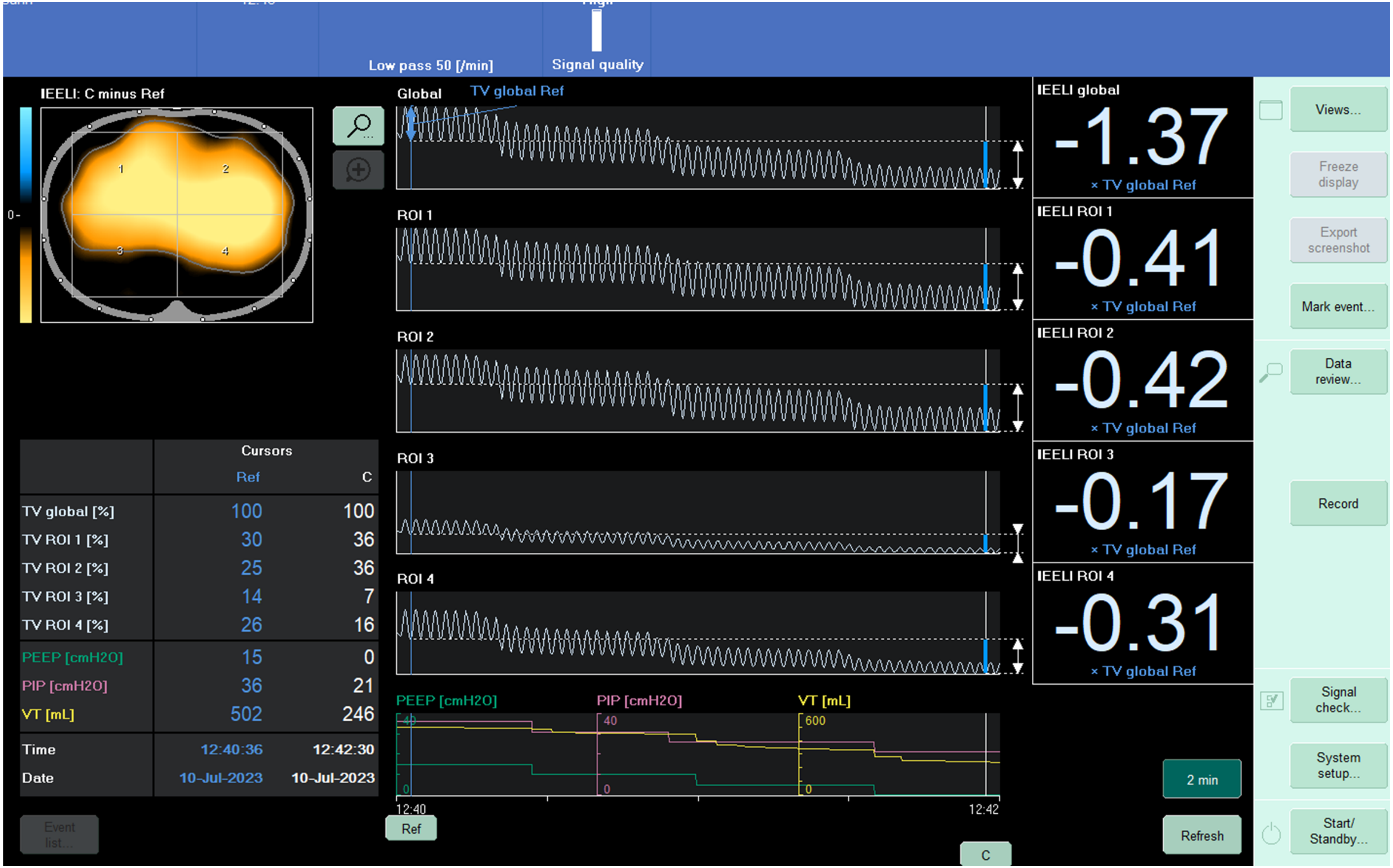
Titrage PEEP

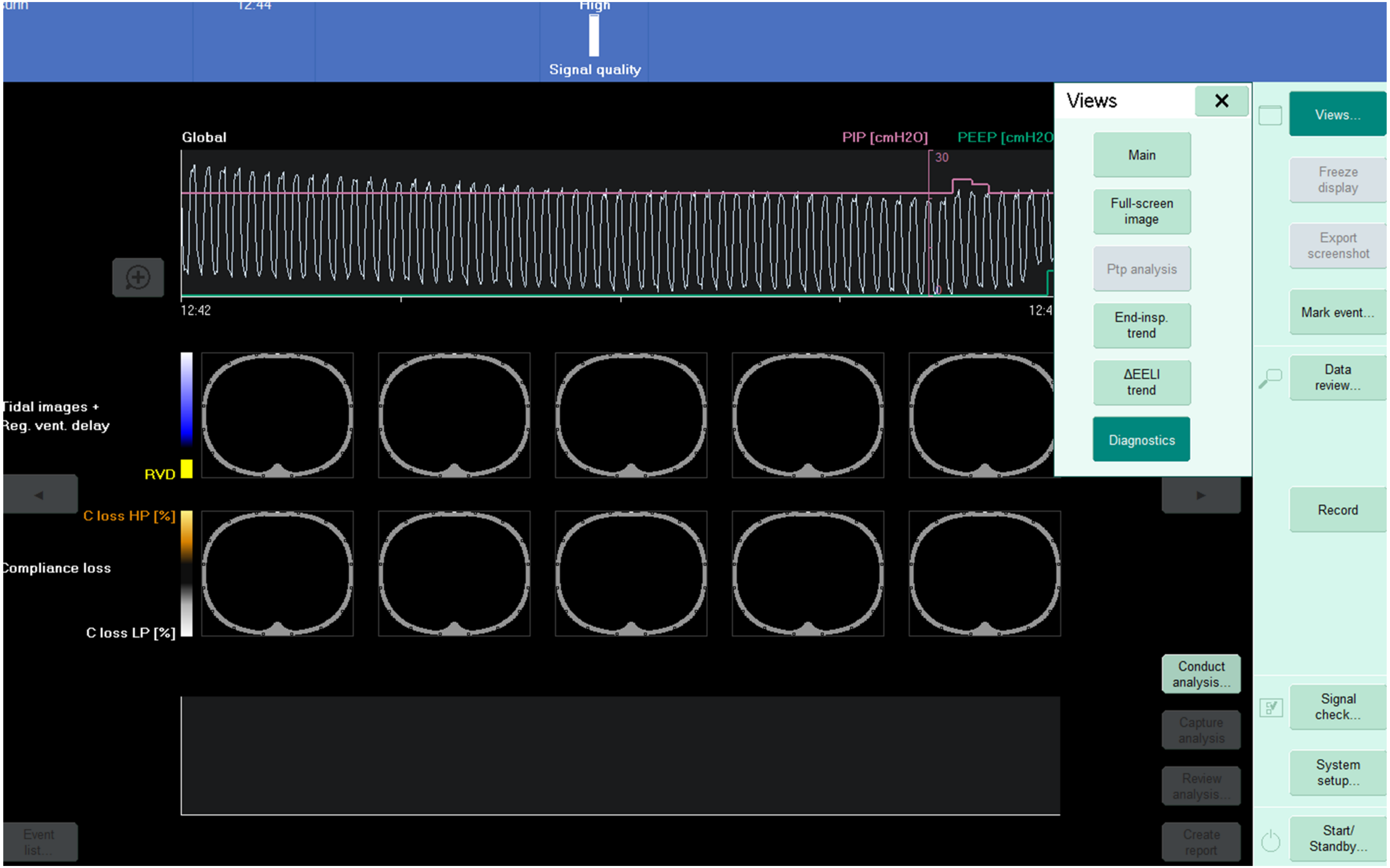
Attention : il existe un pod de connexion au respirateurs Drâger pour associer les données de Pression (aw, oeso) au Pulmovista (PEEP Trial, elastance..) néanmoins il y a un décalage de synchronisation des données Paw et EIT.
Pour éviter cela il est possible de connecter directement le Pulmovista au respirateur via une prise VGA.

?

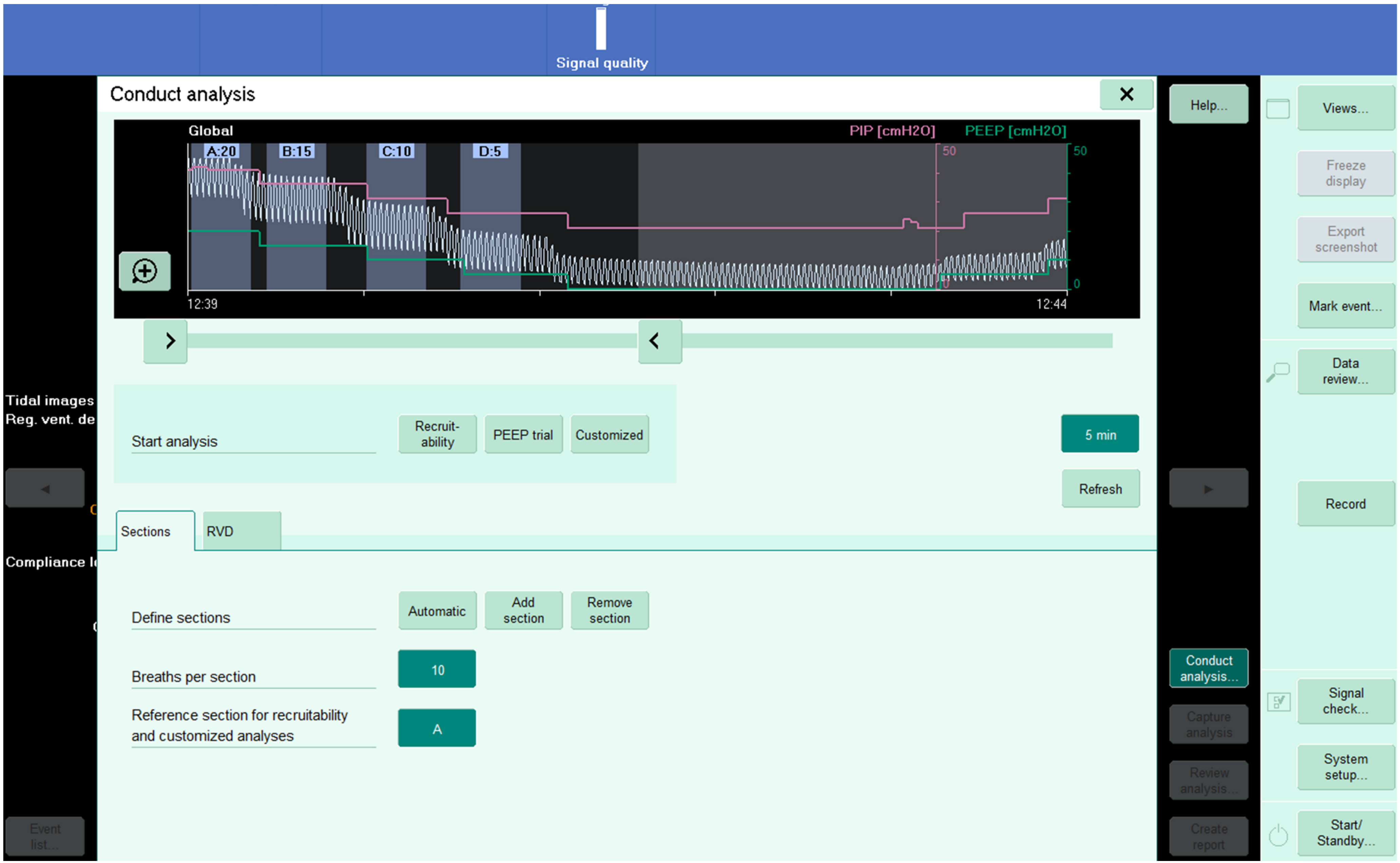


Low pass 50 [/min]
Signal quality
Dynamic image
Minute image
Enhance contrast
Set ROI...
Global
ROI 1
ROI 2
ROI 3
ROI 4
0
10
20
30s
Ref
Views
Main
Full-screen image
Ptp analysis
End-insp. trend
ΔEELI trend
Diagnostics
MTV ROI 2 %
30
MTV ROI 3 %
10
MTV ROI 4 %
20
Views...
Freeze display
Export screenshot
Mark event...
Data review...
Record
Signal check...
System setup...
Start/ Standby...

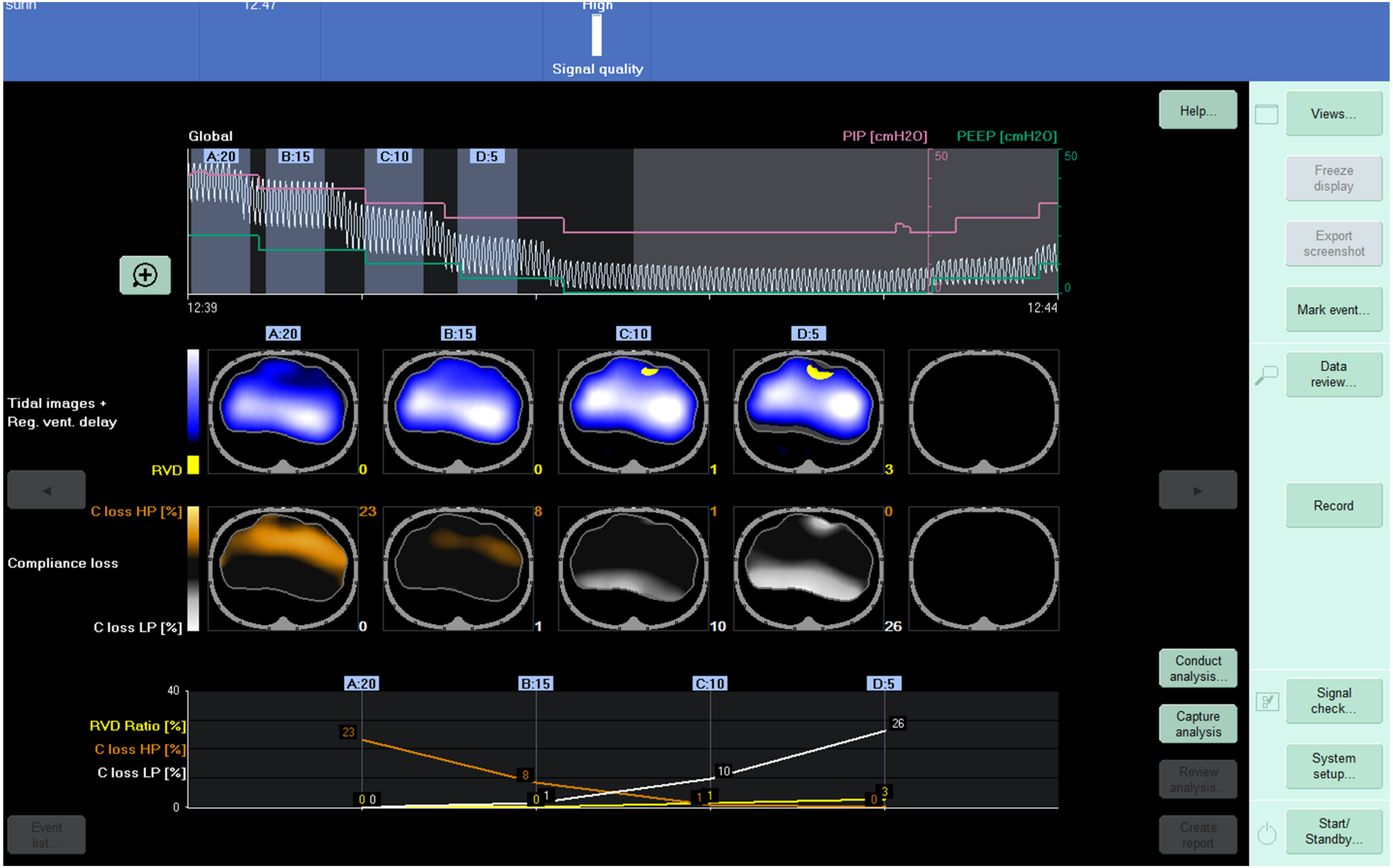

Low pass 50 [/min]
Signal quality
IEELI: C minus Ref
0 -
Global
TV global Ref
ROI 1
ROI 2
ROI 3
ROI 4
IEELI global
-1.37
× TV global Ref
IEELI ROI 1
-0.41
× TV global Ref
IEELI ROI 2
-0.42
× TV global Ref
IEELI ROI 3
-0.17
× TV global Ref
IEELI ROI 4
-0.31
× TV global Ref
Views...
Freeze display
Export screenshot
Mark event...
Data review...
Record
Signal check...
System setup...
Start/ Standby...
Cursors
Ref
C
TV global [%] 100 100
TV ROI 1 [%] 30 36
TV ROI 2 [%] 25 36
TV ROI 3 [%] 14 7
TV ROI 4 [%] 26 16
PEEP [cmH2O] 15 0
PIP [cmH2O] 36 21
VT [mL] 502 246
Time 12:40:36 12:42:30
Date 10-Jul-2023 10-Jul-2023
PEEP [cmH2O]
PIP [cmH2O]
VT [mL]
40
40
600
0
0
0
12:40
12:42
Ref
C
2 min
Refresh
Event list...



12:44
High
Signal quality
Global
PIP [cmH2O]
PEEP [cmH2O
30
12:42
Tidal images +
Reg. vent. delay
RVD
C loss HP [%]
Compliance loss
C loss LP [%]
Views
Main
Full-screen image
Ptp analysis
End-insp. trend
ΔEELI trend
Diagnostics
Views...
Freeze display
Export screenshot
Mark event...
Data review...
Record
Conduct analysis...
Capture analysis
Review analysis...
Create report
Event list...
Signal check...
System setup...
Start/ Standby...



Signal quality
Conduct analysis
Global
PIP [cmH2O]
PEEP [cmH2O]
A:20
B:15
C:10
D:5
50
50
0
12:39
12:44
Help...
Views...
Freeze display
Export screenshot
Mark event...
Data review...
Tidal images
Reg. vent. de
Start analysis
Recruit-ability
PEEP trial
Customized
5 min
Refresh
Record
Sections
RVD
Compliance l
Define sections
Automatic
Add section
Remove section
Breaths per section
10
Reference section for recruitability and customized analyses
A
Conduct analysis...
Capture analysis
Review analysis...
Create report
Signal check...
System setup...
Start/ Standby...
Event list...



High
Signal quality
Help...
Views...
Freeze display
Export screenshot
Mark event...
Data review...
Record
Conduct analysis...
Capture analysis
Review analysis...
Create report
Signal check...
System setup...
Start/ Standby...
Event list...
Global
PIP [cmH2O]
PEEP [cmH2O]
A:20
B:15
C:10
D:5
12:39
12:44
Tidal images + Reg. vent. delay
RVD
C loss HP [%]
Compliance loss
C loss LP [%]
RVD Ratio [%]

TIE

Discussion

Applications Cliniques MKREA

→ **Place dans l'arsenal d'outils d'évaluation ?**

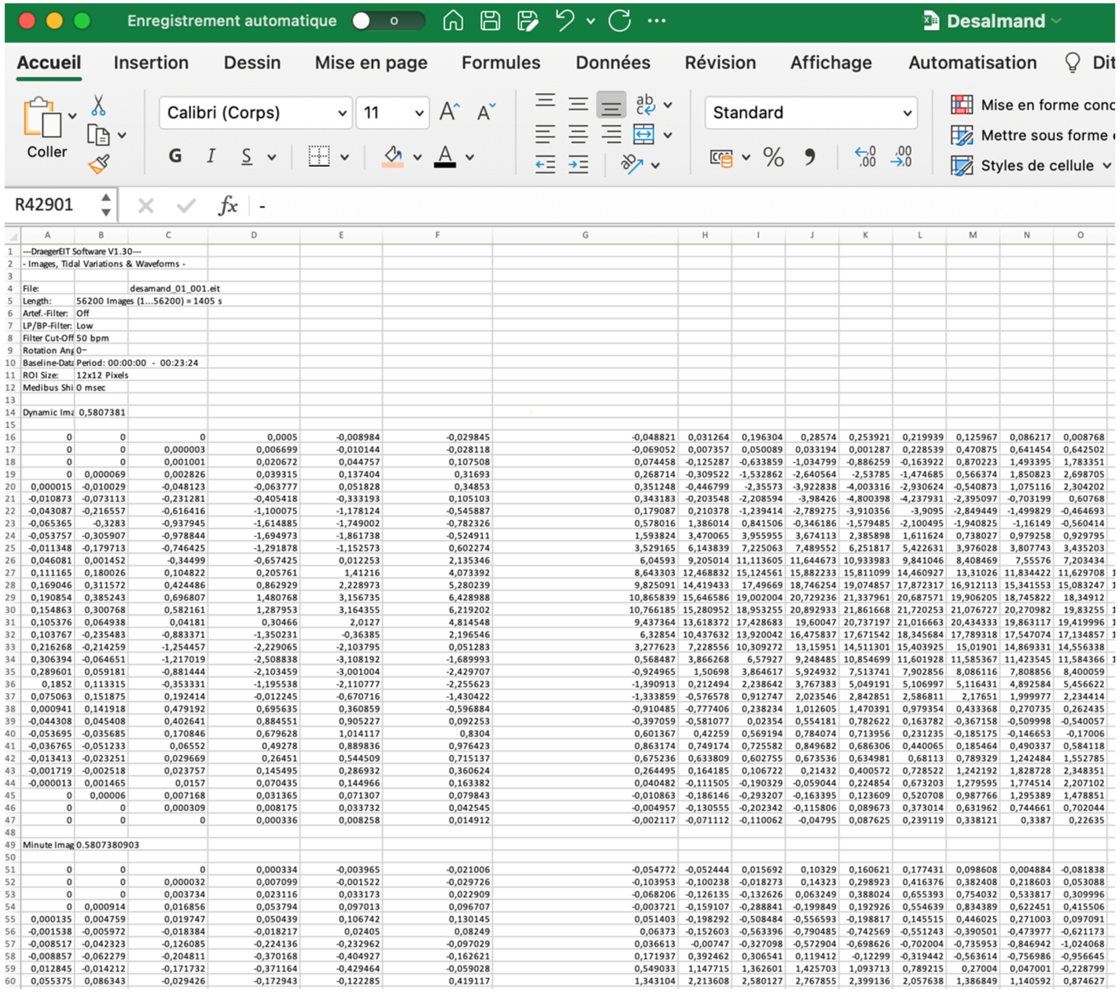
- Clinique -
- Auscultation -
- GDS -
- Rx -
- Echographie -

Complémentarité

→ Bénéfices Théoriques → Bénéfices Cliniques ?

TIE

Analyses post-mesures



TIE

CONTRIBUTION

Evaluation des pratiques

Recherche Clinique

Individualisation du soin

Pratique Clinique

Outils Pédagogique

Formation

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