Les modes ventilatoires « modernes » en VNI

Claudio Rabec

Service de Pneumologie et Soins Intensifs Respiratoires
Centre Hospitalier et Universitaire de Dijon

Principe général (théorique) des appareils à ventilation cible

- Mode hybride entre volumétrique et barométrique
- Permettant de ventiler en mode barométrique

  et d'assurer un volume cible pré-réglé

  - ✓ *Plus ou moins fréquence de backup automatique ou variable*
  - ✓ *Plus ou moins PEP autopilotée*

- Modes dits "intelligents"

Quizz

Concernant les modes modernes

1) Je les utilise à titre systématique comme traitement de première ligne

2) Je les reserve pour des “cas difíciles”

3) Je les utilise quand tous les autres modes faillent

4) Je ne les utilise pas mais je pense que je les utiliserai dans l’avenir

5) Je ne les ai jamais utilisé et je ne vois pas leur place

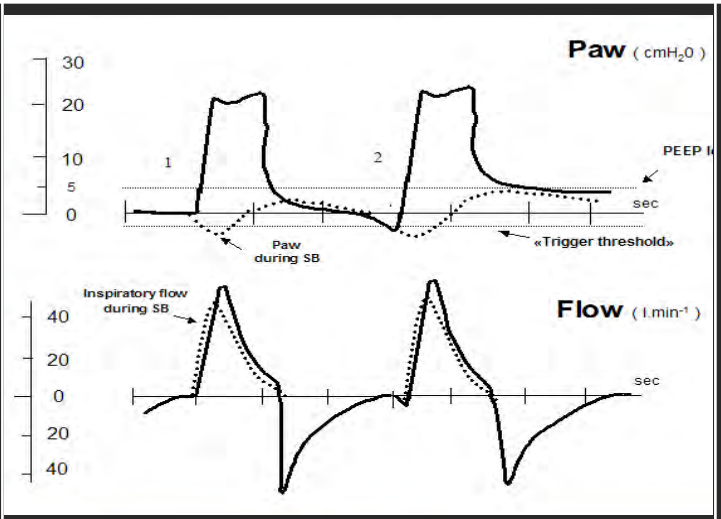
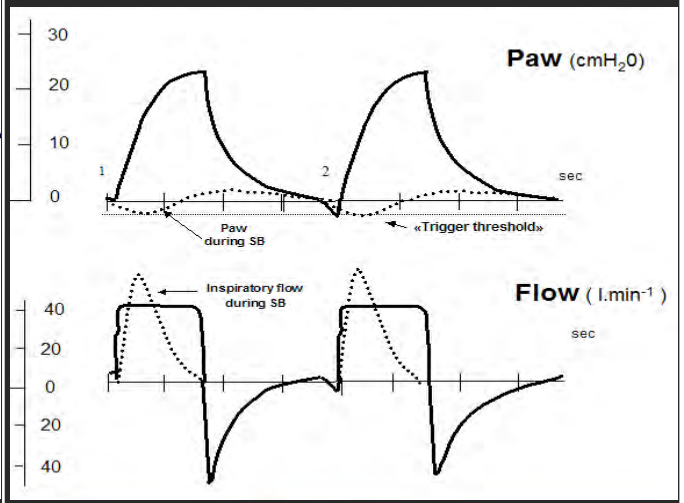
6) Je n’ai pas une opionion précise

Plan

- Rationale d'utilisation d'un mode à ventilation cible
- Differents loops et paramètres de regulation.
- Scénarios potentiels (ou cibles…) d'utilisation
- Inconvenients potentiels

Plan

- Rationale d'utilisation d'un mode à ventilation cible
- Differents loops et paramètres de regulation.
- Scénarios potentiels (ou cibles…) d'utilisation
- Inconvenients potentiels

	Barométrique	Volumétrique
		
Variable controlée	Pression constante	Débit constant
Variablilité cycle à cycle	Possible. Débit et volume peuvent varier	Impossible. Volume fixe
Possibilité de assurer Vt	Non (varie si varie R et C)	Oui (en absence de fuites)
Compensation de fuites	Acceptable pour des fuites légères à moderées	Les fuites compromettent le Vt reçu et peuvent induire une hypoventilation

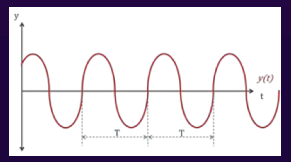
Rabec, Thorax 2011

Rationale d'un mode barométrique « variable »

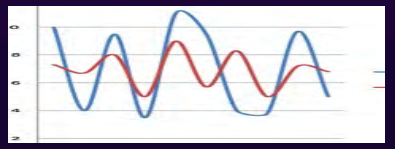
- Assurer un volume stable ou fixe
  - → *Perfida herencia de los intensivistas?*
- Para respetar la variabilidad « fisiologica »
- Para asegurar una ventilacion adecuada durante toda la noche adaptandose a los cambios fisiologicos durante el sueño

Objectifs de l'assistance ventilatoire

- *En aigu* : Assurer une ventilation alvéolaire adaptée aux conditions (rapidement) instables



- *Au long cours* : corriger l'hypoventilation alvéolaire chronique



→ Mécanismes de action possibles de la ventilation au long cours

  - *Repos muscles respiratoires*
  - *Amélioration compliance*
  - *« Reset » commande ventilatoire*

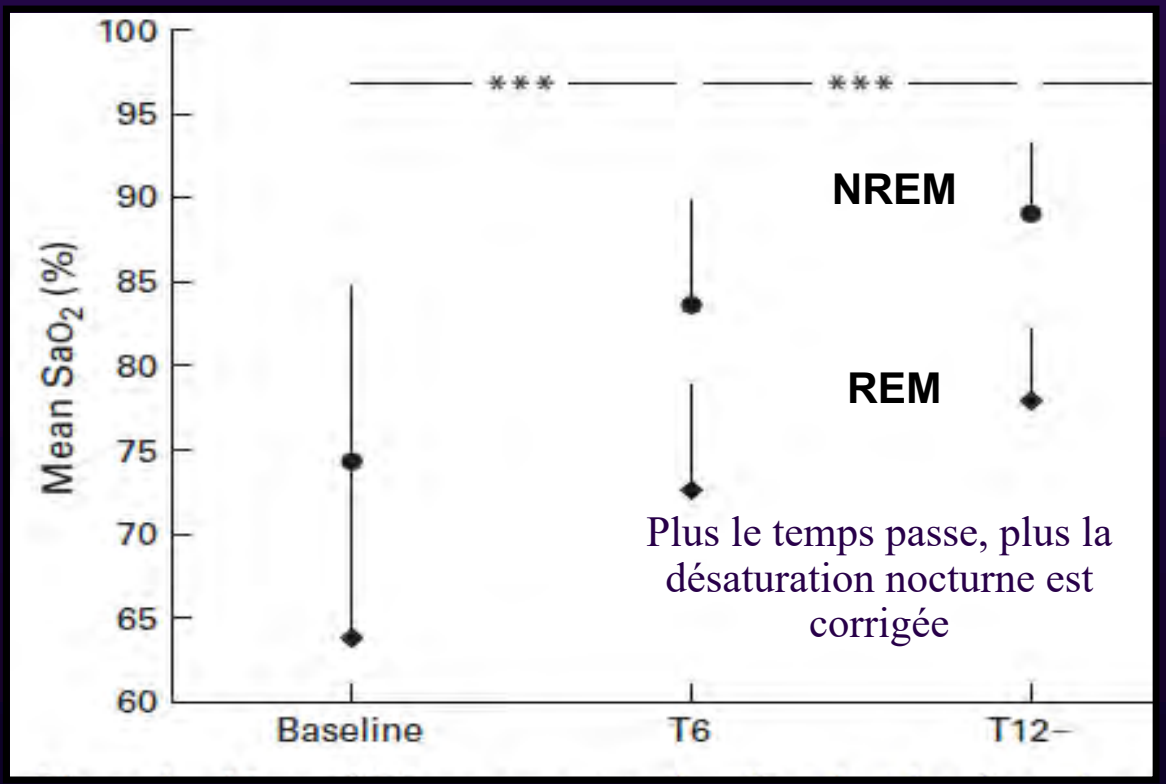
Rationnel d'un mode barométrique « variable »

- Assurer un volume stable ou fixe
  - → *Perfide heritage des réanimateurs?*
- Para respetar la variabilidad « fisiologica »
- Para asegurar una ventilacion adecuada durante toda la noche adaptandose a los cambios fisiologicos durante el sueño


MAESTRO...

Effect of non-invasive mechanical ventilation on sleep and nocturnal ventilation in patients with chronic respiratory failure

Schönhofer Thorax 2000.



Principe basique de physiologie:
respecter l'homéostasie

Corriger les phénomènes avec une cinétique similaire à celle de son installation (sauf si risque vital)

Objectif de la VNI au long cours: casser le cercle vicieux de l'hypoventilation alvéolaire

Rationnel d'un mode barométrique « variable »

- Para asegurar un volumen corriente (o minuto) estable o fijo
  - → *Perfida herencia de los intensivistas? Imagen volumen igual todo el tiempo*
- Respecter la variabilité « physiologique »
- Para asegurar una ventilacion adecuada durante toda la noche adaptandose a los cambios fisiologicos durante el sueño

L'humain

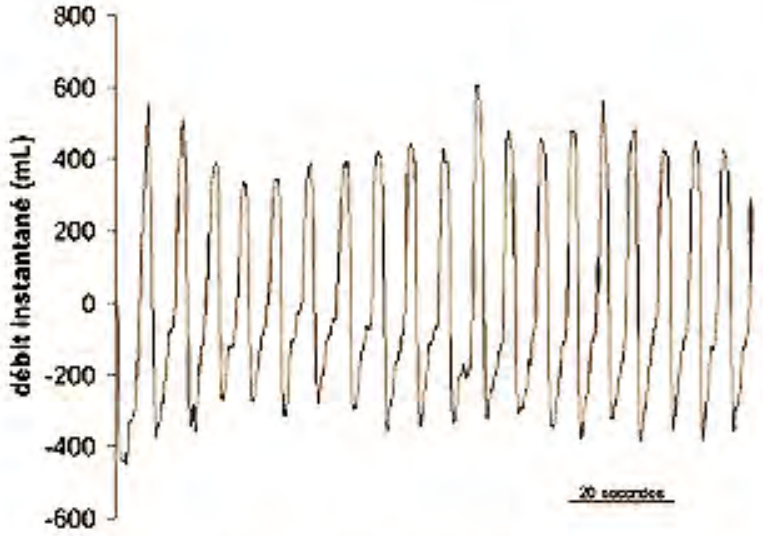
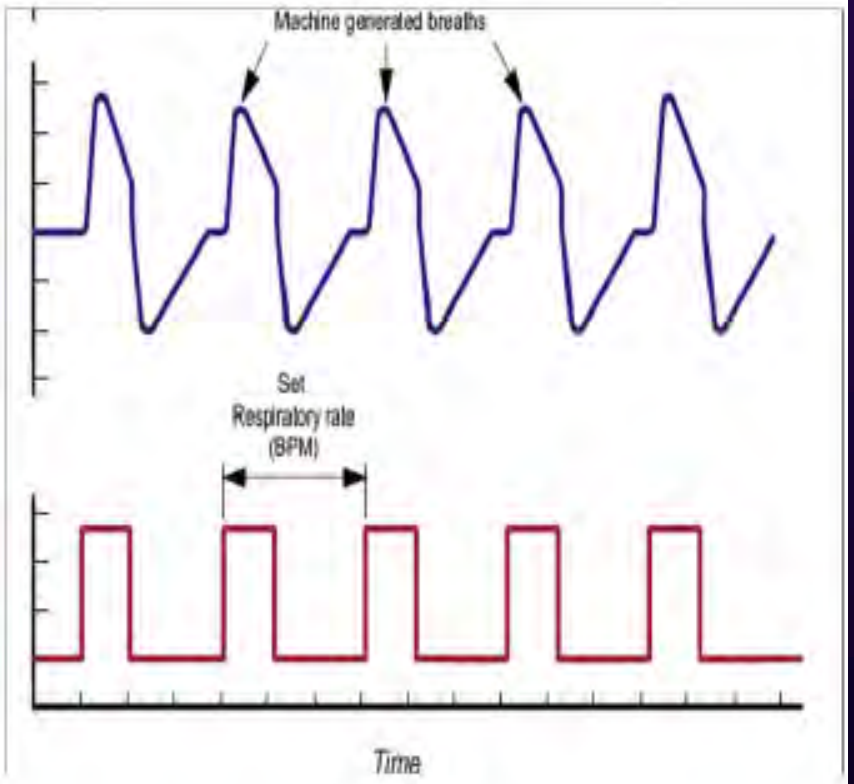


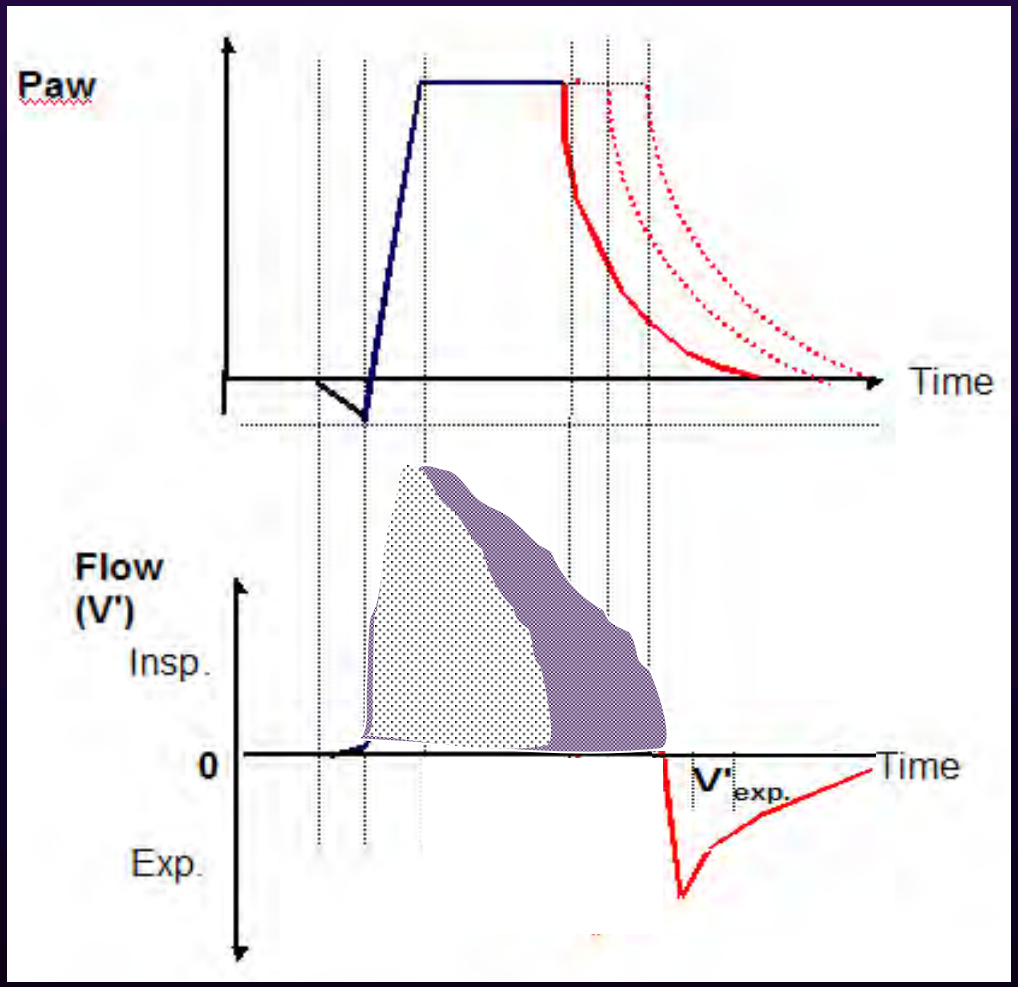
Fig. 1. Enregistrement du signal de débit d'un sujet sain au repos. Il existe une variabilité importante d'un cycle à l'autre, en termes de débit inspiratoire, débit expiratoire, temps inspiratoire et expiratoire.

La machine



Remerciements à D Adler

Le cas particulier de l'AI



Rationnel d'un mode barométrique « variable »

- Para asegurar un volumen corriente (o minuto) estable o fijo
  - → *Perfida herencia de los intensivistas? Imagen volumen igual todo el tiempo*
- Respecter la variabilité « physiologique »
  - → *Mais si avec l'AI nous le donnons une telle variabilité…!!*

    (VT, FR, débit, ti, et al)
- Para asegurar una ventilacion adecuada durante toda la noche adaptandose a los cambios fisiologicos durante el sueño

Rationnel d'un mode barométrique « variable »

- Para asegurar un volumen corriente (o minuto) estable o fijo

- Para respetar la variabilidad « fisiologica »

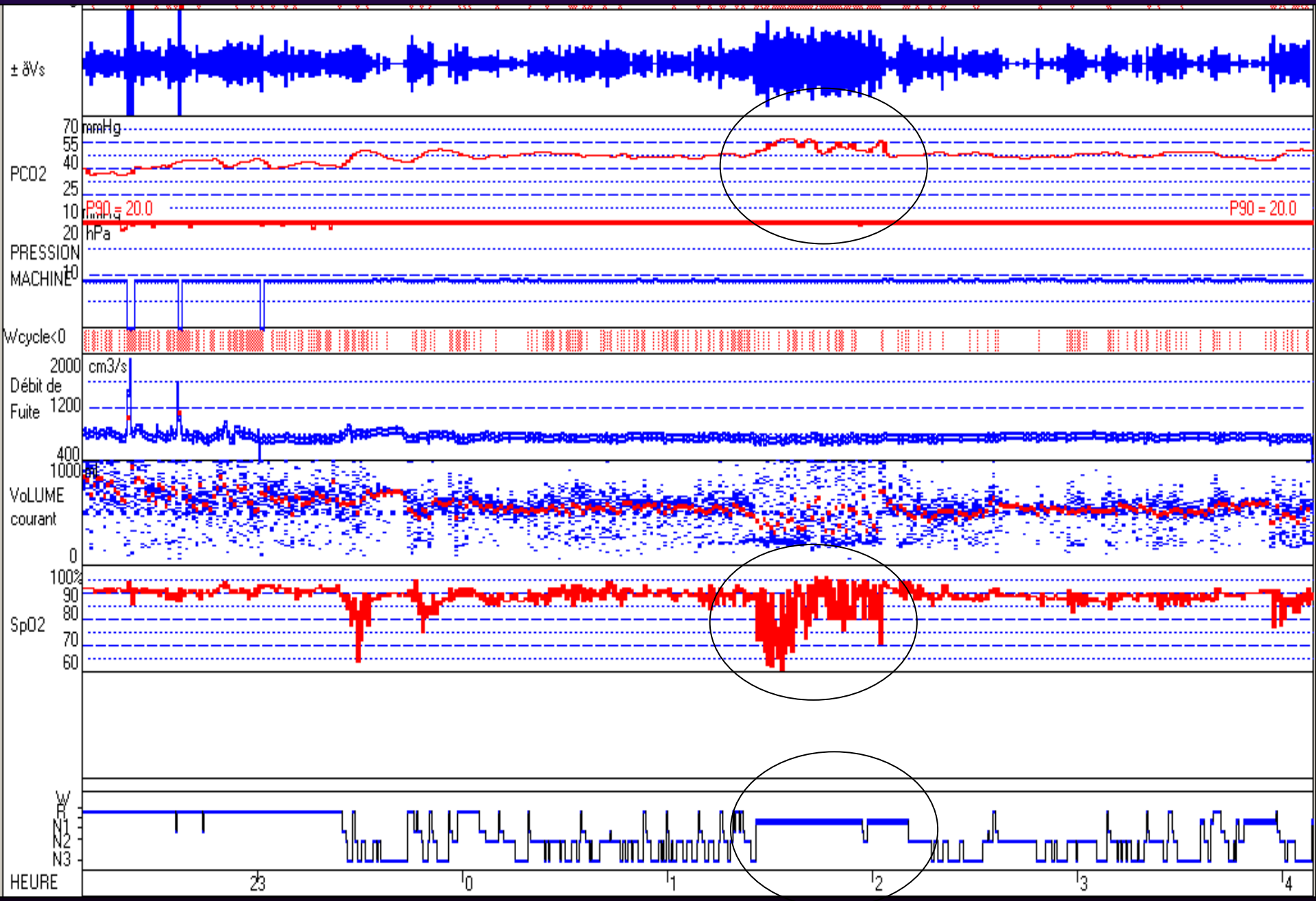
- Assurer une ventilation appropriée au cours de la nuit en s'adaptant aux modifications physiologiques ou pathologiques pendant le sommeil
  - *En particulierr proveer una ventilacion apropiada durante los periodos de fragilidad sin « sobreventilar » durante el resto de la noche imagen capnografia*

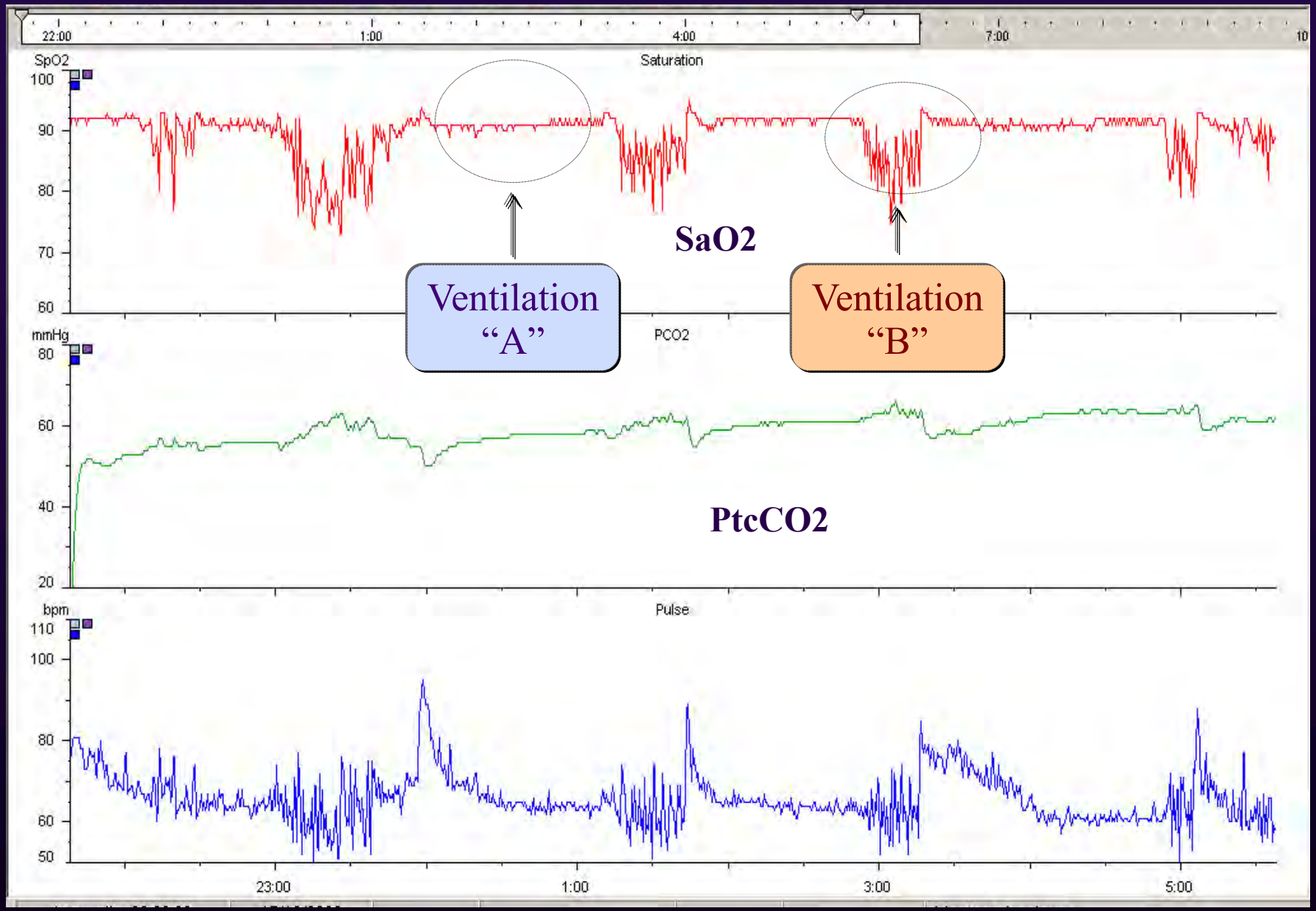
Rationnel d'un mode barométrique « variable »

- Para asegurar un volumen corriente (o minuto) estable o fijo

- Para respetar la variabilidad « fisiologica »

- Assurer une ventilation appropriée au cours de la nuit en s'adaptant aux modifications physiologiques ou pathologiques pendant le sommeil
  - *Fournir une ventilation appropriée pendant les périodes « fragiles » sans surventiler pendant le reste de la nuit*


± ëVs
70
55
40
25
10
mmHg
PCO2
P90 = 20.0
P90 = 20.0
20
hPa
PRESSION
MACHINE
0
Wcycle<0
2000
cm3/s
Débit de
Fuite
1200
400
1000
VoLUME
courant
0
100%
90
80
70
60
SpO2
W
R
N1
N2
N3
HEURE
23
0
1
2
3
4


22:00
1:00
4:00
7:00
SpO2
Saturation
100
90
80
70
60
SaO2
Ventilation "A"
Ventilation "B"
mmHg
PCO2
80
60
40
20
PtcCO2
bpm
Pulse
110
100
80
60
50
23:00
1:00
3:00
5:00

Rationnel d'un mode barométrique « variable »

- Para asegurar un volumen corriente (o minuto) estable o fijo

- Para respetar la variabilidad « fisiologica »

- Assurer une ventilation appropriée au cours de la nuit en s'adaptant aux modifications physiologiques ou pathologiques pendant le sommeil
  - *Le cas paradigmatique de certains pathologies*

Le cas paradigmatique du SOH

Necesité de traiter

- Les apnées obstructives
  (mais aussi les centrales s'il y en a)
- L'hypoventilation
  - Centrale
  - Mais aussi obstructive
- L'hypoxémie résiduelle (non liée à l'hypoventilation)

Outils

- PPC
- VDNP

- VDNP → PPC
- (+/- O2)

Le cas paradigmatique du SOH

Necesité de traiter

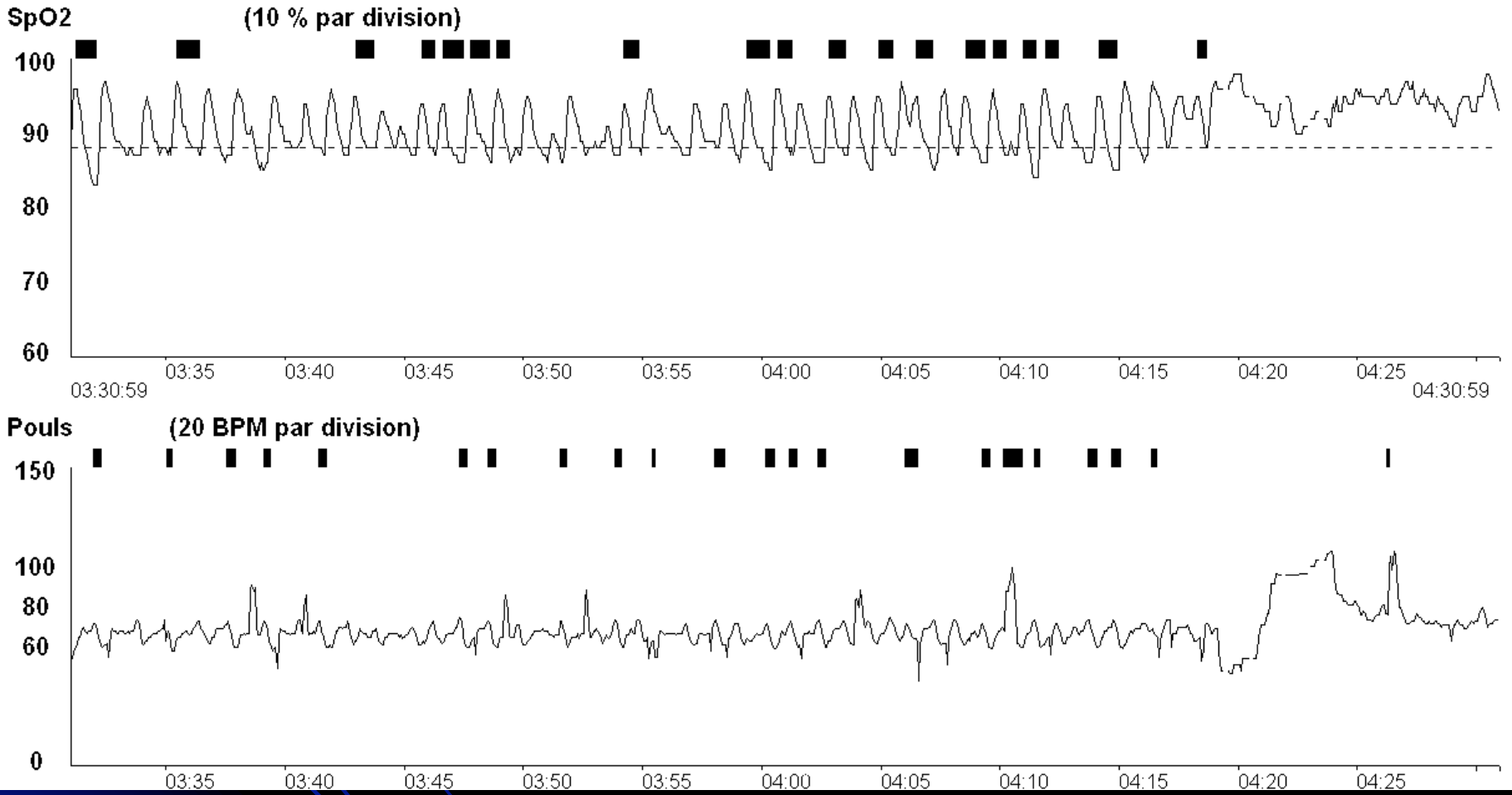
- Les apnées obstructives

  (mais aussi les centrales s'il y en a)
- L'hypoventilation
  - Centrale
  - Mais aussi obstructive
- L'hypoxémie résiduelle (non liée à l'hypoventilation)

Outils

- PPC
- VDNP

- VDNP → PPC
- (+/- O2)


SpO2
(10 % par division)
100
90
80
70
60
03:30:59
03:35
03:40
03:45
03:50
03:55
04:00
04:05
04:10
04:15
04:20
04:25
04:30:59
Pouls
(20 BPM par division)
150
100
80
60
0
03:35
03:40
03:45
03:50
03:55
04:00
04:05
04:10
04:15
04:20
04:25

Pas à pas (1)

Paramétrer le niveau appropriée de PEP

Le cas paradigmatique du SOH

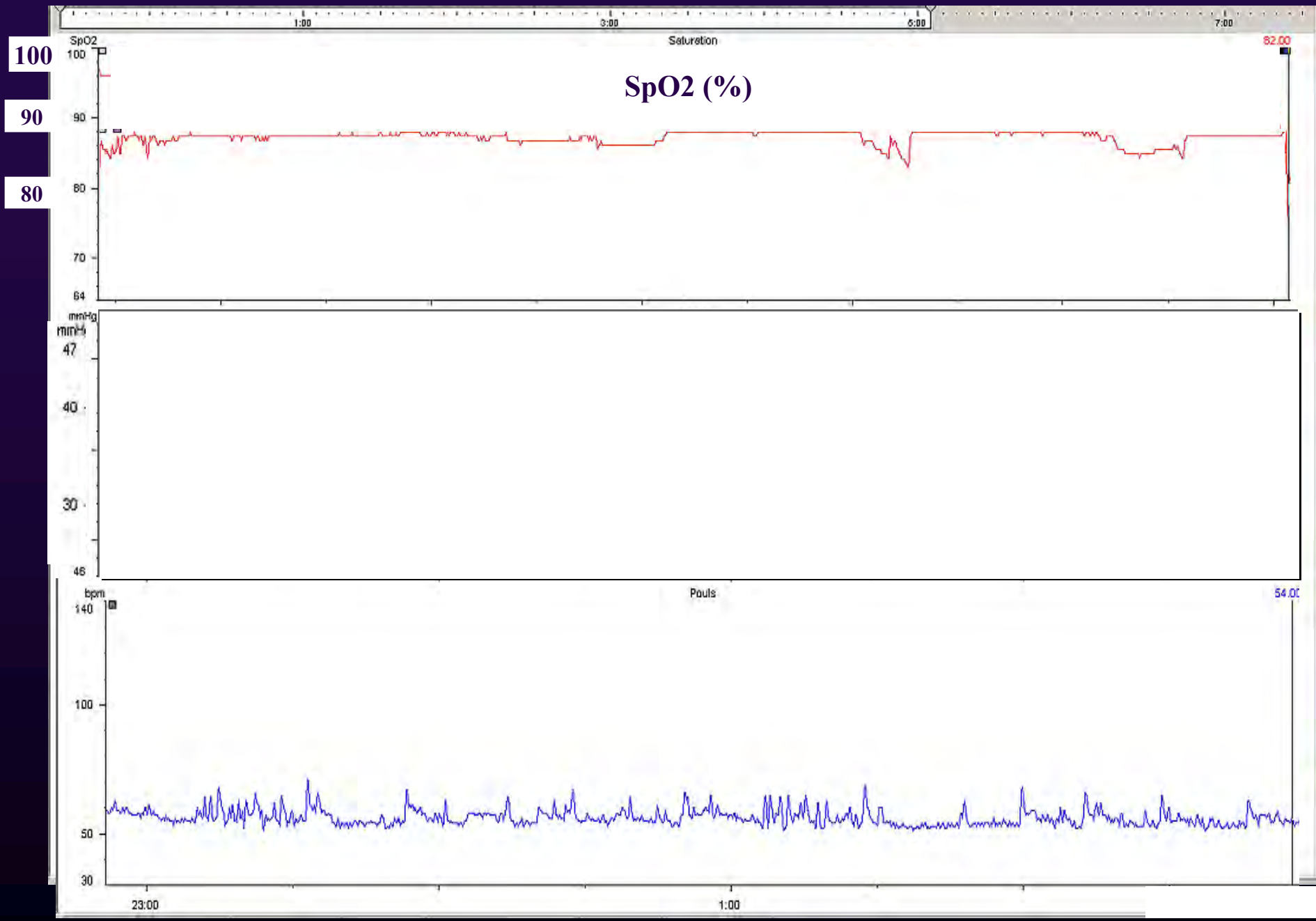
Necesité de traiter

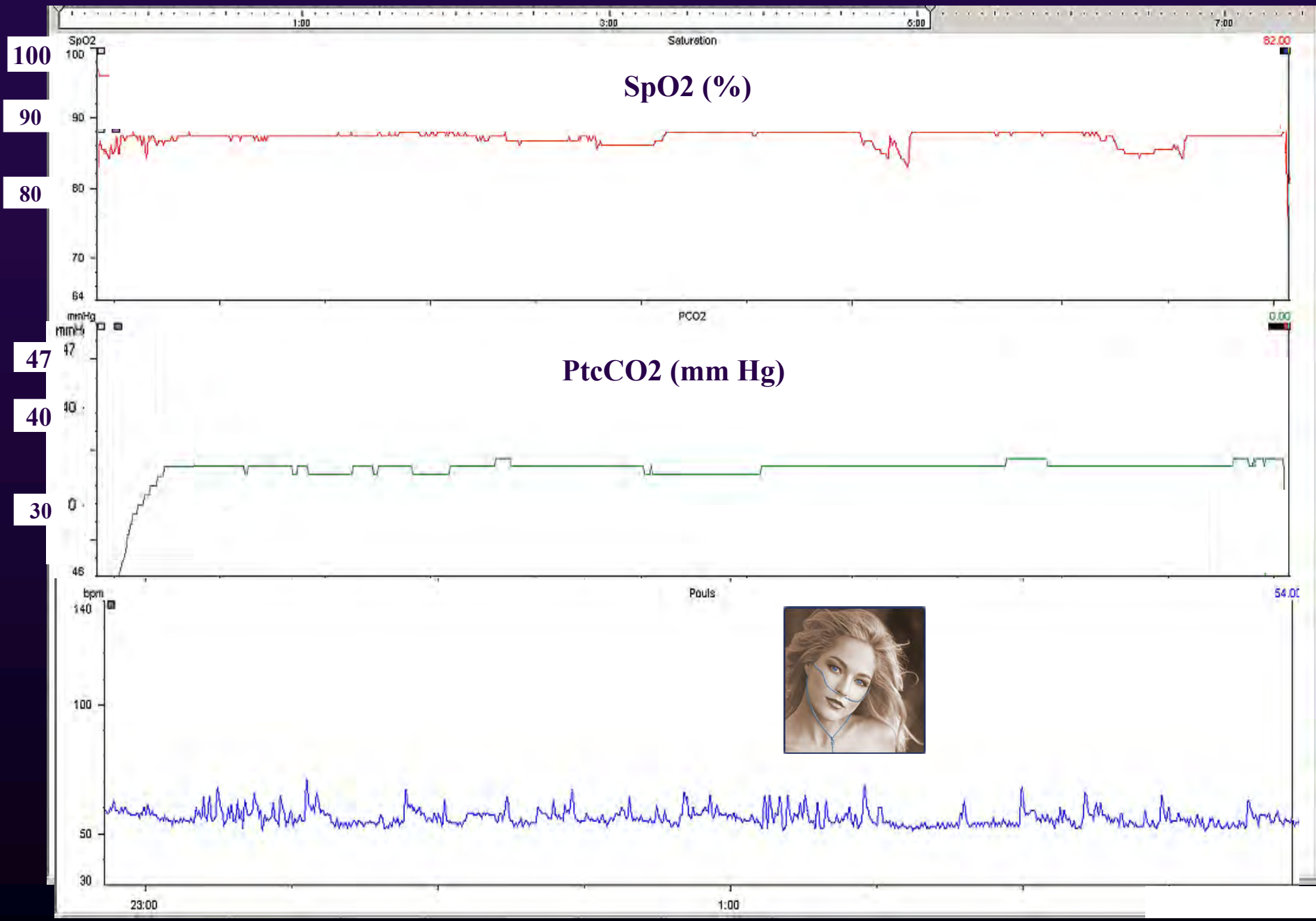
- Les apnées obstructives
  (mais aussi les centrales s'il y en a)
- L'hypoventilation
  - Centrale
  - Mais aussi obstructive
- L'hypoxémie résiduelle (non liée à l'hypoventilation)

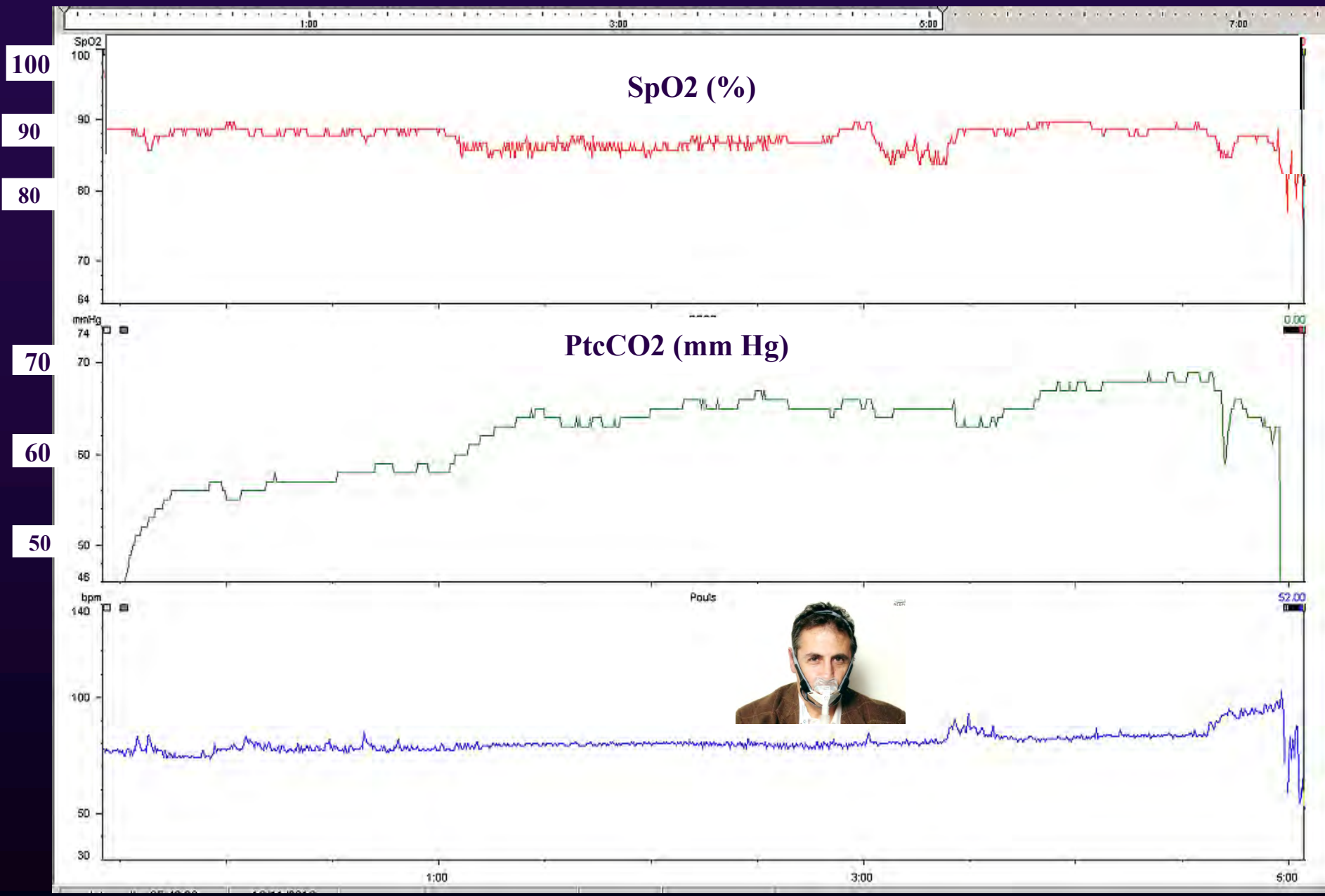
Outils

- PPC
- VDNP

- VDNP → PPC
- (+/- O2)


100
90
80
SpO2 (%)
SpO2
Saturation
100
90
80
70
64
mmHg
47
40
30
46
bpm
Pouls
140
100
50
30
23:00
1:00


100
90
80
SpO2 (%)
47
40
30
PtcCO2 (mm Hg)


100
90
80
70
60
50
SpO2 (%)
PtcCO2 (mm Hg)
1:00
3:00
5:00
7:00
SpO2
mmHg
bpm
Pouls
1:00
3:00
5:00

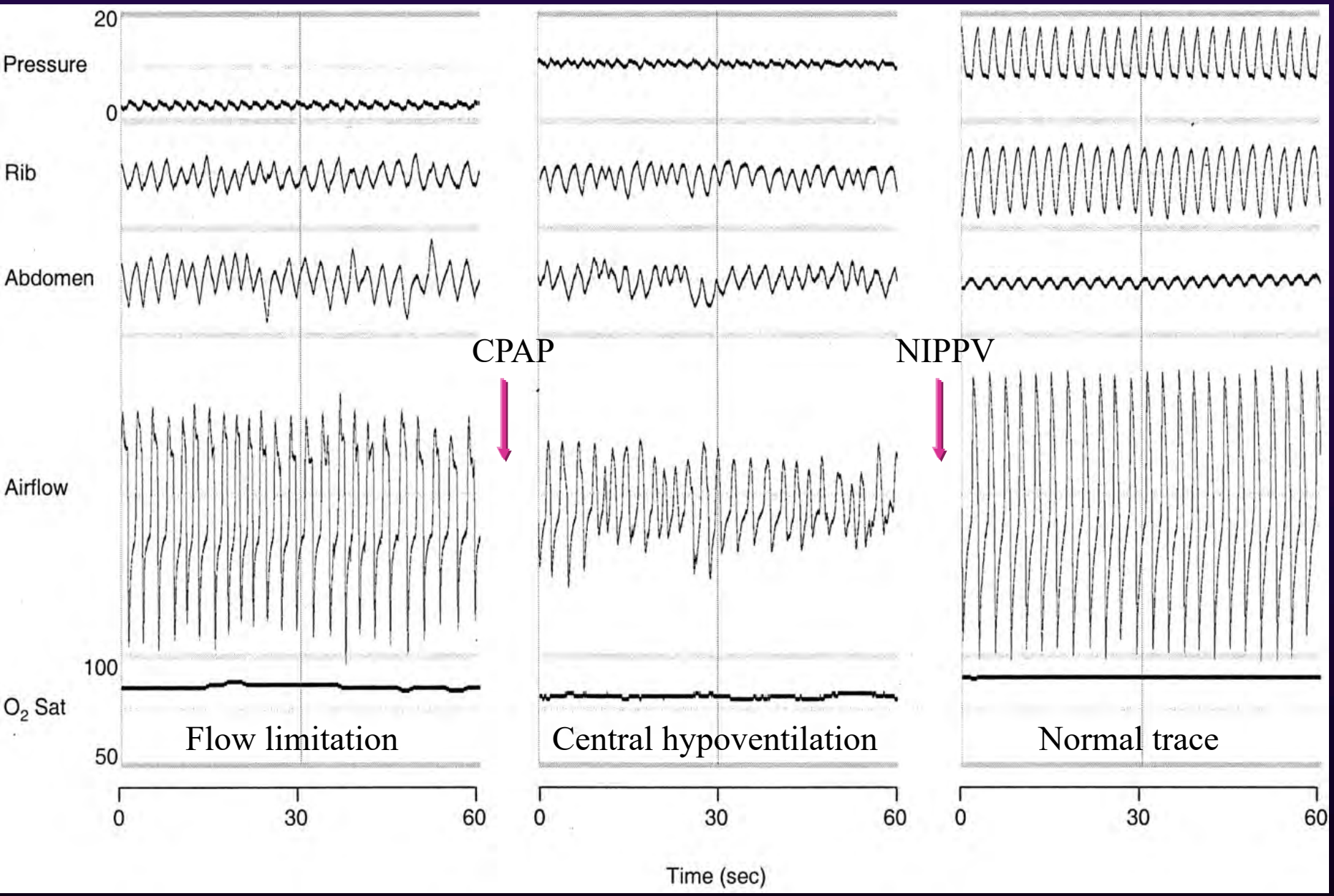
Quels sont les hypothèses face à une hypoventilation résiduelle sous VNI chez un obèse?

Table 2 Classification of ventilatory sleep disorders in obese subjects

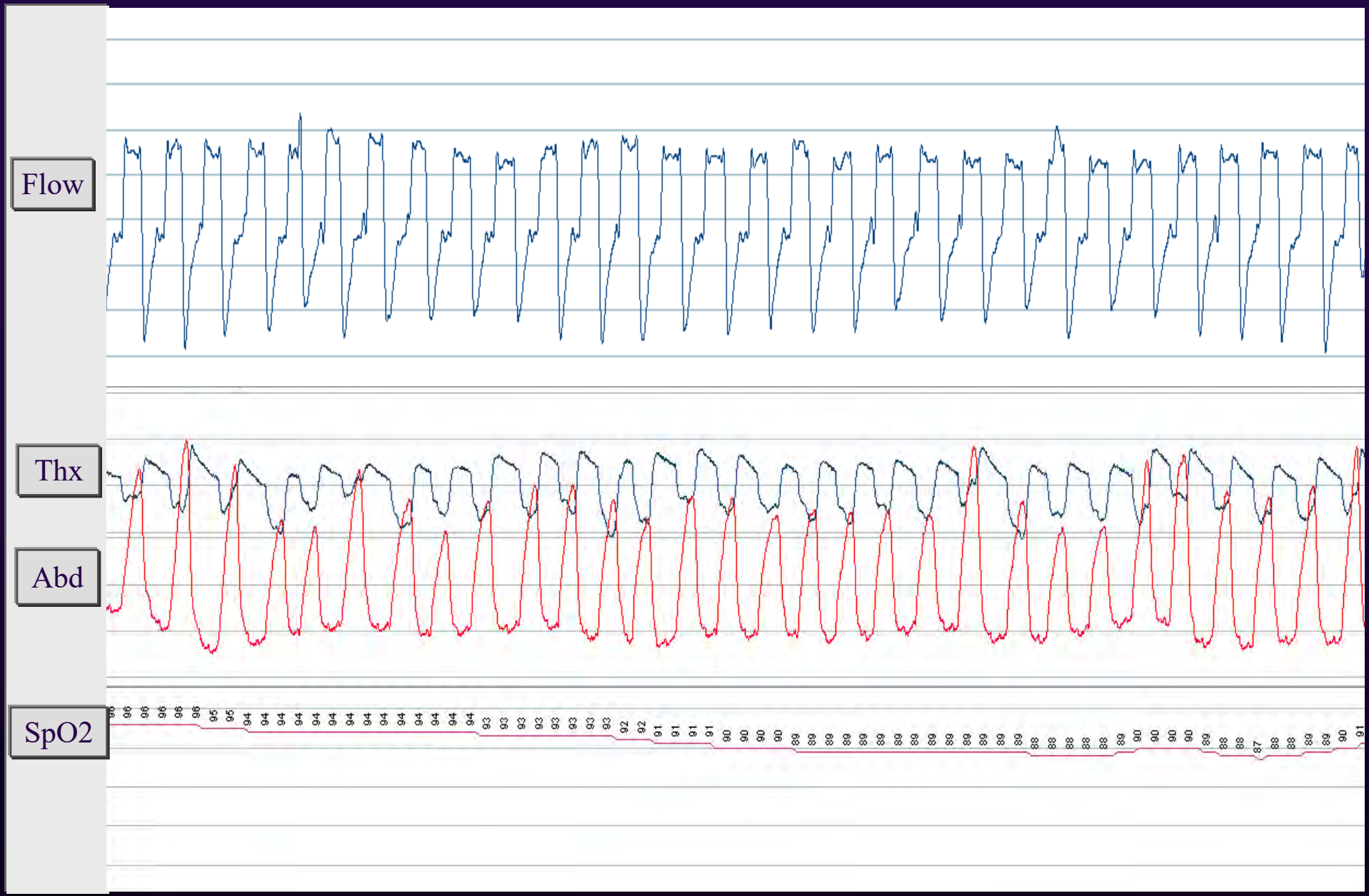
Obstructive apnoeas and/or hypopnoeas
Central apnoeas
Continuous oxygen desaturation
With nocturnal hypercapnia
Central hypoventilation (also named 'sleep hypoventilation')
'Obstructive' hypoventilation
Without nocturnal hypercapnia
Impairment of V'/Q' inequality

Veale et al, Breathe 2008

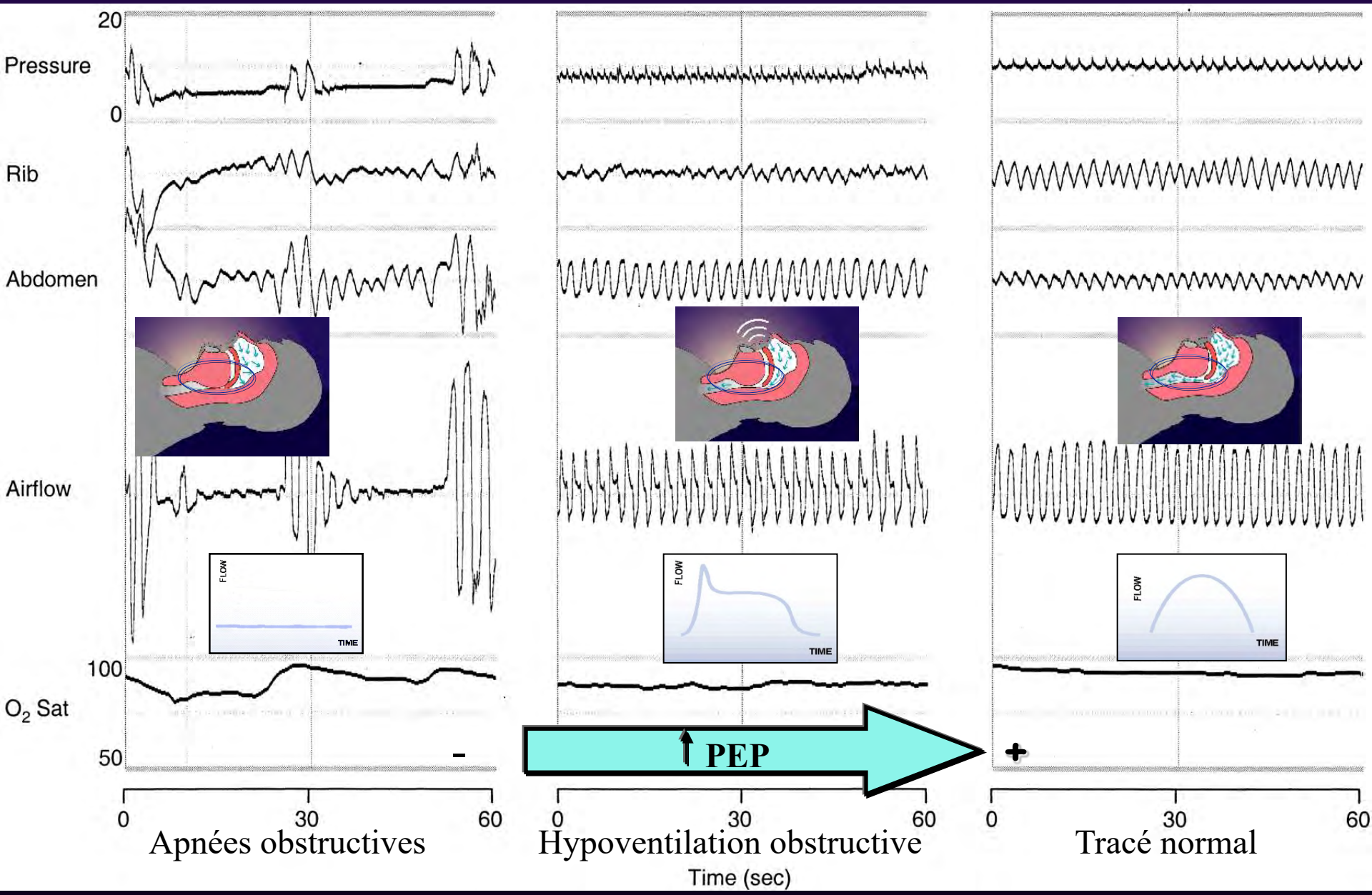
Hypoventilation « centrale » (page 2’)



Berger,. Chest 2001



Hypoventilation « obstructive » (page 2’)



Berger, K. I. et al. Chest 2001;120:1231-1238

Pas à pas (2)

Déceler et traiter le/s mécanisme/s de désaturation résiduelle

- $\dot{Q}$ → Aggravation des inégalités V/Q
- → Hypoventilation
  - ✓ Centrale
  - ✓ Obstructive

Plan

tionale d’utilisation d’un mode à ventilation cible

- Differents loops et paramètres de régulation.

cénarios potentiels (ou cibles…)

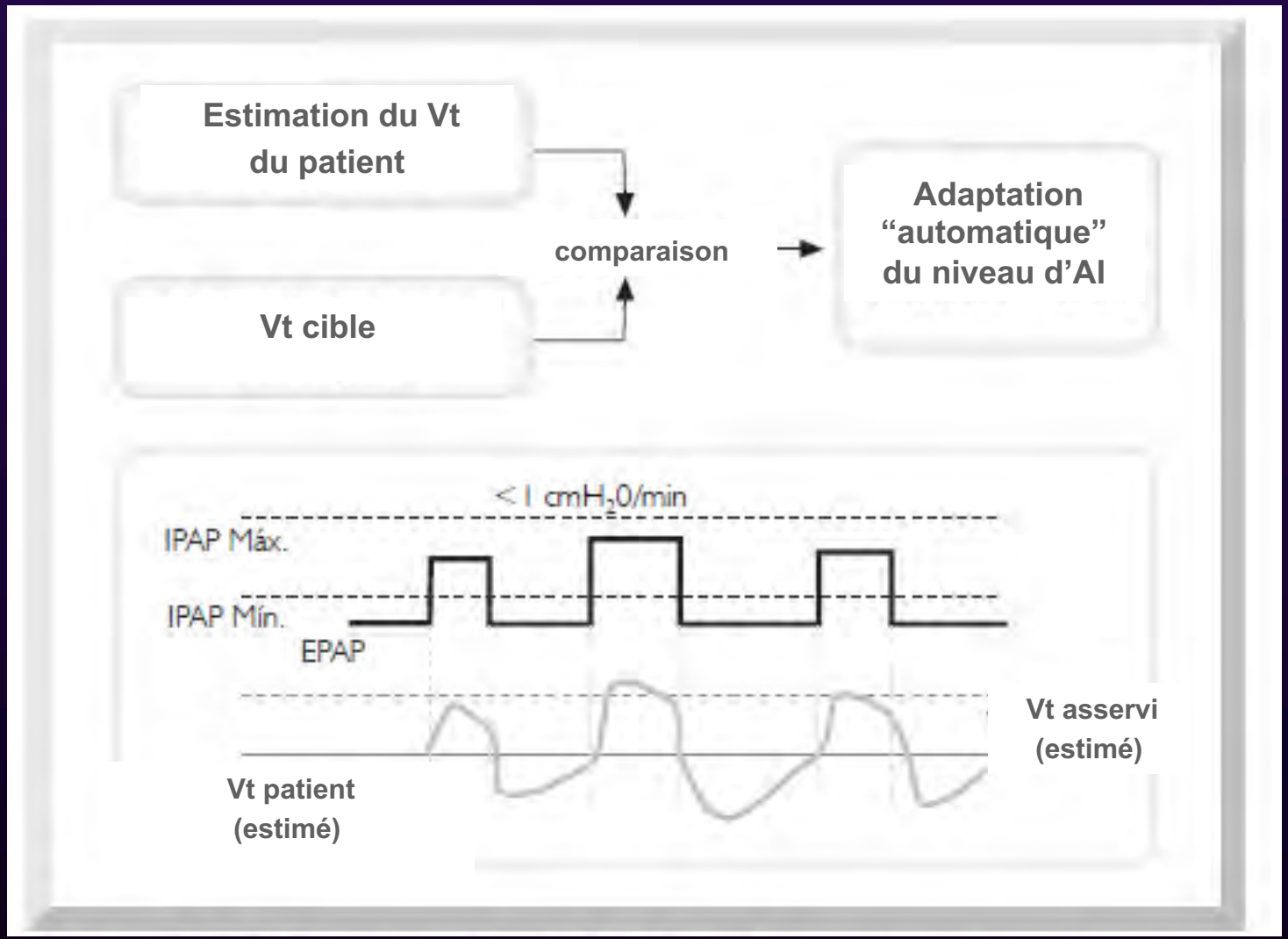
d’utilisationInconvenients potentiels

Différents loops et cibles de régulation des modes dit “inteligents”

- 3 types

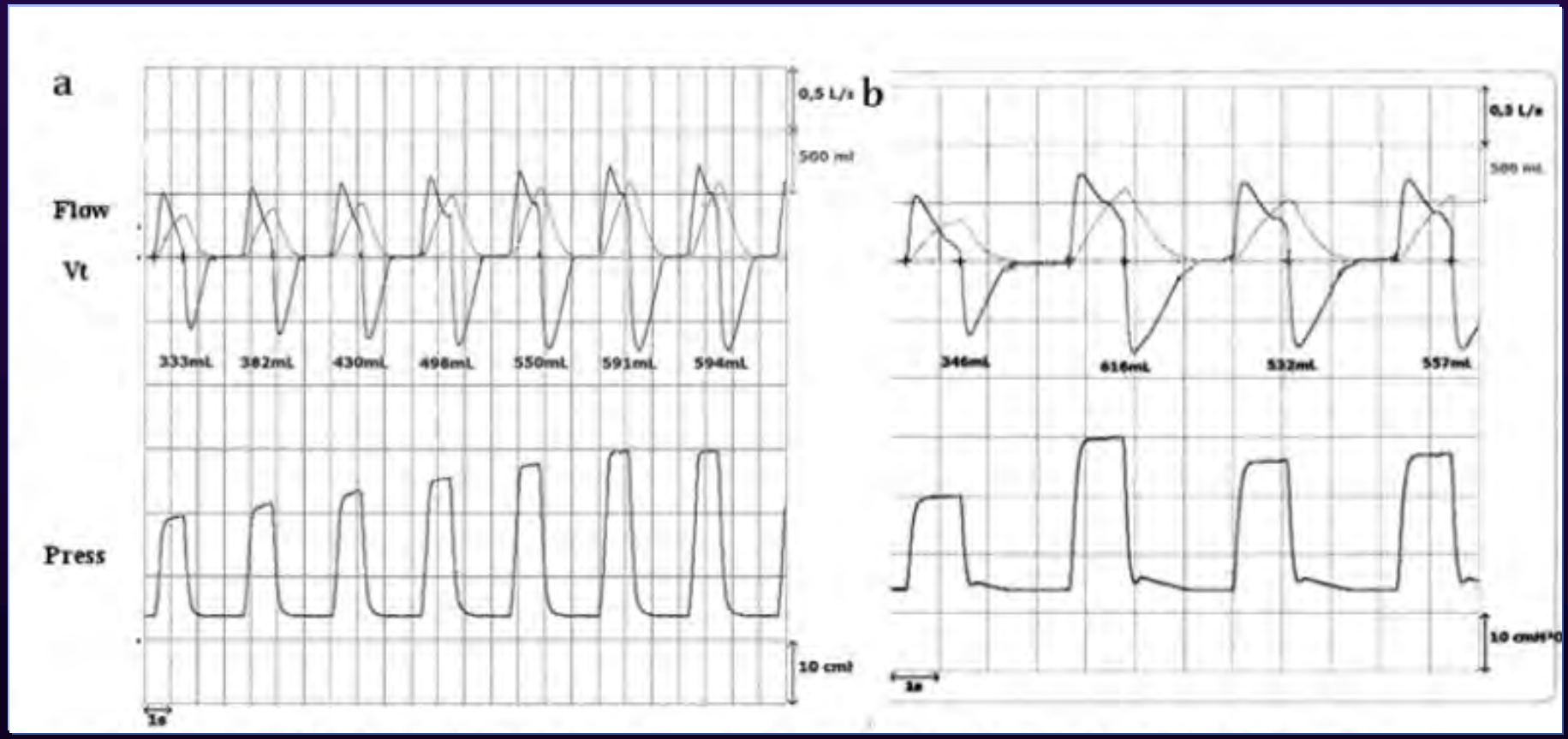
- ✓ a cible de Vt : Synchrony/Trilogy™ “AVAPS” (Philips), Vivo 50 ™ (Breas), Monnal T50 ™ (ALMS), Ventimotion ™ (Weinmann), VS3 (Resmed)
- ✓ à target de VM (variabilidad FR et VT) (“IVAPS”, Resmed)
- ✓a target de Vt + target de PEP auto (regulacion independiente de PS y PEEP) (“AVAPS AE”, Philips)

Le principe théorique

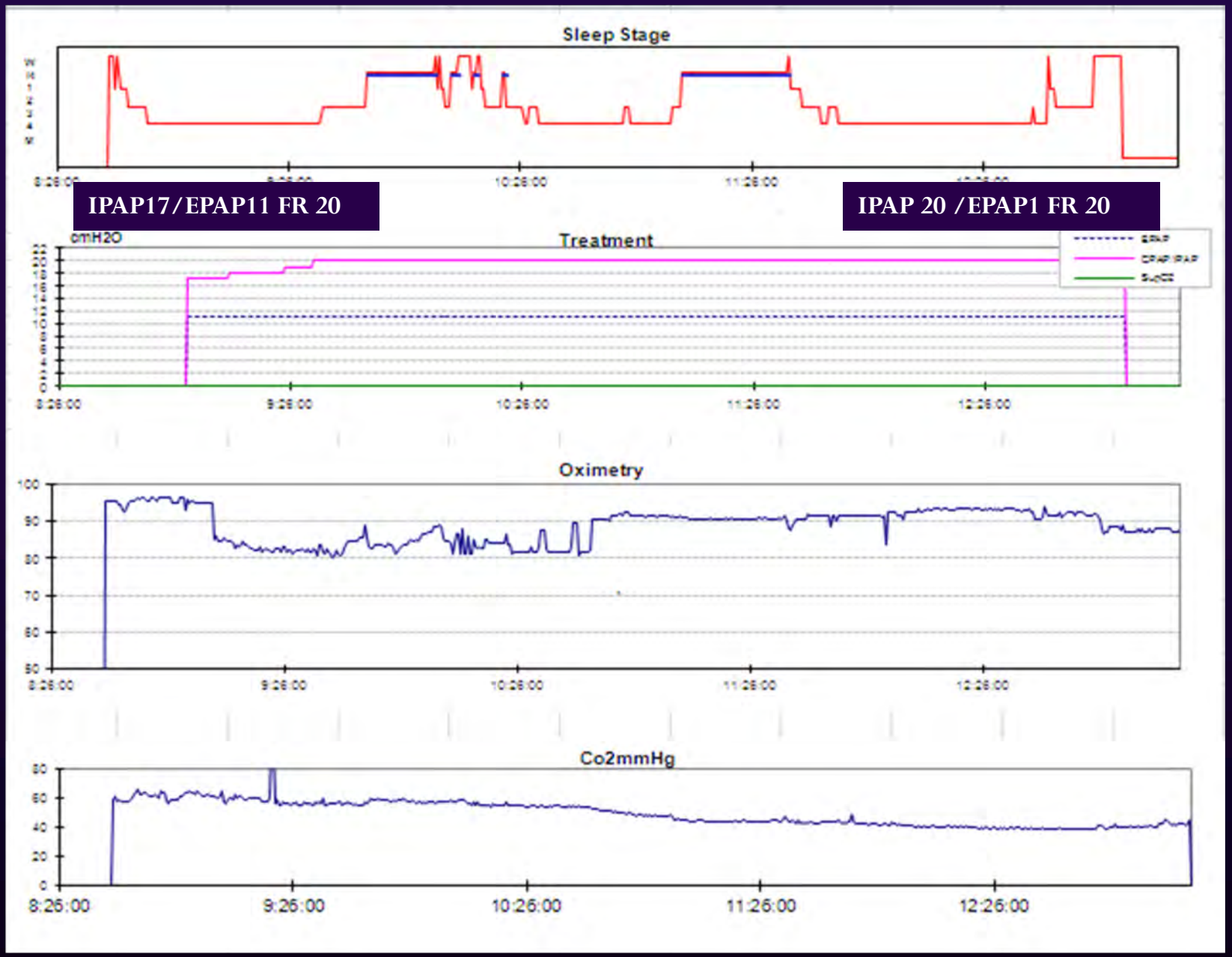


Remerciements à M. Torres Fraga

Vt target: modos de regulacion



Rabec, Thorax 2011



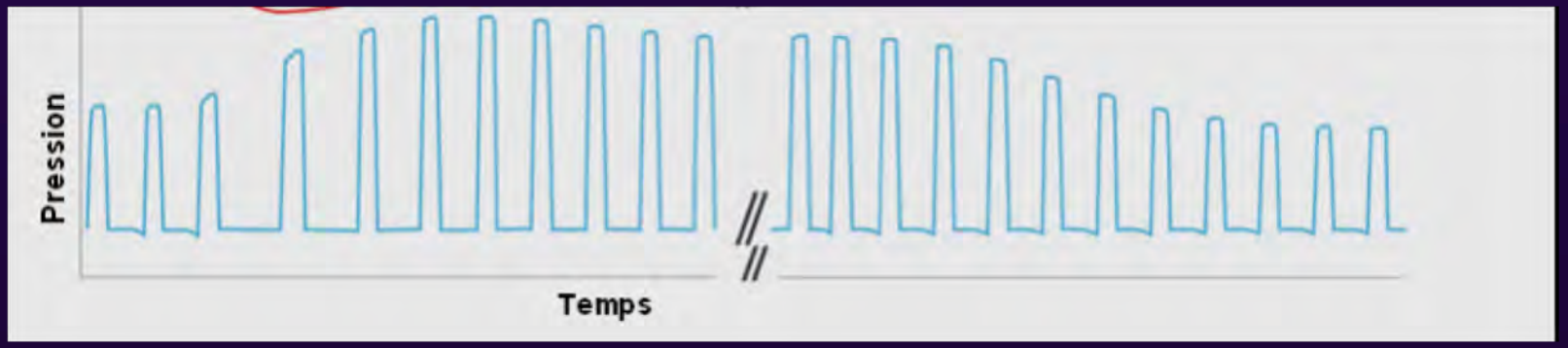
Remerciements à M. Torres Fraga

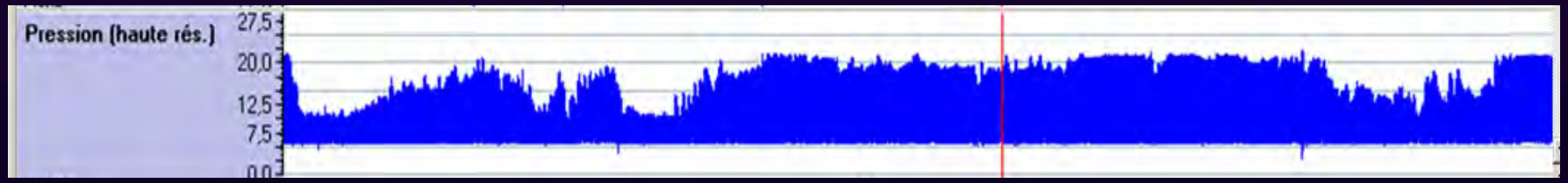
Différents loops et cibles de régulation des modes dit “inteligents”

- 3 types
  - ✓ a cible de Vt : Synchrony/Trilogy (“AVAPS” Philips), Vivo 50 (Breas), Monnal T50 (ALMS)

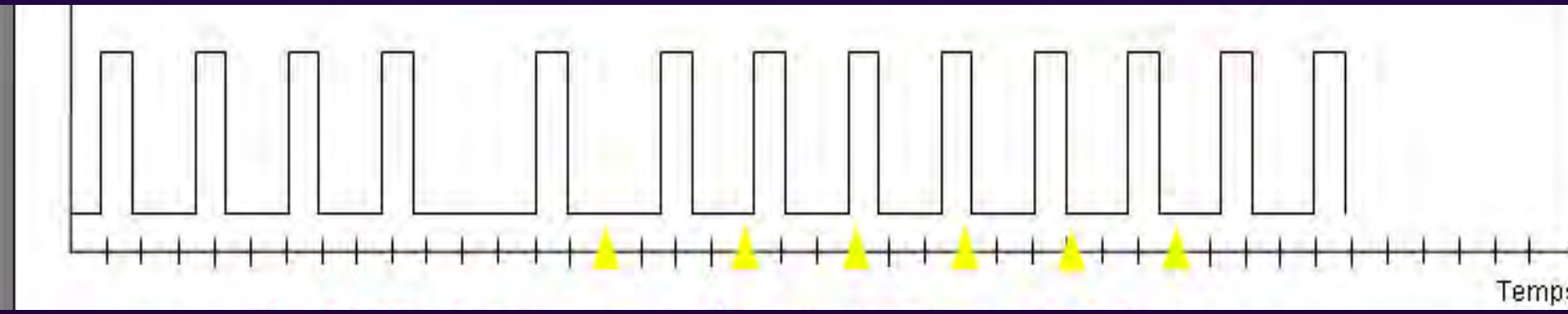
  - ✓ à cible de VM (V alv) → régulation conjointe de la pression et de la FR de backup (S9, Stellar, Lumis “IVAPS”™, Resmed)
  - ✓a target de Vt + target de PEP auto (regulacion independiente de PS y PEEP) (“AVAPS AE”, Philips)

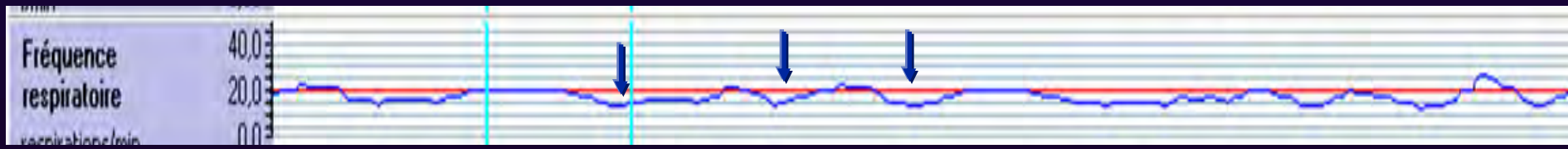
Pression variable dans une fourchette predeterminée

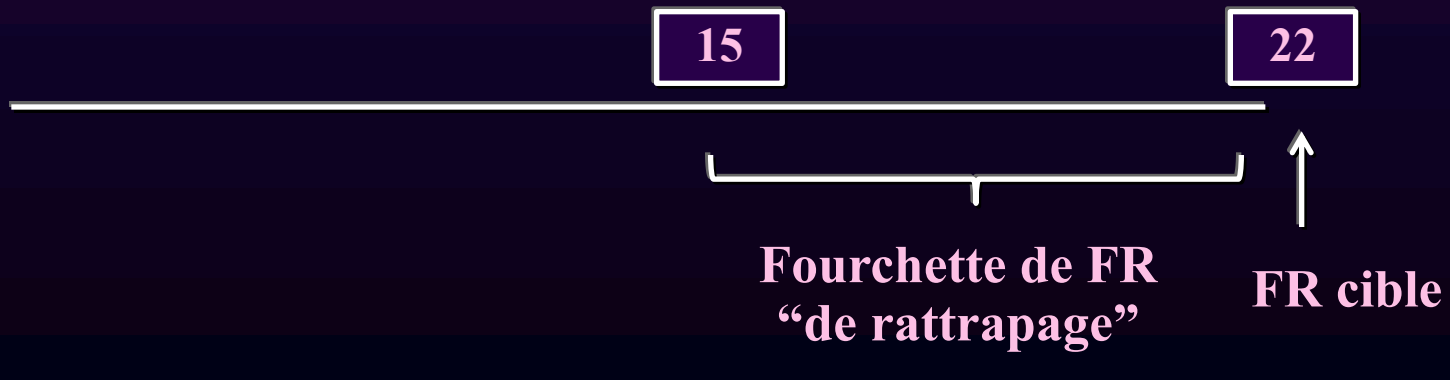




FR de rattrapage variable

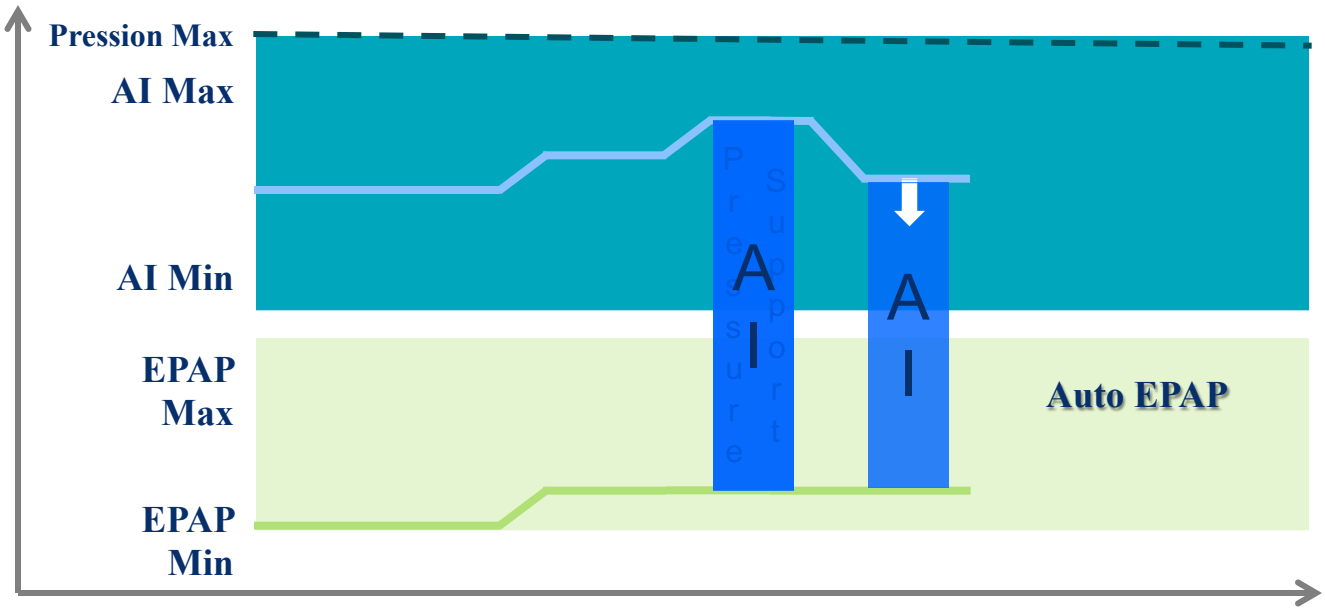


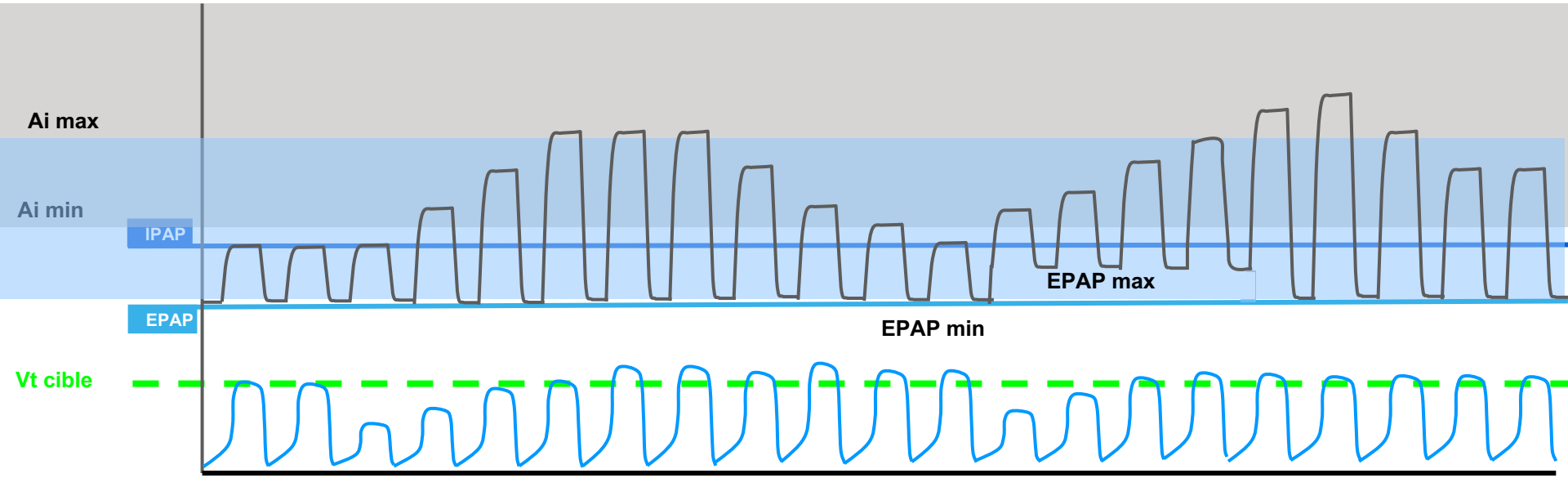




Différents loops et cibles de régulation des modes dit “inteligents”

- 3 types
  - ✓ a cible de Vt : Synchrony/Trilogy (“AVAPS” Philips), Vivo 50 (Breas), Monnal T50 (ALMS)
  - ✓ à target de VM (variabilidad FR et VT) (“IVAPS”, Resmed)
  - ✓ à cible de Vt + PEP auto →regulation independante de la PIP et la PEP ± FR (Synchrony, Trilogy “AVAPS AE”, Philips)

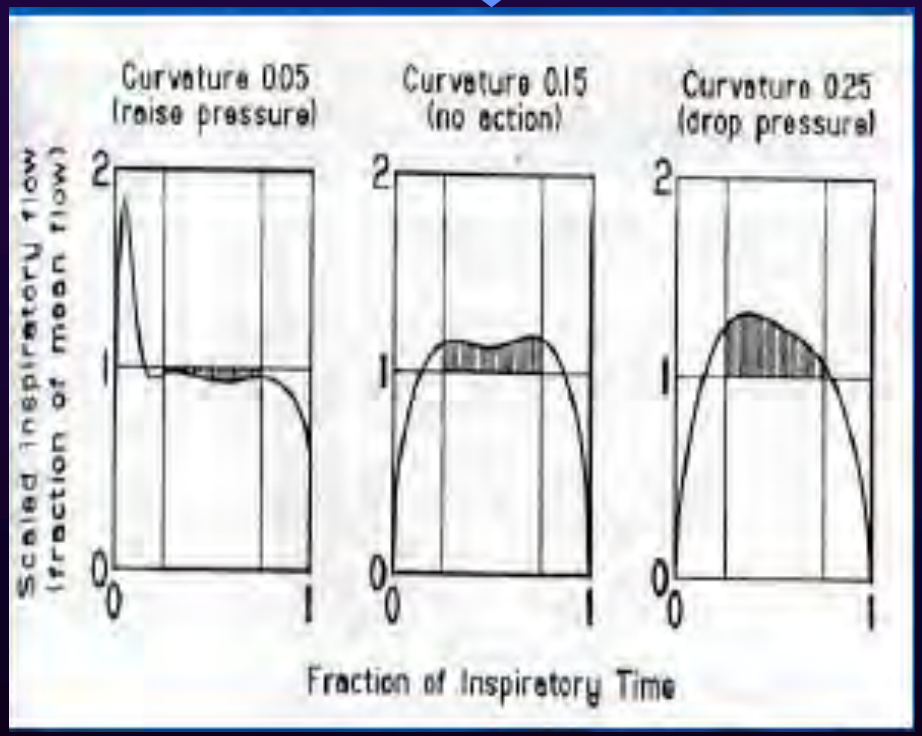




Remerciements L Makhlouf

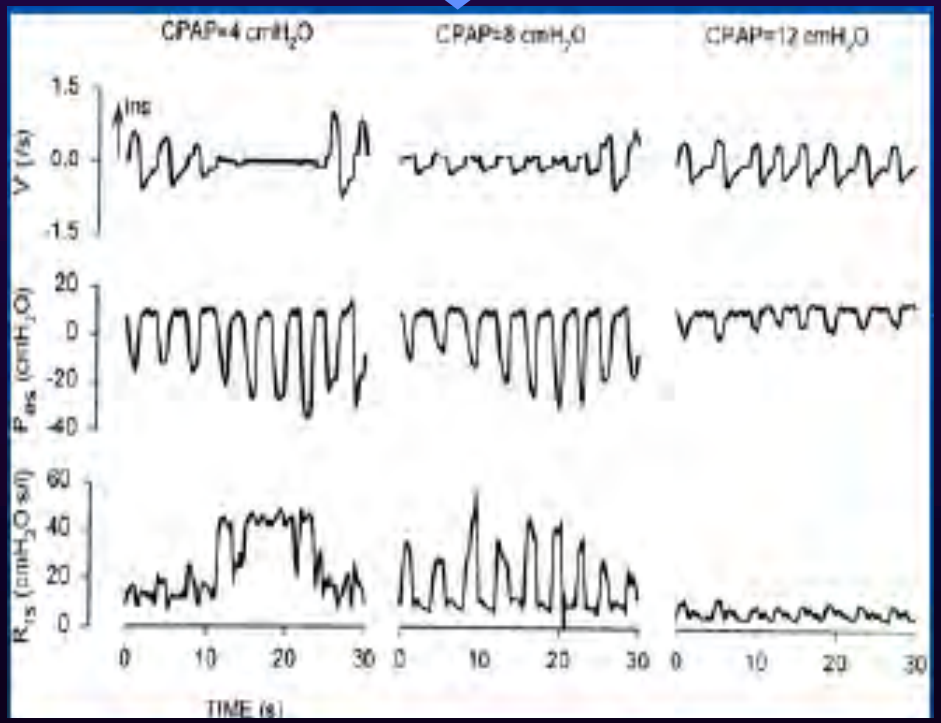
Comment “guetter” la VAS?
Deux cibles

Débit



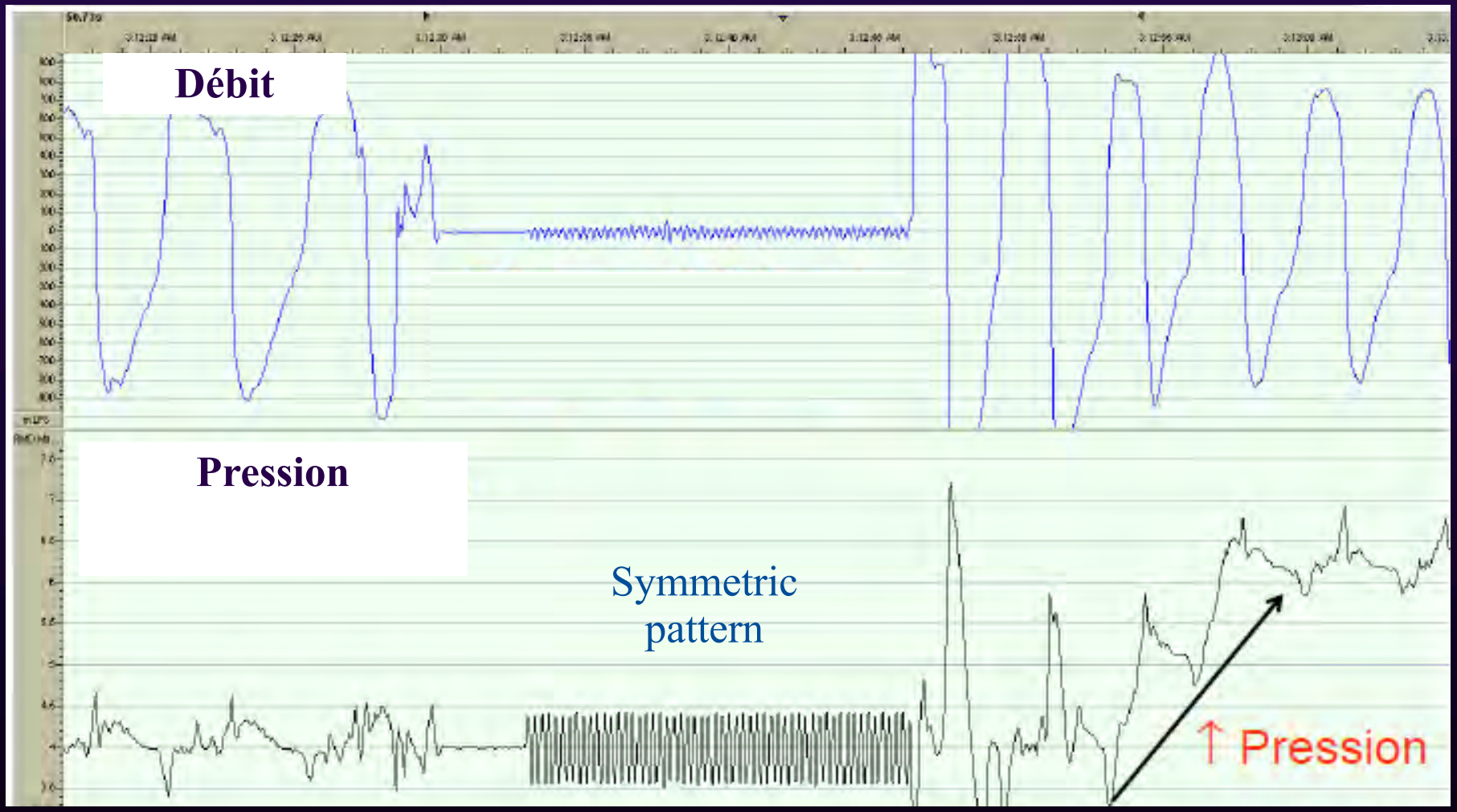
Pneumotach

Résistance VAS

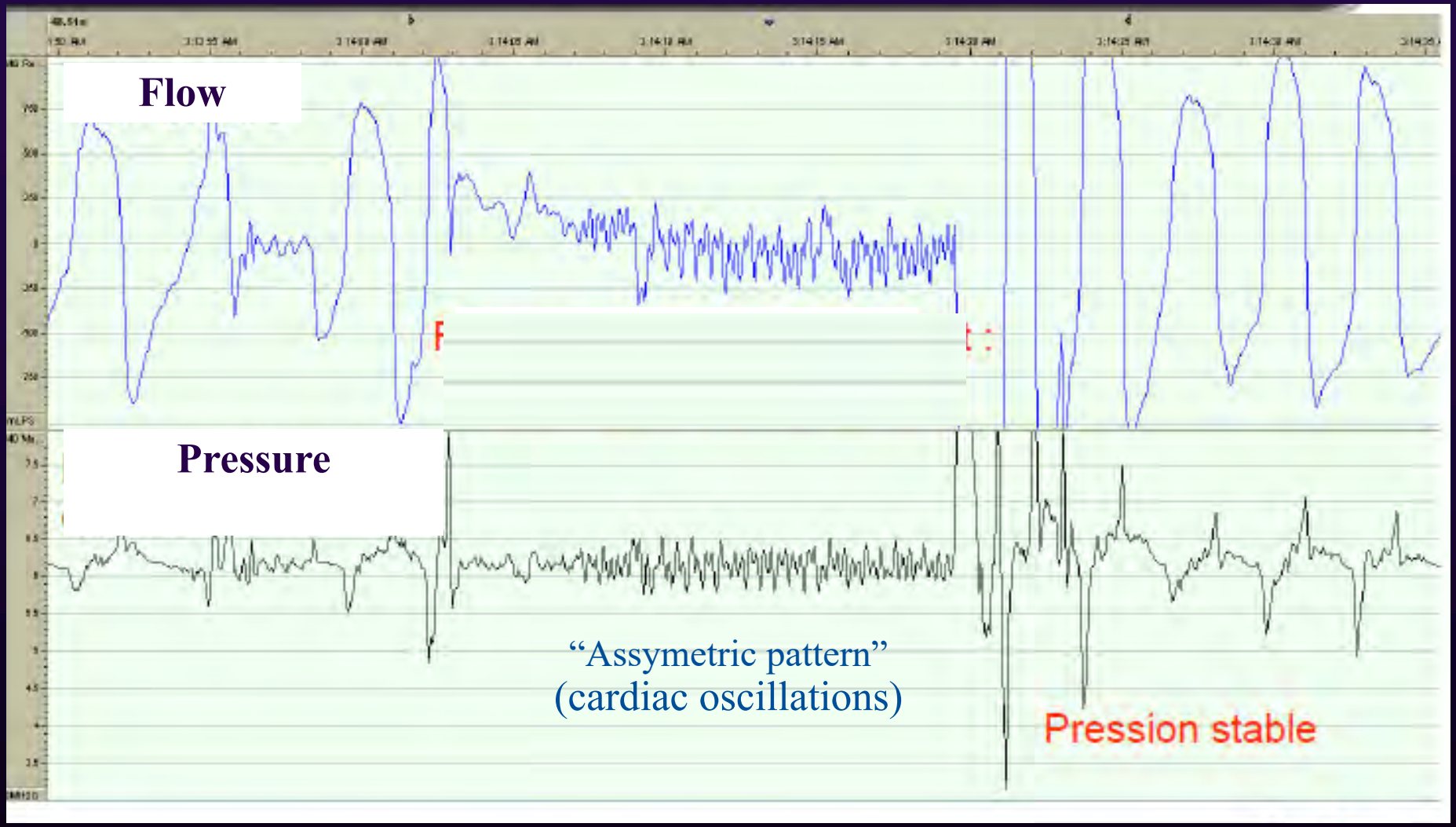


Oscillation forcée
ou réponse à un “pulse”

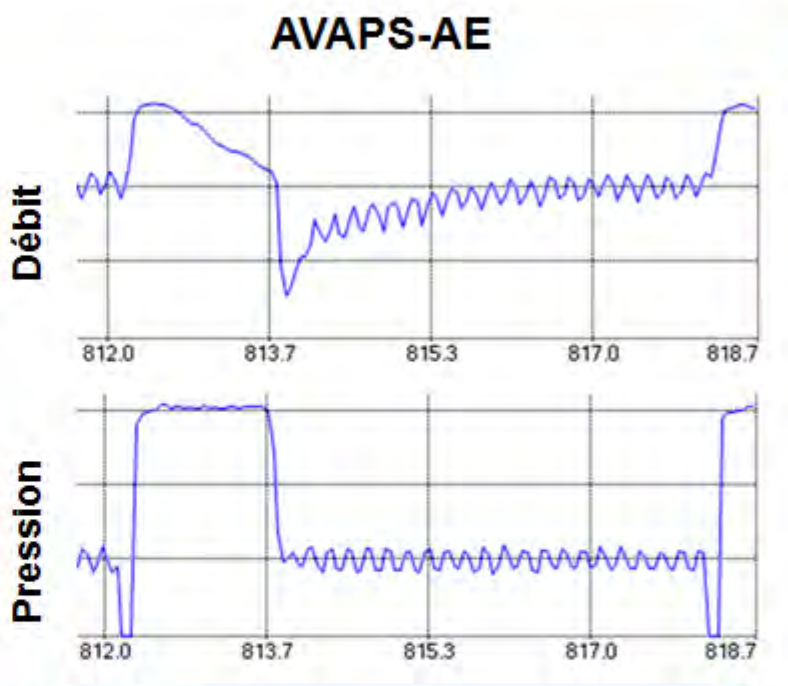
Closed UA



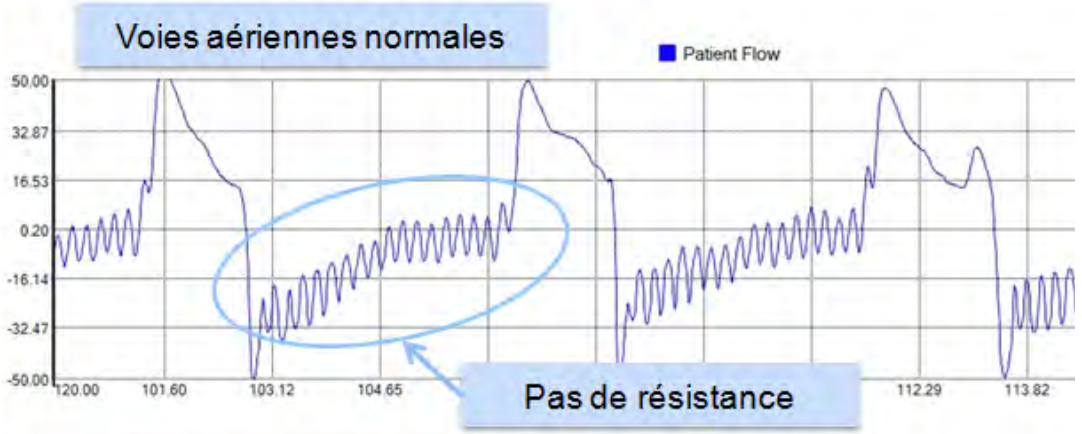
Open UA

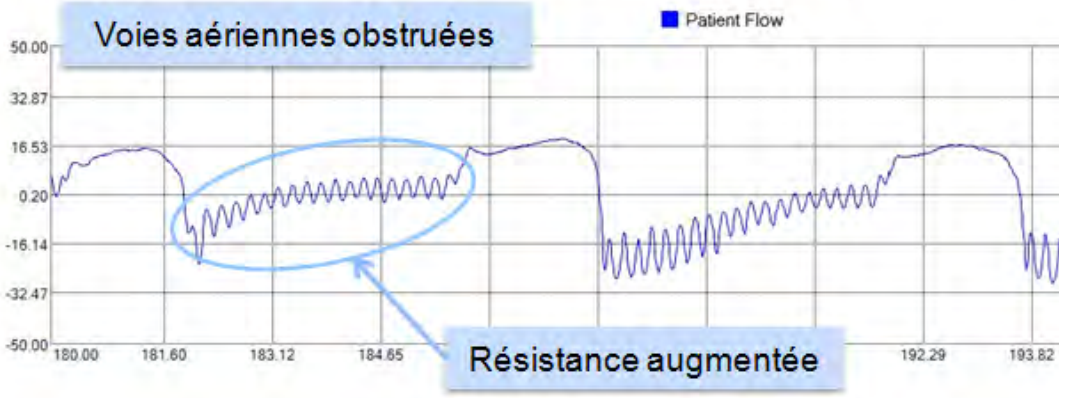

Flow
Pressure
"Assymetric pattern"
(cardiac oscillations)
Pression stable

AE : réponse aux variations de resistance de la VAS

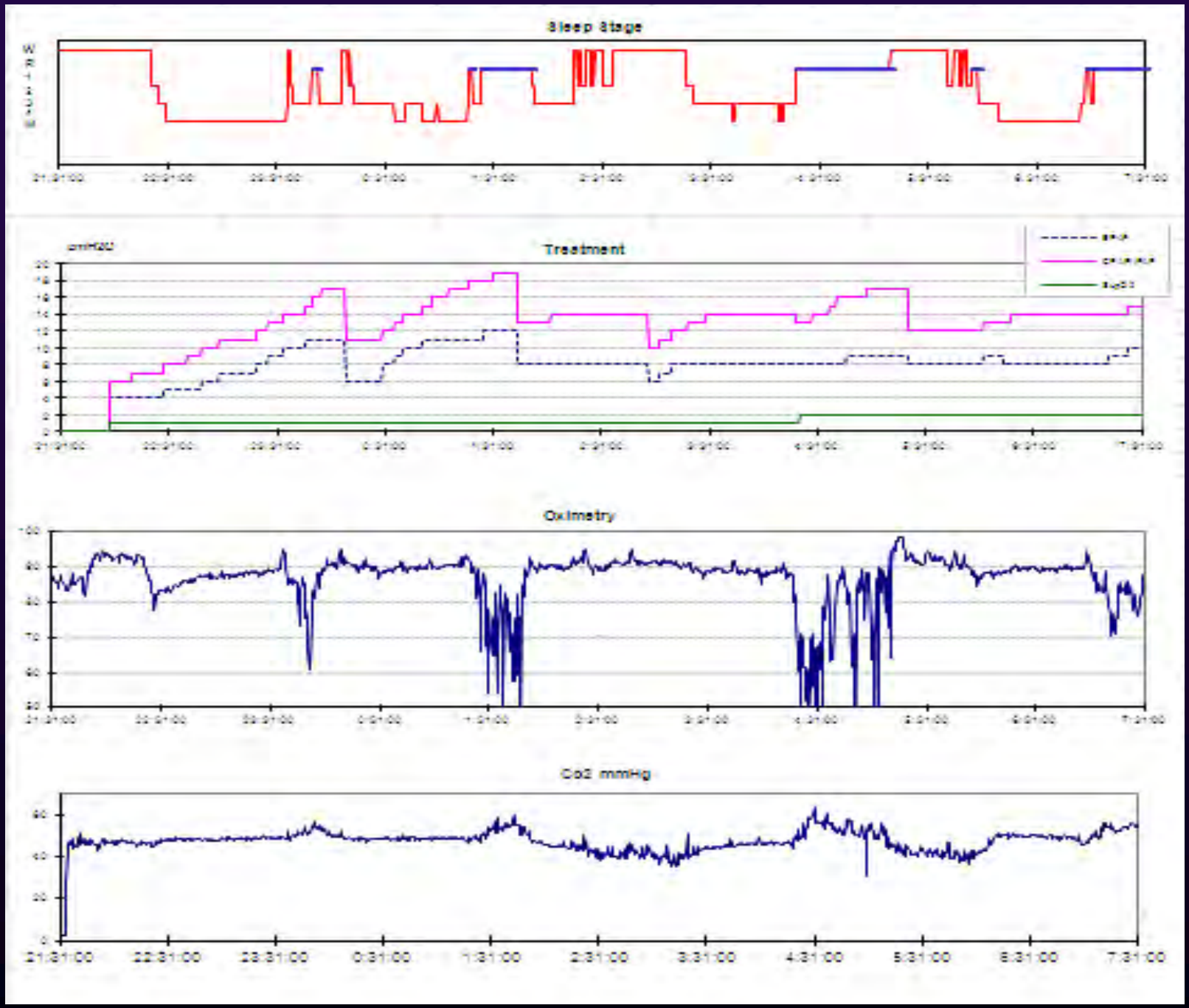


- Calcul de la resistance par oscillation forcée (FOT)
- Seulement sur les cycles avec débit stable (périodes de fuites non comptabilisées)





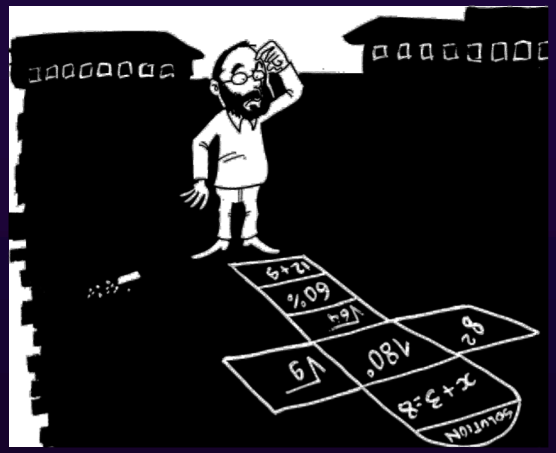
Courbes 11/02/2014 12:54 - 12/02/2014 04:13


Sleep Stage
W
R
1
2
3
4
21:31:00
22:31:00
23:31:00
0:31:00
1:31:00
2:31:00
3:31:00
4:31:00
5:31:00
6:31:00
7:31:00
cmH2O
Treatment
Oximetry
Co2 mmHg

…Et différents algothitmes et modelisations…

Prisma 40

Vivo 50/ 60



PR1/Trilogy

Prisma 25 /30

EOVE

Lumis/
Stellar/
Astral

Monnal T50

Plan

- Rationale d'utilisation d'un mode à ventilation cible
- Differents loops et paramètres de regulation.
- Scénarios potentiels (ou cibles…) d'utilisation
- Inconvenients potentiels

Scénarios potentiels (ou cibles…) d'utilisation d'un mode cible

- Utilisation systématique: un mode (une mode?) pour « tout le monde » (en remplacement du ST): chercher à automatiser au maximum la procédure de réglage
  - Objectif → supériorité? *(« top mode »)*
  - Objectif → non-infériorité mais simplification du réglage *(« easy mode »)*

- Utilisation experte « un mode réservé aux échecs du ST »

Il est grand temps de passer de la foi à la science

Qu'est-ce qu'il dit la presse?

Qu'est-ce qu'il dit la presse?

Nouvelles du front : 1) modes a Vt cible

CHEST

Original Research

RESPIRATORY CARE

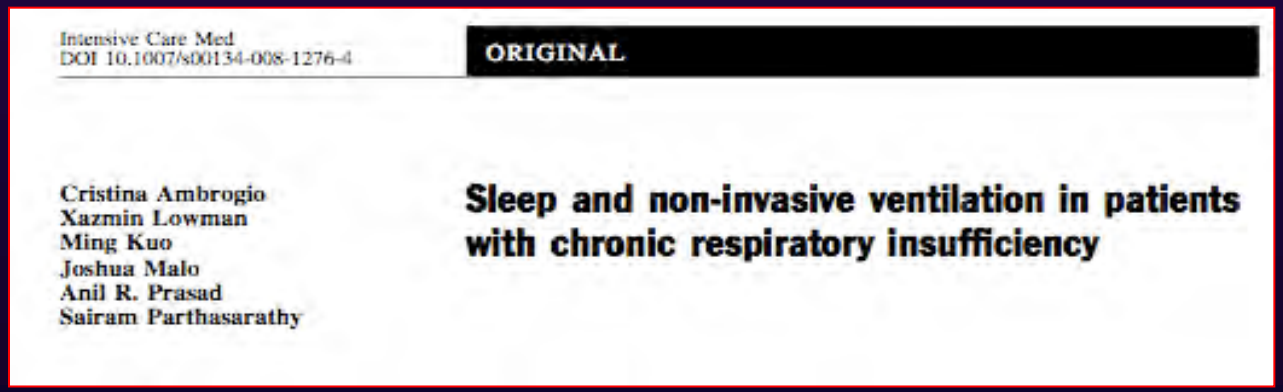
Average Volume-Assured Pressure Support in Obesity Hypoventilation*

A Randomized Crossover Trial

Jan Hendrik Storre, MD;† Benjamin Seuthe;† René Fiechter, MD; Stavroula Milioglou; Michael Dreher, MD; Stephan Sorichter, MD; and Wolfram Windisch, MD

6 sem X 2

SOH (AVAPS)



Intensive Care Med
DOI 10.1007/s00134-008-1276-4

ORIGINAL

Cristina Ambrogio
Xazmin Lowman
Ming Kuo
Joshua Malo
Anil R. Prasad
Sairam Parthasarathy

Sleep and non-invasive ventilation in patients with chronic respiratory insufficiency

1 nuit x2

IRC causes divers (AVAPS)

Respiratory Medicine (2008) xx, 1–8

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/rmed

ELSEVIER

Impact of volume targeting on efficacy of bi-level non-invasive ventilation and sleep in obesity-hypoventilation☆,☆☆

Jean-Paul Janssens [a,*], Marie Metzger [a], Emilia Sforza [b]

1 nuit x 2

SOH (AVAPS)

COPD: Journal of Chronic Obstructive Pulmonary Disease, 7:398–403
ISSN: 1541-2555 print / 1541-2563 online

DOI: 10.3109/15412555.2010.528084

informa
healthcare

ORIGINAL RESEARCH

A Randomised Crossover Trial Comparing Volume Assured and Pressure Preset Noninvasive Ventilation in Stable Hypercapnic COPD

Nicholas Stephen Oscroft (nickoscroft@doctors.net.uk), **Masood Ali** (masood.ali@papworth.nhs.uk), **Atul Gulati** (atul.gulati@papworth.nhs.uk), **Michael Gordon Davies** (michael.davies@papworth.nhs.uk), **Timothy George Quinnell** (timothy.quinnell@papworth.nhs.uk), **John Michael Shneerson** (john.shneerson@papworth.nhs.uk), and **Ian Edward Smith** (ian.smith@papworth.nhs.uk)

Respiratory Support and Sleep Centre, Papworth Hospital NHS Foundation Trust, Papworth Everard, Cambridge, UK CB23 3RE

BPCO
2x 4sem
(AVAPS)

ORIGINAL ARTICLE

Volume targeted versus pressure support non-invasive ventilation in patients with super obesity and chronic respiratory failure: a randomised controlled trial

Patrick Brian Murphy,[1,2] Craig Davidson,[2] Matthew David Hind,[3] Anita Simonds,[3] Adrian J Williams,[2] Nicholas S Hopkinson,[3] John Moxham,[1] Michael Polkey,[3] Nicholas Hart[4]

SOH 3 mois
(randomisée
controlée)
(AVAPS)

Qu'est-ce qu'il dit la presse?

Nouvelles du front : 2) modes a Valv cible

ORIGINAL RESEARCH

Minute Ventilation During Spontaneous Breathing, High-Intensity Noninvasive Positive Pressure Ventilation and Intelligent Volume Assured Pressure Support in Hypercapnic COPD

COPD 2014

Emelie Ekkernkamp,[1] Hans-Joachim Kabitz,[1] David J. Walker,[1] Claudia Schmoor,[2] Jan H. Storre,[3] Wolfram Windisch,[3] and Michael Dreher[4]

BPCO (IVAPS)

BPCO (IVAPS)

Impact of Intelligent Volume-Assured Pressure Support on Sleep Quality in Stable Hypercapnic Chronic Obstructive Pulmonary Disease Patients: A Randomized, Crossover Study

Resp iration 2014

Emelie Ekkernkamp[a] Jan H. Storre[b] Wolfram Windisch[b] Michael Dreher[c]

Home Mechanical Ventilation for COPD: High-Intensity Versus Target Volume Noninvasive Ventilation

Resp Care 2014

Jan H Storre MD, Elena Matrosovich MD, Emelie Ekkernkamp MD, David J Walker MD, Claudia Schmoor PhD, Michael Dreher MD, and Wolfram Windisch MD

BPCO (IVAPS)

Etiologies diverses (IVAPS)

Randomized trial of 'intelligent' autotitrating ventilation versus standard pressure support non-invasive ventilation: Impact on adherence and physiological outcomes

Respirology 2014

JULIA L. KELLY,* JAY JAYE,* RACHEL E. PICKERSGILL, MICHELLE CHATWIN, MARY J. MORRELL AND ANITA K. SIMONDS

Scénarios potentiels (ou cibles…) d'utilisation

- Utilisation systématique « un mode (une mode?) pour « tout le monde » (en remplacement du ST): chercher à automatiser au maximum la procédure de reglage
  - Objectif → superiorité? *(« top mode »)*
  - Objectif → non-inferiorité mais simplification du reglage *(« easy mode »)*
- Utilisation experte « un mode réservé aux échecs du ST »

Storre	Stable OHS (n=10)	ST : IPAP 20, AVAPS : Vt 7-10 ml/IBW IPAP set between EPAP and 30 mb	Greater reduction in tcPCO2 with AVAPS No differences in sleep or HRQL
Janssens	Stable OHS (n=12)	ST : usual ventilator settings, AVAPS: Vt: 8-12 ml/kg IBW Minimal IPAP set between usual level minus 3, and 30 mb	Greater reduction in tcPCO2 with AVAPS at the expense of decrease in objective and subjective quality of sleep and comfort
Ambroggio	Stable mixed population (n=39, most OHS)	ST: usual ventilator settings, AVAPS: Vt 110% of baseline during 6 mb CPAP or 8 ml/kg IBW	Greater increase of VE and Vt with AVAPS No differences in sleep quality or ABG
Crisafulli	Stable COPD (n=9)	ST: IPAP at maximal tolerated (up to 30 mb), AVAPS: Vt 8 ml/IBW. IPAP set between EPAP and 30 mb	Greater improvement in subjective quality of sleep with AVAPS. No differences in ABG, comfort or compliance
Oscroft	COPD (n=25)	ST: usual ventilator settings, IVAPS: Target Vt as obtained by applying ST ventilation at usual settings. Maximal IPAP 25	No differences
Murphy	OHS (n=46)	Initial settings: for ST IPAP at 18-22 mb, for AVAPS: target Vt 8-10 ml/IBW and I IPAP set between EPAP + 4 and 30 mb. Progressively adjusted	No differences
Eikkenkamp	COPD (n=14)	PAC: stepwise increases in IPAP and RR in order to achieve maximally decrease PaCO2, IVAPS: target alveolar ventilation and RR as obtained by applying PAC settings. IPAP range set between -5 + 5 from the pressure support	Reported sleep better with IVAPS at 6 weeks. No difference neither in quality of sleep, sleep efficiency, and subjective comfort nor in ABG
Eikkenkamp	COPD (n=22)	PAC: previous usual settings. IVAPS: target alveolar ventilation and target RR as obtained by applying PAC settings during daytime ventilation. Inspiratory pressure support between 10 and 30 mb	Same effect of both PAC and IVAPS in obese patients with no significant differences in MV between both modes
Jaye	Mixed population (n=18)	ST: IPAP set at "maximally tolerated" pressure, RR just below spontaneous rate IVAPS: Target alveolar ventilation and back up RR calculated over an awake learn period while breathing at CPAP 4 mb	Better adherence with IVAPS, no difference in objective quality of sleep, tolerance, overnight SpO2 or PtcCO2. Lower mean delivered PS with IVAPS

Storre	Stable OHS (n=10)	ST : IPAP 20, AVAPS : Vt 7-10 ml/IBW IPAP set between EPAP and 30 mb	Greater reduction in tcPCO2 with AVAPS No differences in sleep or HRQL
Janssens	Stable OHS (n=12)	ST : usual ventilator settings, AVAPS: Vt: 8-12 ml/kg IBW Minimal IPAP set between usual level minus 3, and 30 mb	Greater reduction in tcPCO2 with AVAPS at the expense of decrease in objective and subjective quality of sleep and comfort
Ambroggio	Stable mixed population (n=39, most OHS)	ST : usual ventilator settings, AVAPS: Vt 110% of baseline during 6 mb CPAP or 8 ml/kg IBW	Greater increase of VE and Vt with AVAPS No differences in sleep quality or ABG
Crisafulli	Stable COPD (n=9)	ST : IPAP at maximal tolerated (up to 30 mb), AVAPS: Vt 8 ml/IBW. IPAP set between EPAP and 30 mb	Greater improvement in subjective quality of sleep with AVAPS. No differences in ABG, comfort or compliance
Oscroft	COPD (n=25)	ST : usual ventilator applying ST ventilati	rences
Murphy	OHS (n=46)	Initial settings: for S 8-10 ml/IBW and I IP Progressively adjust	rences
Eikkenkam	COPD (n=14)	PAC: stepwise incre maximally decrease PaCO2, IVAPS: target alveolar ventilation and RR as obtained by applying PAC settings. IPAP range set between -5 + 5 from the pressure support	d sleep better with IVAPS at 6 weeks. No difference neither in quality of sleep, sleep efficiency, and subjective comfort nor in ABG
Eikkenkam	COPD (n=22)	PAC: previous usual settings. IVAPS: target alveolar ventilation and target RR as obtained by applying PAC settings during daytime ventilation. Inspiratory pressure support between 10 and 30 mb	Same effect of both PAC and IVAPS in obese patients with no significant differences in MV between both modes
Jaye	Mixed population (n=18)	ST : IPAP set at "maximally tolerated" pressure, RR just below spontaneous rate IVAPS: Target alveolar ventilation and back up RR calculated over an awake learn period while breathing at CPAP 4 mb	Better adherence with IVAPS, no difference in objective quality of sleep, tolerance, overnight SpO2 or PtcCO2. Lower mean delivered PS with IVAPS

Populations hétérogènes, faibles effectifs

Storre	Stable OHS (n=10)	ST : IPAP 20, AVAPS : Vt 7-10 ml/IBW IPAP set between EPAP and 30 mb	Greater reduction in tcPCO2 with AVAPS No differences in sleep or HRQL
Janssens	Stable OHS (n=12)	ST : usual ventilator settings, AVAPS: Vt: 8-12 ml/kg IBW Minimal IPAP set between usual level minus 3, and 30 mb	Greater reduction in tcPCO2 with AVAPS at the expense of decrease in objective and subjective quality of sleep and comfort
Ambroggio	Stable mixed population (n=39, most OHS)	ST: usual ventilator settings, AVAPS: Vt 110% of baseline during 6 mb CPAP or 8 ml/kg IBW	Greater increase of VE and Vt with AVAPS No differences in sleep quality or ABG
Crisafulli	Stable COPD (n=9)	ST: IPAP at maximal tolerated (up to 30 mb), AVAPS: Vt 8 ml/IBW. IPAP set between EPAP and 30 mb	Greater improvement in subjective quality of sleep with AVAPS. No differences in ABG, comfort or compliance
Oscroft	COPD (n=25)	ST: usual ventilator settings, IVAPS: Target Vt as obtained by applying ST ventilation at usual settings. Maximal IPAP 25	No differences
Murphy	OHS (n=46)	Initial settings: for ST IPAP at 18-22 mb, for AVAPS: target Vt 8-10 ml/IBW and I IPAP set between EPAP + 4 and 30 mb. Progressively adjusted	No differences
Eikkenkamp	COPD (n=14)	PAC: stepwise increases in IPAP and RR in order to achieve maximally decrease PaCO2, IVAPS: target alveolar ventilation and RR as obtained by applying PAC settings. IPAP range set between -5 + 5 from the pressure support	
Eikkenkamp	COPD (n=22)	PAC: previous usual settings. IVAPS: target alveolar ventilation and target RR as obtained by applying PAC settings during daytime ventilation. Inspiratory pressure support between 10 and 30 mb	
Jaye	Mixed population (n=18)	ST: IPAP set at "maximally tolerated" pressure, RR just below spontaneous rate IVAPS: Target alveolar ventilation and back up RR calculated over an awake learn period while breathing at CPAP 4 mb	Better adherence with IVAPS, no difference in objective quality of sleep, tolerance, overnight SpO2 or PtcCO2. Lower mean delivered PS with IVAPS

Réglages et algorithmes hétérogènes,

Storre	Stable OHS (n=10)	ST : IPAP 20, AVAPS : Vt 7-10 ml/IBW IPAP set between EPAP and 30 mb	Greater reduction in tcPCO2 with AVAPS No differences in sleep or HRQL
Janssens	Stable OHS (n=12)	ST : usual ventilator settings, AVAPS: Vt: 8-12 ml/kg IBW Minimal IPAP set between usual level minus 3, and 30 mb	Greater reduction in tcPCO2 with AVAPS at the expense of decrease in objective and subjective quality of sleep and comfort
Ambroggio	Stable mixed population (n=39, most OHS)	ST: usual ventilator settings, AVAPS: Vt 110% of baseline during 6 mb CPAP or 8 ml/kg IBW	Greater increase of VE and Vt with AVAPS No differences in sleep quality or ABG
Crisafulli	Stable COPD (n=9)	ST: IPAP at maximal tolerated (up to 30 mb), AVAPS: Vt 8 ml/IBW. IPAP set between EPAP and 30 mb	Greater improvement in subjective quality of sleep with AVAPS. No differences in ABG, comfort or compliance
Oscroft	COPD (n=25)	ST: usual ventilator settings, IVAPS: Target Vt as obtained by applying ST ventilation at usual settings. Maximal IPAP 25	No differences
Murphy	OHS (n=46)	Initial settings: for ST IPAP at 18-22 mb, for AVAPS: target Vt 8-10 ml/IBW and I IPAP set between EPAP + 4 and 30 mb. Progressively adjusted	No differences
Eikkenkamp	COPD (n=14)	PAC: stepwise increases in IPAP and RR in order to achieve maximally decrease PaCO2, IVAPS: target alveolar ventilation and RR as obtained by applying PAC settings. IPAP range set between -5 + 5 from the pressure support	**Différents Vt cible**
Eikkenkamp	COPD (n=22)	PAC: previous usual settings. IVAPS: target alveolar ventilation and target RR as obtained by applying PAC settings during daytime ventilation. Inspiratory pressure support between 10 and 30 mb	patients with no significant differences in MV between both modes
Jaye	Mixed population (n=18)	ST: IPAP set at "maximally tolerated" pressure, RR just below spontaneous rate IVAPS: Target alveolar ventilation and back up RR calculated over an awake learn period while breathing at CPAP 4 mb	Better adherence with IVAPS, no difference in objective quality of sleep, tolerance, overnight SpO2 or PtcCO2. Lower mean delivered PS with IVAPS

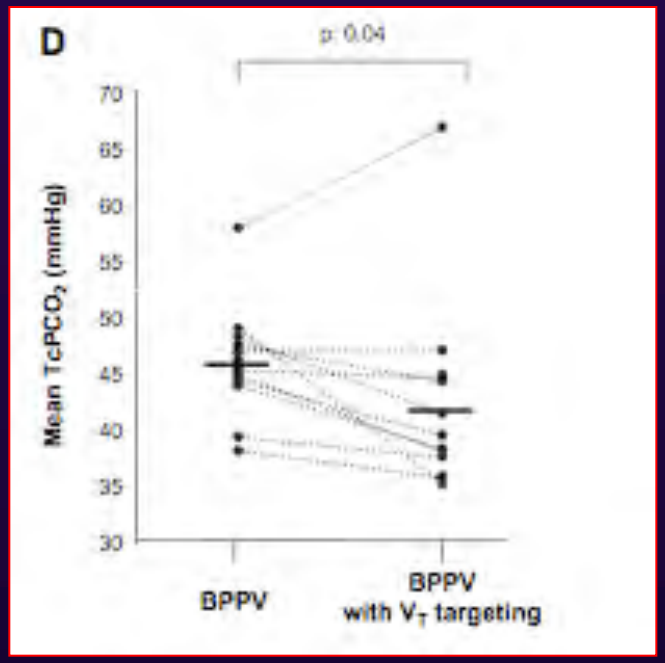
Storre	Stable OHS (n=10)	ST : IPAP 20, AVAPS : Vt 7-10 ml/IBW IPAP set between EPAP and 30 mb	Greater reduction in tcPCO2 with AVAPS No differences in sleep or HRQL
Janssens	Stable OHS (n=12)	ST : usual ventilator settings, AVAPS: Vt: 8-12 ml/kg IBW Minimal IPAP set between usual level minus 3, and 30 mb	Greater reduction in tcPCO2 with AVAPS at the expense of decrease in objective and subjective quality of sleep and comfort
Ambroggio	Stable mixed population (n=39, most OHS)	ST: usual ventilator settings, AVAPS: Vt 110% of baseline during 6 mb CPAP or 8 ml/kg IBW	Greater increase of VE and Vt with AVAPS No differences in sleep quality or ABG
Crisafulli	Stable COPD (n=9)	ST: IPAP at maximal tolerated (up to 30 mb), AVAPS: Vt 8 ml/IBW. IPAP set between EPAP and 30 mb	Greater improvement in subjective quality of sleep with AVAPS. No differences in ABG, comfort or compliance
Oscroft	COPD (n=25)	ST: usual ventilator settings, IVAPS: Target Vt as obtained by applying ST ventilation at usual settings. Maximal IPAP 25	No differences
Murphy	OHS (n=46)	Initial settings: for ST IPAP at 18-22 mb, for AVAPS: target Vt 8-10 ml/IBW and I IPAP set between EPAP + 4 and 30 mb. Progressively adjusted	No differences
Eikkenkamp	COPD (n=14)	PAC: stepwise increases in IPAP and RR in order to achieve maximally decrease PaCO2, IVAPS: target alveolar ventilation and RR as obtained by applying PAC settings. IPAP range set between -5 + 5 from the pressure support	**Différents plages d'AI et FR**
Eikkenkamp	COPD (n=22)	PAC: previous usual settings. IVAPS: target alveolar ventilation and target RR as obtained by applying PAC settings during daytime ventilation. Inspiratory pressure support between 10 and 30 mb	patients with no significant differences in MV between both modes
Jaye	Mixed population (n=18)	ST: IPAP set at "maximally tolerated" pressure, RR just below spontaneous rate IVAPS: Target alveolar ventilation and back up RR calculated over an awake learn period while breathing at CPAP 4 mb	Better adherence with IVAPS, no difference in objective quality of sleep, tolerance, overnight SpO2 or PtcCO2. Lower mean delivered PS with IVAPS

Storre	Stable OHS (n=10)	ST : IPAP 20, AVAPS : Vt 7-10 ml/IBW IPAP set between EPAP and 30 mb	Greater reduction in tcPCO2 with AVAPS No differences in sleep or HRQL
Janssens	Stable OHS (n=12)	ST : usual ventilator settings, AVAPS: Vt: 8-12 ml/kg IBW Minimal IPAP set between usual level minus 3, and 30 mb	Greater reduction in tcPCO2 with AVAPS at the expense of decrease in objective and subjective quality of sleep and comfort
Ambroggio	Stable mixed population (n=39, most OHS)	ST: usual ventilator settings, AVAPS: Vt 110% of baseline during 6 mb CPAP or 8 ml/kg IBW	Greater increase of VE and Vt with AVAPS No differences in sleep quality or ABG
Crisafulli	Stable COPD (n=9)	ST: IPAP at maximal tolerated (up to 30 mb), AVAPS: Vt 8 ml/IBW. IPAP set between EPAP and 30 mb	Greater improvement in subjective quality of sleep with AVAPS. No differences in ABG, comfort or compliance
Oscroft	COPD (n=25)	ST: usual ventilator settings, IVAPS: Target Vt as obtained by applying ST ventilation at usual settings. Maximal IPAP 25	No differences
Murphy	OHS (n=46)	Initial settings: for ST IPAP at 18-22 mb, for AVAPS: target Vt 8-10 ml/IBW and I IPAP set between EPAP + 4 and 30 mb. Progressively adjusted	No differences
Eikkenkamp	COPD (n=14)	PAC: stepwise increases in IPAP and RR in order to achieve maximally decrease PaCO2, IVAPS: target alveolar ventilation and RR ge set betwe	Reported sleep better with IVAPS at 6 weeks. No difference neither in quality of sleep, sleep efficiency, and subjective comfort nor in ABG
Eikkenkamp	COPD (n=22)	PAC: p ntilation and ta ring daytim ween 10 and 30 mb	Same effect of both PAC and IVAPS in obese patients with no significant differences in MV between both modes
Jaye	Mixed population (n=18)	ST: IPAP set at "maximally tolerated" pressure, RR just below spontaneous rate IVAPS: Target alveolar ventilation and back up RR calculated over an awake learn period while breathing at CPAP 4 mb	Better adherence with IVAPS, no difference in objective quality of sleep, tolerance, overnight SpO2 or PtcCO2. Lower mean delivered PS with IVAPS

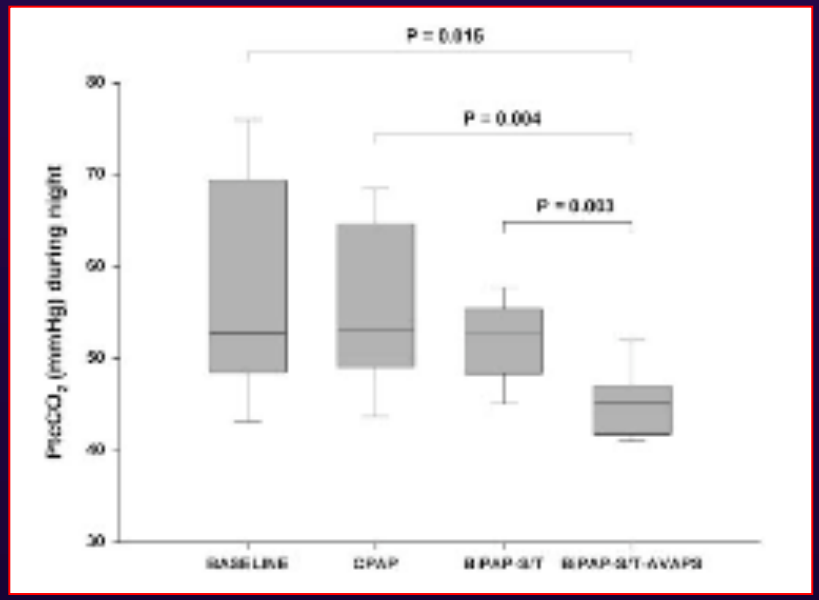
1 seule étude en groups paralleles

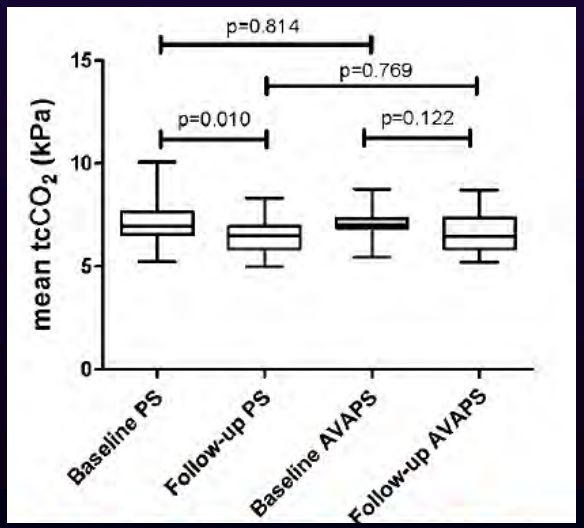
PaCO2/PtcCO2 (1)

Janssens, RespirMed, 2008



Storre, Chest 2008





Murphy Thorax 2012

PaCO2/ PtcCO2 (2)

Table 2 Time course of the study outcomes recorded during both treatment periods

Variables	PS modality				AVAPS modality				P**
	T0	T1	T2	P*	T0	T1	T2	P*	
pH	7.37 (0.02)	7.37 (0.02)	7.38 (0.02)	0.872	7.37 (0.03)	7.38 (0.01)	7.39 (0.01)	0.296	0.175
$PaCO_2$ (mmHg)	63.2 (6.7)	59.1 (8.3)	54.5 (8.1)	**0.019**	59.8 (7.7)	55.5 (6.3)	54.8 (7.7)	**0.047**	0.134
PaO_2 (mmHg)	72.7 (14.4)	73.0 (9.2)	80.2 (8.1)	0.074	70.2 (9.2)	72.3 (8.8)	70.2 (7.8)	0.666	0.064
PaO_2/FiO_2	271.1 (65.1)	274.9 (60.8)	299.6 (46.3)	0.087	262.5 (50.6)	270.5 (49.4)	261.6 (39.7)	0.618	0.057
VAS (comfort to NPPV) (mm)	57.5 (31.8)	53.2 (26.2)	49.5 (26.3)	**0.019**	49.5 (24.1)	46.2 (23.6)	43.0 (20.5)	**0.042**	0.056
Sleep quality questionnaire (score)	5.1 (1.7)	5.1 (1.6)	4.7 (1.3)	0.219	5.1 (2.0)	5.0 (2.1)	4.1 (2.2)	**0.001**	**0.031**

Crisafulli, Lung 2009

	pH	PaO_2 (mmHg)	$PaCO_2$ (mmHg)
AVAPS	7.40 ± 0.02	73.3 ± 9.4	41.2 ± 5.3
NIV-PS	7.39 ± 0.03	72.4 ± 12	41.9 ± 6.01

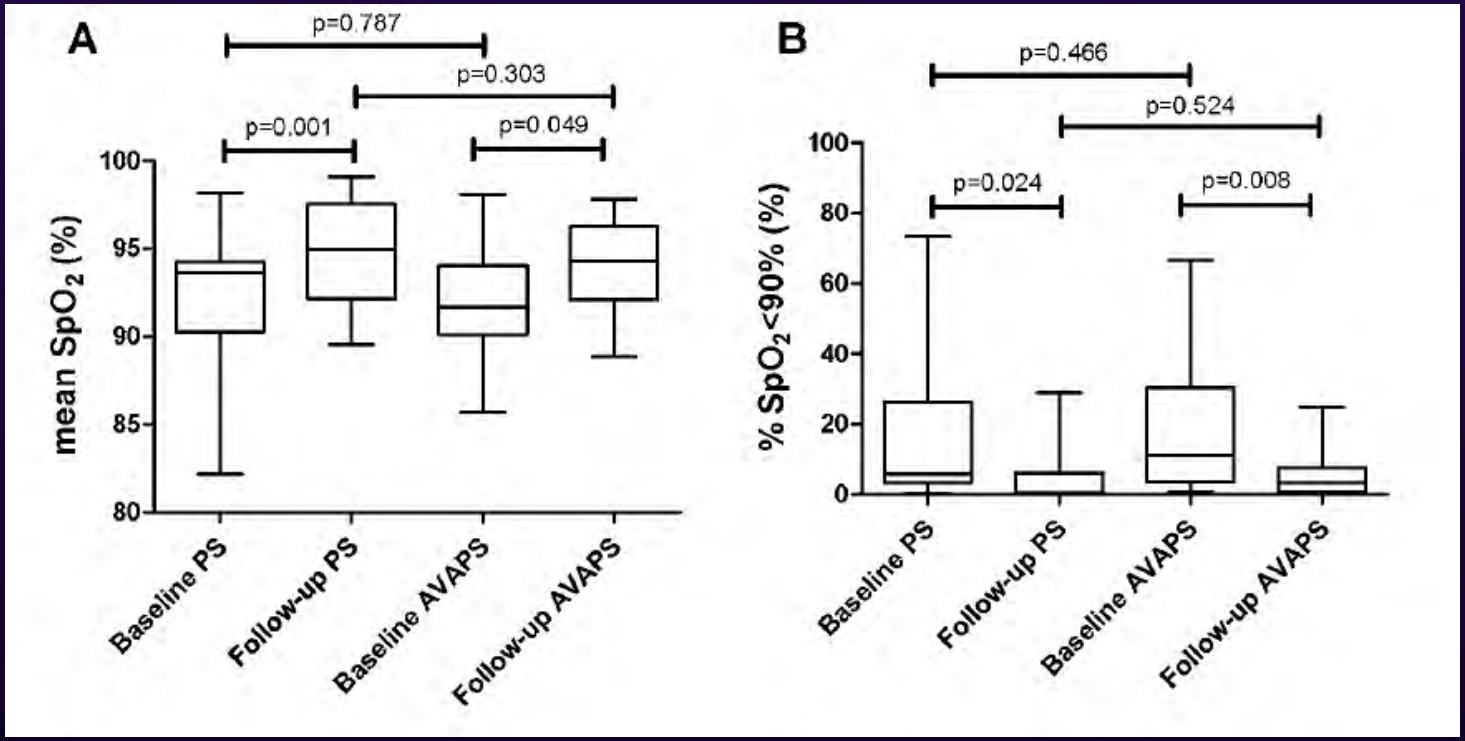
Ambrogio, ICM, 2008

Table 3 Overnight sleep parameters following treatment with iVAPS and standard PS non-invasive ventilation

	iVAPS	Standard PS	Median difference between treatments (95% CI)	P
Overnight $SpO^2/PtcCO_2$ monitoring (n = 18)				
Mean overnight SpO_2 (%)	96 (95–98)	96 (93–97)	0.4 (–0.2 to 1.0)	0.13
Min overnight SpO_2 (%)	86 (71–91)	80 (66–90)	2.5 (–3 to 11)	0.34
SpO_2 desaturation index (<4%) (events/hour)	2.5 (1.3–12.2)	5.0 (1.5–11.6)	–1 (–2 to 1)	0.42
Mean overnight $PtcCO_2$ (kPa)	6.5 (5.8–6.8)	6.2 (5.8–6.9)	0.0 (–0.3 to 0.4)	0.54
Max overnight $PtcCO_2$ (kPa)	7.1 (6.3–7.6)	6.9 (6.3–7.5)	0.0 (–0.5 to 0.5)	0.94

Kelly, Respirology 2014

SaO2



Murphy Thorax 2012

QDV

Table 5 HRQL pre–post treatment in AVAPS and PS groups

	AVAPS			Fixed-level PS		
	Baseline	Follow-up	p Value	Baseline	Follow-up	p Value
SRI-SS (/100)	55±16	66±19	<0.001	51±14	57±15	0.018
SRI-RC (/100)	55±20	70±20	0.001	49±24	59±22	0.025
SRI-PF (/100)	50±24	58±26	0.069	42±20	47±22	0.139
SRI-AS (/100)	48±17	62±20	0.003	48±19	54±16	0.100
SRI-SR (/100)	66±20	72±24	0.116	67±20	73±18	0.165
SRI-AX (/100)	48±24	65±29	0.001	41±23	50±21	0.094
SRI-WB (/100)	55±19	64±21	0.007	51±16	55±17	0.303
SRI-SF (/100)	61±24	73±20	0.005	55±22	63±22	0.143
VAS-sleep comfort (/100)	44±30	57±27	0.026	33±27	53±22	0.001
VAS-activity (/100)	43±24	52±26	0.177	47±23	47±22	0.967
VAS-fatigue (/100)	39±23	59±27	0.001	42±26	55±28	0.058
ESS (/24)	11±5	6±5	0.001	13±6	7±5	<0.001
FSS (/56)	43±14	34±15	0.014	45±16	37±18	0.038

The p values refer to paired t test analysis from initiation to follow-up values within each group.

Murphy Thorax 2012

Et la qualité du sommeil?

Table 2 Polysomnographic data with and without V_T targeting.

	Without V_T targeting mean ± SD	With V_T targeting mean ± SD	p Value
TST (min)	397 ± 79	334 ± 68	0.004
Sleep efficiency (%)	75 ± 10	68 ± 11	0.06
Sleep latency (min)	14 ± 12	21 ± 19	0.1
Stage 1 (% of TST)	22.6 ± 6.4	25.7 ± 8.7	0.07
Stage 2 (% of TST)	55.6 ± 6.9	50.4 ± 6.3	0.007
Slow wave sleep (% of TST)	8.8 ± 5.3	10.6 ± 5.6	0.11
REM sleep (% of TST)	13.8 ± 5.4	13.2 ± 5.8	0.28
Stage changes (n)	394 ± 145	326 ± 98	0.019
Wake after sleep onset (% of TST)	25.8 ± 10.6	33.8 ± 12.0	0.017
Awakenings >2 min (n)	101 ± 38	97 ± 29	0.31
Awakenings >20 s (n)	11 ± 7	16 ± 8	0.05
Micro-arousal index (n/h)	32 ± 11	30 ± 12	0.22
Sleep fragmentation index (n/h)	75 ± 27	78 ± 30	0.27

TST: total sleep time; REM: rapid eye movement sleep; p value for paired Student's t test.

Table 3—*Polysomnography, Nocturnal $Ptcco_2$, and Daytime Blood Gas Levels for Patients Receiving CPAP, BPV-S/T, and BPV-S/T-AVAPS Therapy**

Variables	Baseline	CPAP Therapy	BPV-S/T Therapy	BPV-S/T-AVAPS Therapy	
TST, min	307 ± 77	309 ± 98	279 ± 124	270 ± 87	
Sleep efficiency, %	76 ± 19	80 ± 10	82 ± 27	78 ± 16	p?
NREM sleep stage, % TST					
1	18 ± 11	8 ± 8	9 ± 11	14 ± 14	
2	66 ± 20	57 ± 17	54 ± 13	53 ± 24	
3 + 4	10 ± 11	19 ± 11	28 ± 9†	22 ± 14†	p?
REM sleep, % TST	6 ± 6	16 ± 10	10 ± 10	11 ± 14	
Arousals, No./h)	53 ± 26	22 ± 21†	25 ± 27†	27 ± 18†	
RDI score, events/h	74 ± 25	25 ± 21†	21 ± 15†	31 ± 21†	p?
Apnea index, events/h	21 ± 17	2 ± 3†	0 ± 0†	0 ± 0†	
Sao_2, %	88 ± 5	92 ± 2†	92 ± 2†	92 ± 1†	
Desaturation index, events/h	78 ± 26	29 ± 18†	27 ± 15†	33 ± 17†	
$Ptcco_2$, mm Hg	58 ± 12	56 ± 9	52 ± 4	45 ± 3†	
Heart rate, beats/min	69 ± 14	67 ± 13	67 ± 14	65 ± 11	
PH	7.39 ± 0.02	7.39 ± 0.03	7.40 ± 0.04	7.42 ± 0.04	
$Paco_2$, mm Hg	47.4 ± 2.0	48.0 ± 5.0	45.9 ± 3.7	42.0 ± 5.2†	
Pao_2, mm Hg	73.3 ± 6.3	70.0 ± 7.4	76.31 ± 12.4	72.8 ± 9.1	
HCO^-_3, mmol/L	28.0 ± 1.0	28.4 ± 1.8	27.8 ± 1.8	26.5 ± 2.0†	

*Values are given as the mean ± SD (n = 10). REM = rapid eye movement; TST = total sleep time.
†$p < 0.05$ compared with baseline.

Storre, Chest 2008

M Storre votre licence de Sigmastat est périmée…?

Table 3—*Polysomnography, Nocturnal $Ptcco_2$, and Daytime Blood Gas Levels for Patients Receiving CPAP, BPV-S/T, and BPV-S/T-AVAPS Therapy**

Variables	Baseline	CPAP Therapy	BPV-S/T Therapy	BPV-S/T-AVAPS Therapy	
TST, min	307 ± 77	309 ± 98	279 ± 124	270 ± 87	
Sleep efficiency, %	76 ± 19	80 ± 10	82 ± 27	78 ± 16	p?
NREM sleep stage, % TST					
1	18 ± 11	8 ± 8	9 ± 11	14 ± 14	
2	66 ± 20	57 ± 17	54 ± 13	53 ± 24	
3 + 4	10 ± 11	19 ± 11	28 ± 9†	22 ± 14†	p?
REM sleep, % TST	6 ± 6	16 ± 10	10 ± 10	11 ± 14	
Arousals, No./h)	53 ± 26	22 ± 21†	25 ± 27†	27 ± 18†	
RDI score, events/h	74 ± 25	25 ± 21†	21 ± 15†	31 ± 21†	p?
Apnea index, events/h	21 ± 17	2 ± 3†	0 ± 0†	0 ± 0†	
Sao_2, %	88 ± 5	92 ± 2†	92 ± 2†	92 ± 1†	
Desaturation index, events/h	78 ± 26	29 ± 18†	27 ± 15†	33 ± 17†	
$Ptcco_2$, mm Hg	58 ± 12	56 ± 9	52 ± 4	45 ± 3†	
Heart rate, beats/min	69 ± 14	67 ± 13	67 ± 14	65 ± 11	
PH	7.39 ± 0.02	7.39 ± 0.03	7.40 ± 0.04	7.42 ± 0.04	
$Paco_2$, mm Hg	47.4 ± 2.0	48.0 ± 5.0	45.9 ± 3.7	42.0 ± 5.2†	
Pao_2, mm Hg	73.3 ± 6.3	70.0 ± 7.4	76.31 ± 12.4	72.8 ± 9.1	
HCO^-_3, mmol/L	28.0 ± 1.0	28.4 ± 1.8	27.8 ± 1.8	26.5 ± 2.0†	

*Values are given as the mean ± SD (n = 10). REM = rapid eye movement; TST = total sleep time.
†$p < 0.05$ compared with baseline.

Storre, Chest 2008

Je dors, donc
j'hypoventile

Sleep

Spo2

Sleep induced:
Impaired ventilatory drive
Decreased chest wall and lung compliance
Increased upper airway resistance

PtcCO2

Qu'est-ce qu'il dit la presse?

Nouvelles du front:

2) Modes à « double regulation »

Protocole Evaldin : procédure standardisée de titration

BIPAP - mode ST

- IPAP : 15 – 25 cm H_2O
- EPAP : 6– 12 cm H_2O (Si SAOS associé)
- *EPAP : 5 cm H_2O (Si absence de SAOS, pour stabiliser les voies aériennes sup.)*
- Fréquence respi de sécurité : 14-18
- FiO_2 : réglée pour obtenir une $SaO_2 \geq 92\%$
- Pente : *100 à 400*

BIPAP - mode AVAPS/ AE

- Aide Inspiratoire max 19
- Aide Inspiratoire min 14
- EPAP min : 6
- EPAP min : 14
- VT cible : 8 - 10 ml/Kg (du poids idéal)
- Pente : 100 à 400 msec
- Fréquence respi : automatique (+ Ti auto)

Polygraphie ventilatoire attestant du contrôle satisfaisant de l'hypoventilation nocturne avec :

- **SpO_2 nocturne moyenne : > 90%**
- **$PtcCO_2$: stabilité ou ↘**
- **$PaCO_2$: ↘ 0,5 kPa au réveil**
- **Evénements obstructifs : ↘ IAH (≤ 15/ heure)**

Non

- ↗ EPAP (par paliers de 1 cm H_20, jusqu'à correction des évènements obstructifs et jusqu'à 12 cm max), avec ↗ simultanée de IPAP.
- ↗ IPAP de 10% jusqu'à contrôle satisfaisant de l'hypoventilation (avec O_2 si nécessaire)

Oui

Non

- ↗ VT de 10% jusqu'à obtention d'un contrôle satisfaisant de l'hypoventilation

Retour au domicile

News from the front

4) Auto PS and EPAP level. (AVAPS AE) vs ST

PROTOCOLE EN COURS

Ventilation non invasive : efficacité d'un nouveau mode ventilatoire chez les patients atteints du syndrome obésité-hypoventilation

Noninvasive ventilation: Efficacy of a new ventilatory mode in patients with obesity-hypoventilation syndrome

A. Couillard[a,*], J.-L. Pepin[b], C. Rabec[c], A. Cuvelier[d], A. Portmann[d], J.-F. Muir[d]

Multicenter RCT, 60 patients included, parallel groups, 3 months.

Ongoing data analysis

ATS INTERNATIONAL CONFERENCE
May 17-May 22, 2019

Control/Tracking Number: 2019-S-11923-ATS
Activity: Scientific Abstract
Current Date/Time: 10/31/2018 2:02:29 PM

Sleep Quality Using AVAPS-AE versus ST Mode : A Randomized Controlled Trial in Patients With Obesity Hypoventilation Syndrome

Author Block: M. Patout[1], F. Gagnadoux[2], C. Rabec[3], W. Trzepizur[2], M. Georges[3], C. Perrin[4], R. Tamisier[5], C. Llontop[6], F. Goutorbe[7], C. Gounane[1], S. Marchandise[8], P. Cervantes[9], V. Bironneau[10], A. Portmann[1], J. Delrieu[11], J. Muir[1], A. Cuvelier[1];
[1]Normandie Univ, UNIRouen, EA3830-GRHV, Institute for Research and Innovation in Biomedicine (IRIB), Service de Pneumologie, Oncologie thoracique et Soins Intensifs Respiratoires, Rouen, France, [2]Pneumologie, CHU, Angers, France, [3]Service de Pneumologie et Soins Intensifs Respiratoires, Dijon, France, [4]Service de Pneumologie, Cannes, France, [5]Thorax et Vaisseaux, Laboratoire EFCR et Sommeil, Grenoble, France, [6]Service d'Explorations Fonctionnelles de la Respiration, de l'Exercice et de la Dyspnée, Paris, France, [7]Centre hospitalier de Beziers, Beziers, France, [8]Service de Pneumologie et USI Hopital Larrey, Toulouse, France, [9]Hopital Belle Isle, Metz, France, [10]Service de Pneumologie, Poitiers, France, [11]ANTADIR, Paris, France.

Table 1 - Sleep studies	ST (n=29) Mean ± SD			AVAPS-AE (n=31) Mean ± SD			Between group comparaison at follow-up
	Baseline	Follow-up	Pre-post p-value	Baseline	Follow-up	Pre-post p-value	
Apnea-hypopnea index (AHI) (/h)	50 ± 29	9 ± 10	<0.001	57 ± 35	11 ± 11	<0.001	0.533
3% Desaturation index (/h)	51 ± 33	18 ± 14	<0.001	60 ± 40	16 ± 11	<0.001	0.277
Time spent saturation < 90% (%)	60 ± 38	29 ± 30	<0.001	62 ± 35	32 ± 28	<0.001	0.564
Mean saturation (%)	86 ± 6	91 ± 3	<0.001	86 ± 5	91 ± 2	<0.001	0.512
Total sleep time (min)	327 ± 113	318 ± 111	0.534	338 ± 100	339 ± 103	0.958	0.669
Sleep latency (min)	21 ± 27	21 ± 24	0.683	14 ± 14	17 ± 19	0.241	0.757
REM (%)	10 ± 7	14 ± 7	0.024	11 ± 7	18 ± 10	0.002	0.352
N1 (%)	29 ± 18	19 ± 13	0.010	30 ± 26	17 ± 7	0.006	0.645
N2 (%)	43 ± 11	43 ± 9	0.966	39 ± 15	42 ± 11	0.354	0.534
N3 (%)	19 ± 11	24 ± 11	0.054	20 ± 15	25 ± 12	0.098	0.963
Micro-arousals index (/h)	41 ± 23	20 ± 12	<0.001	51 ± 36	19 ± 10	<0.001	0.148

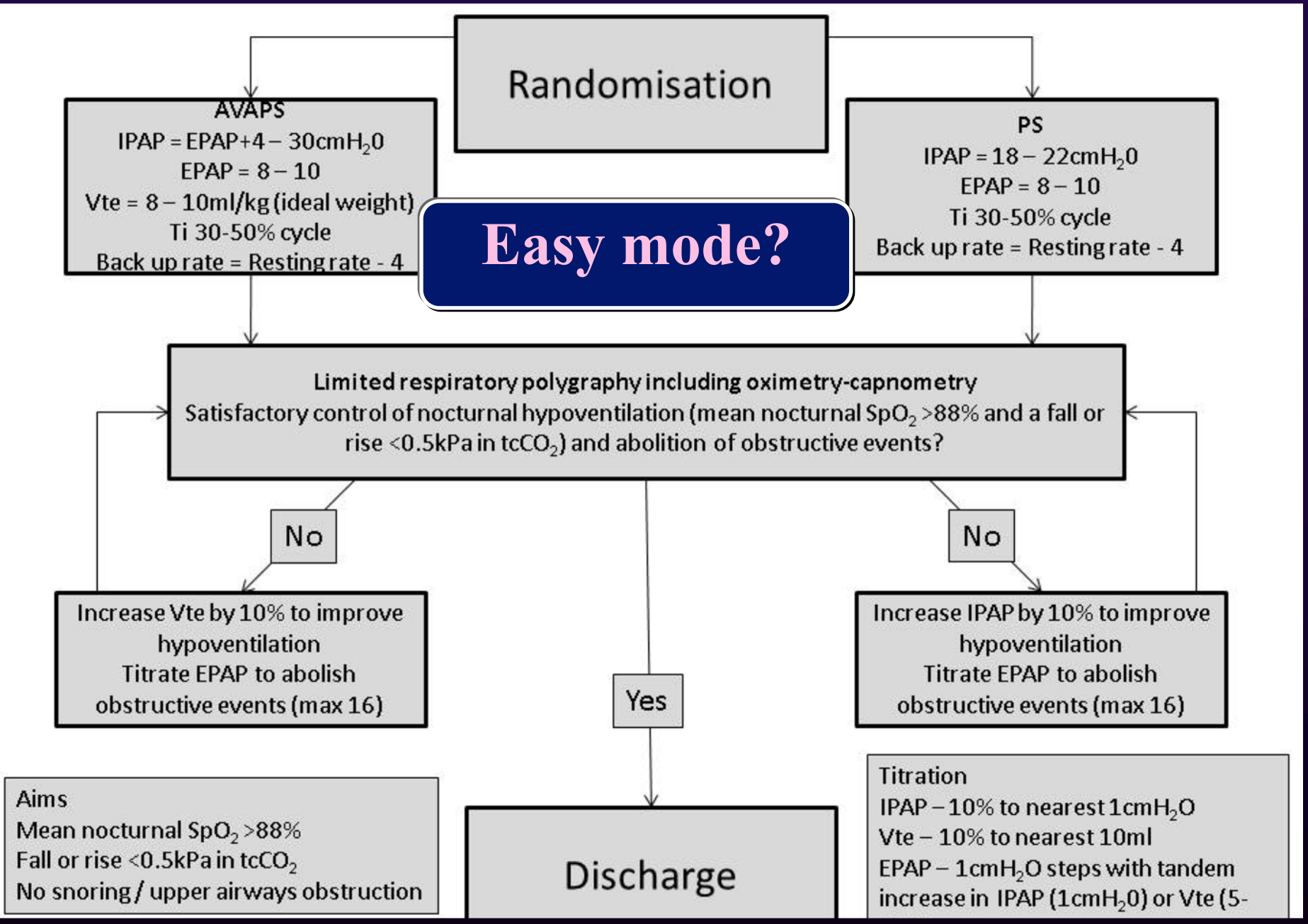
Scénarios potentiels (ou cibles…) d'utilisation

- Utilisation systématique « un mode (une mode?) pour « tout le monde » (en remplacement du ST): chercher à automatiser au maximum la procédure de reglage

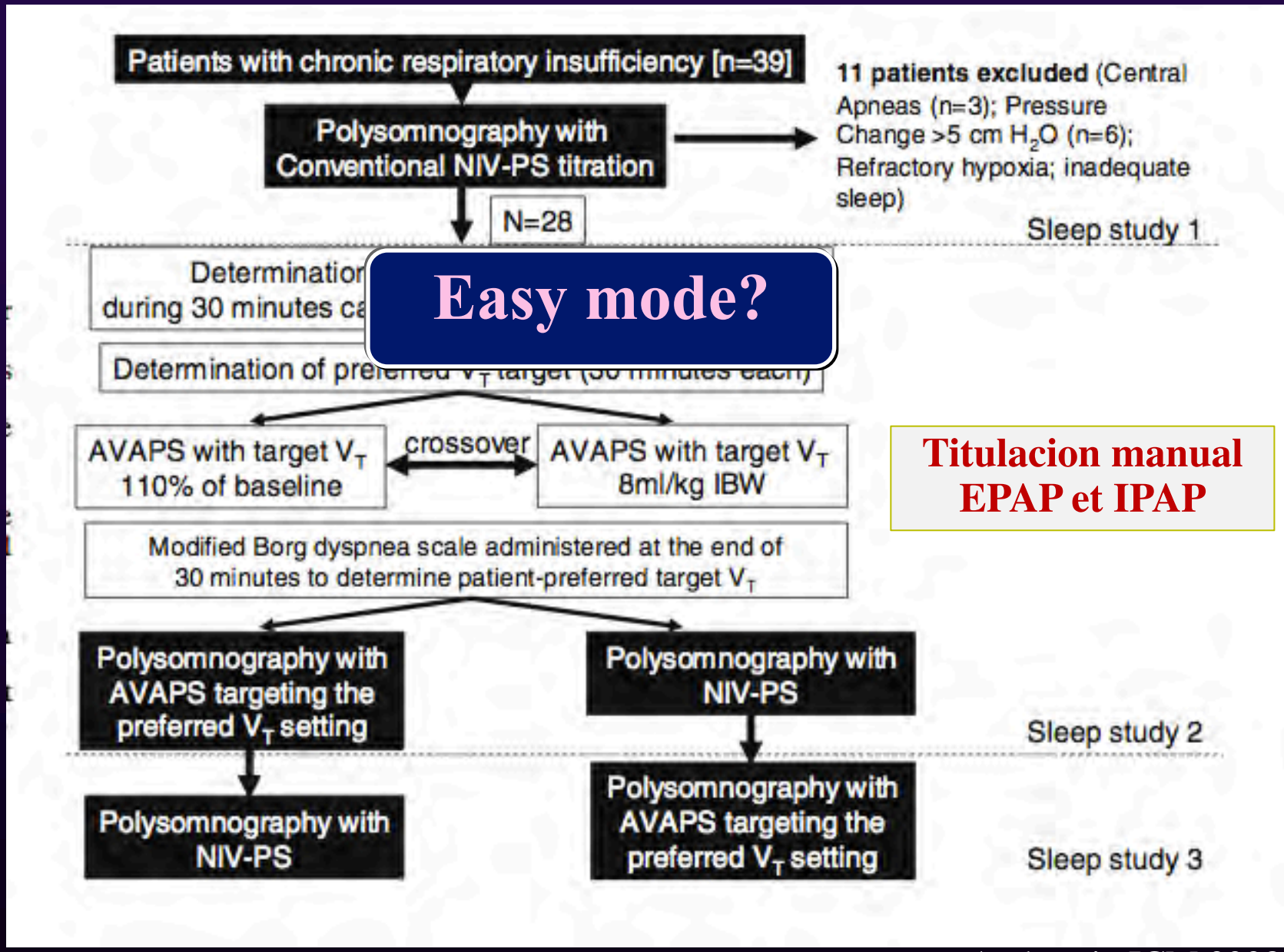
  Objectif → superiorité? *(« top mode »)*

  - Objectif → non-inferiorité mais simplification du reglage *(« easy mode »)*

Utilisation experte « un mode réservé aux échecs du ST »



Murphy, Thorax 2011



Ambrogio ICM 2008

Thorax 2012

Target volume settings for home mechanical ventilation: great progress or just a gadget?

Wolfram Windisch, Jan Hendrik Storre

modes for nocturnal HMV. Controlled ventilation, however, can be achieved by all classical modes. In this regard, target volume appears to be more of a gadget than a great progressive tool.

Vous vous rappelez??

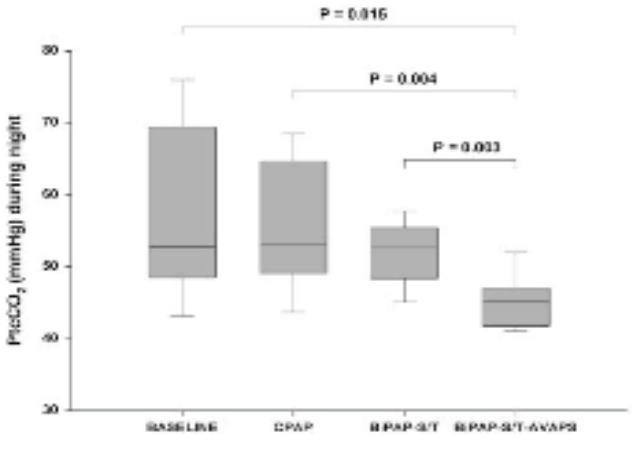
CHEST Original Research

RESPIRATORY CARE

Average Volume-Assured Pressure Support in Obesity Hypoventilation*

A Randomized Crossover Trial

Jan Hendrik Storre, MD;† Benjamin Seuthe;† René Fiechter, MD; Stavroula Milioglou; Michael Dreher, MD; Stephan Sorichter, MD; and Wolfram Windisch, MD



Scénarios potentiels (ou cibles…) d'utilisation

Utilisation systématique « un mode (une mode?) pour « tout le monde » (en remplacement du ST): chercher à automatiser au maximum la procédure de reglage

Objectif → superiorité? *(« top mode »)*

Objectif → non-inferiorité mais simplification du reglage *(« easy mode »)*

- Utilisation experte « un mode réservé aux échecs du ST »

Plan

- Rationale d'utilisation d'un mode à ventilation cible
- Differents loops et paramètres de regulation.
- Scénarios potentiels (ou cibles…) d'utilisation
- Inconvenients potentiels

Inconvenients potentiels d'une mode dit « intelligent »

- Le problème de la variabilité
- Le problème de la fiabilité
  - Calcul du Vt
  - Algorhitmes
  - Réponse en présence des fuites
  - Configuration des circuits
- Le problème du paramétrage
  - Quel Vt cible
  - Quels plages d'AI, FR, PEP

Inconvenients potentiels d'une mode dit « intelligent »

- Le problème de la variabilité

Le problème de la fiabilité

Calcul du Vt

Algorhitmes

Réponse en présence des fuites

Configuration des circuits

Le problème du parametrage

Quel Vt cible

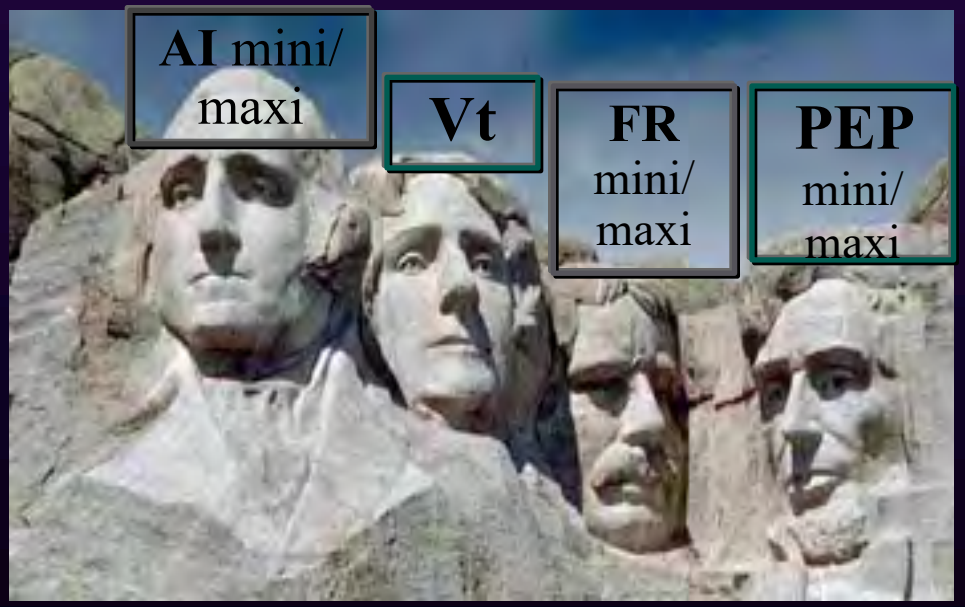
Quels plages d'AI, FR, PEP

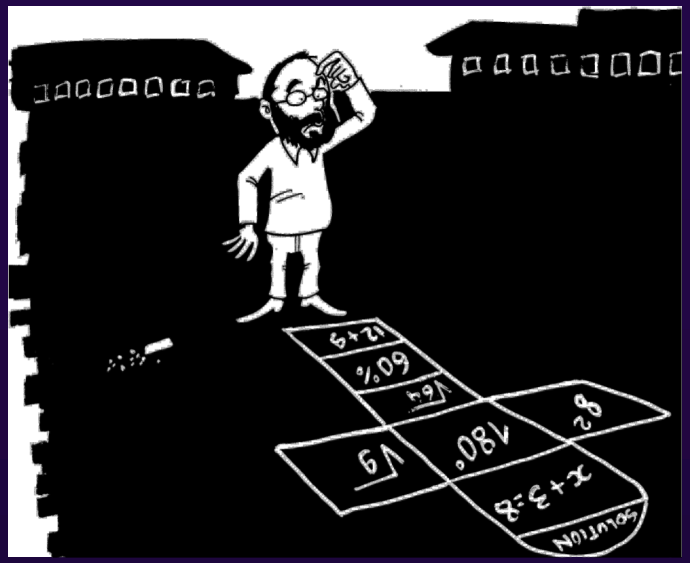
Mode barométrique « variable »
Quel risques potentiels?

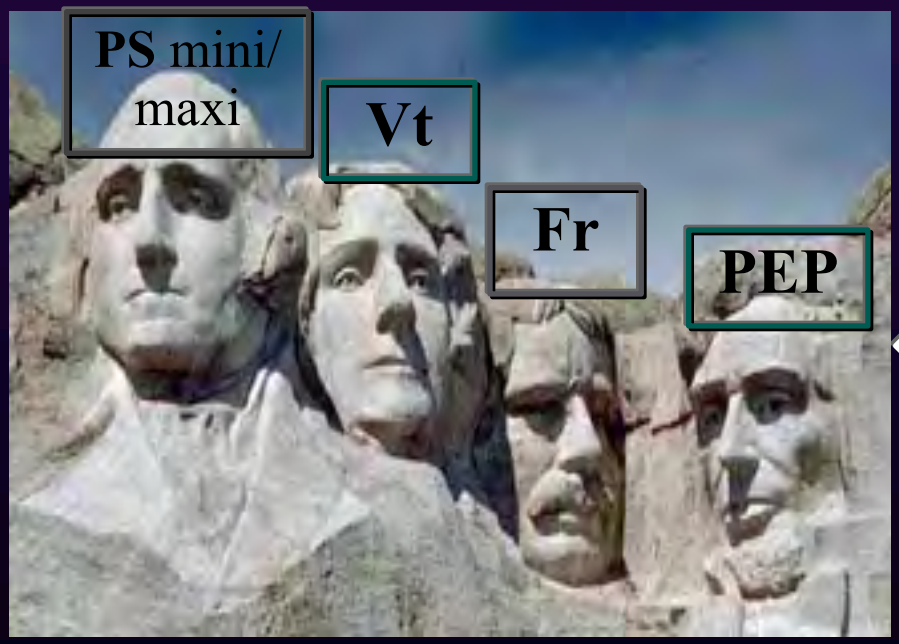
Risque d'ajouter variabilité à la variabilité

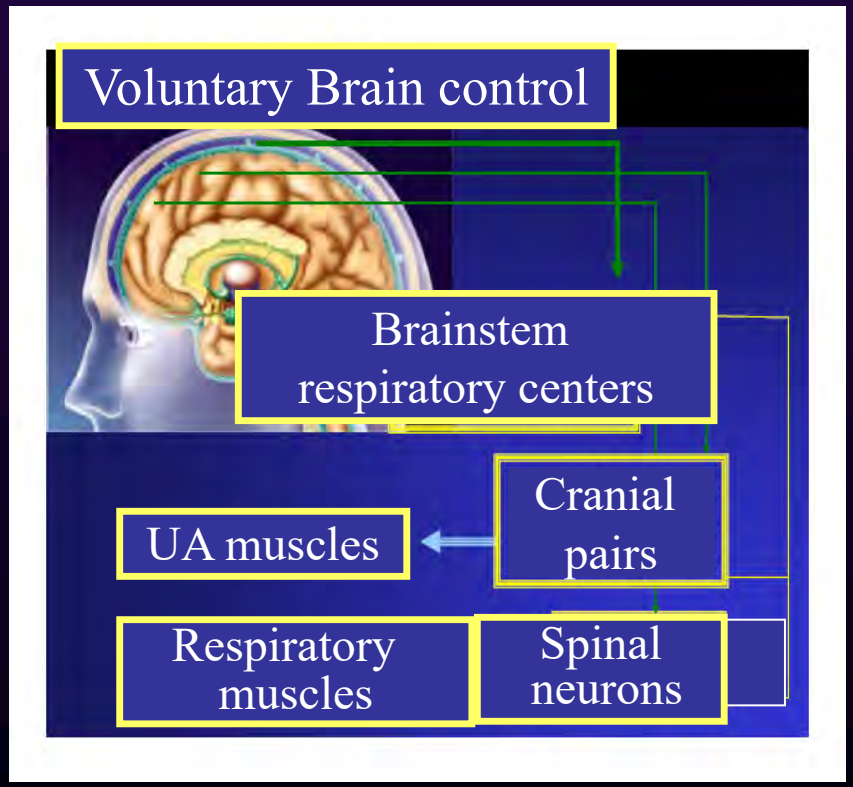
→ Et plus on a de variables

- Dynamique plus chaotique
- «Casse tête» de réglage
  (de « easy » mode
  à « expert » mode)






PS mini/
maxi
Vt
Fr
PEP


Voluntary Brain control
Brainstem
respiratory centers
Cranial
pairs
UA muscles
Respiratory
muscles
Spinal
neurons

6 têtes réfléchissent plus qu'une seule s'il y a eu une autre qui les fait fonctionner bien…..

Le problème de la variabilité

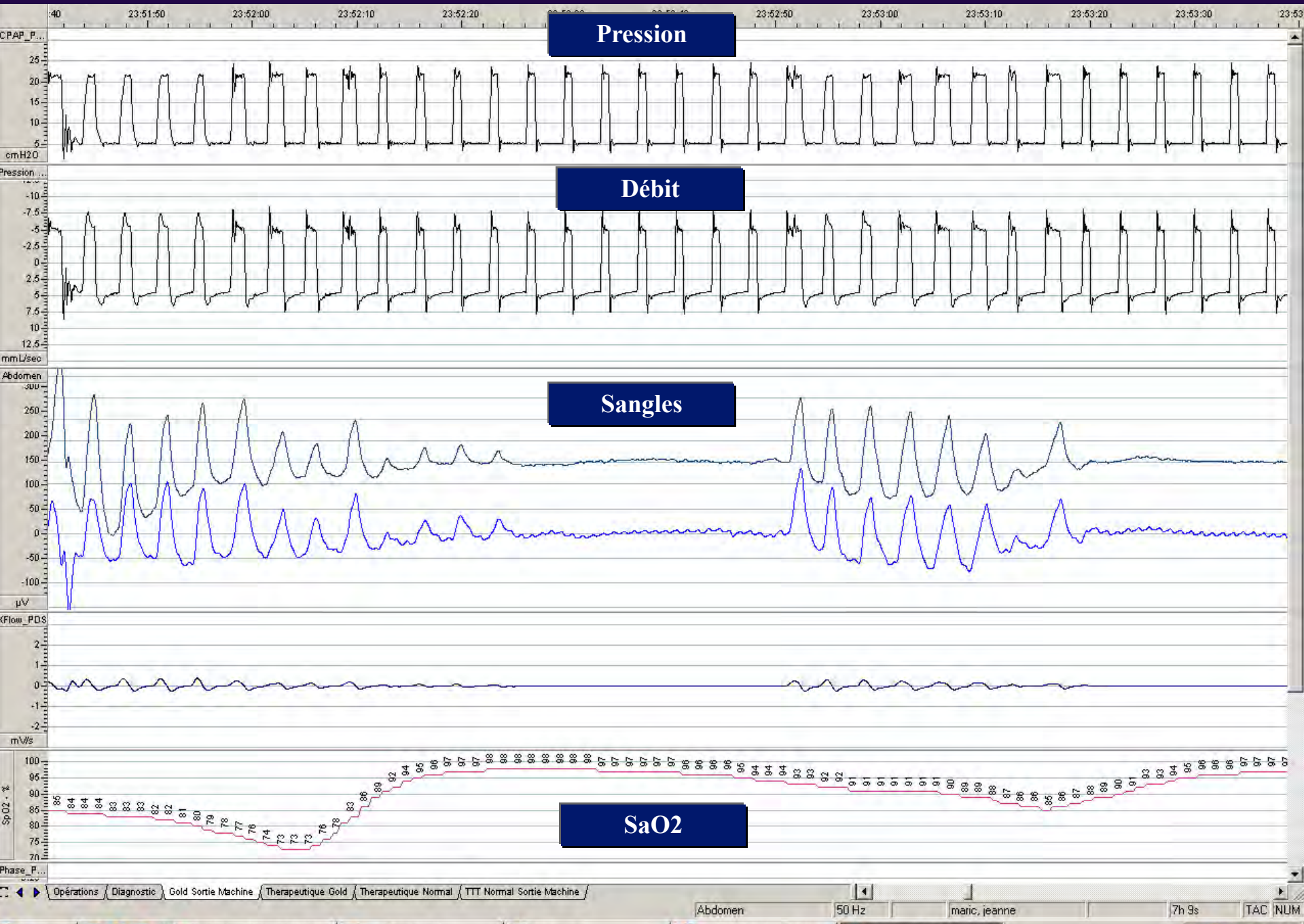
- Hyperventilation → induction d'apnées glottiques

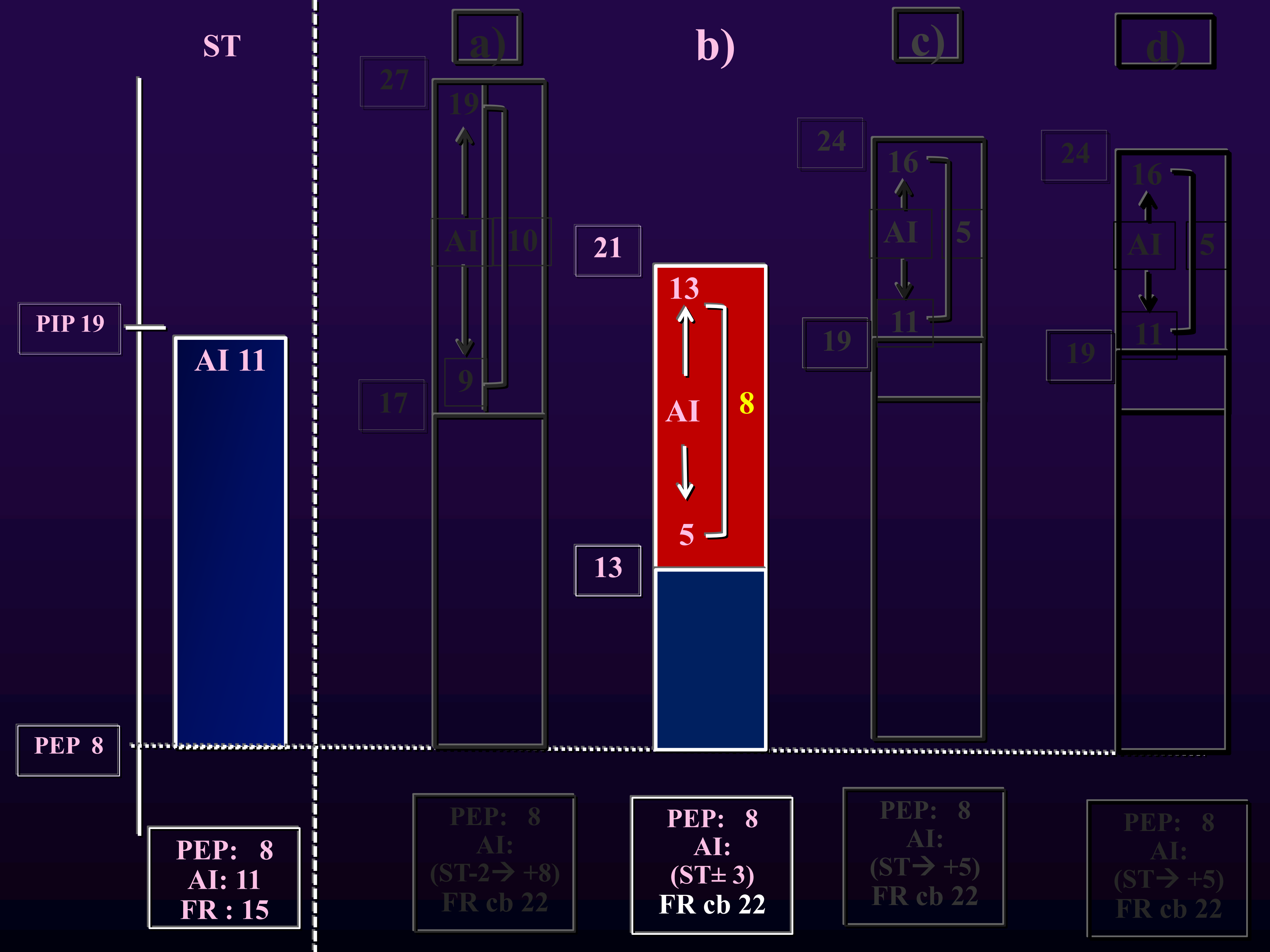
  (Jounieaux, J Appl Physiol 1995)

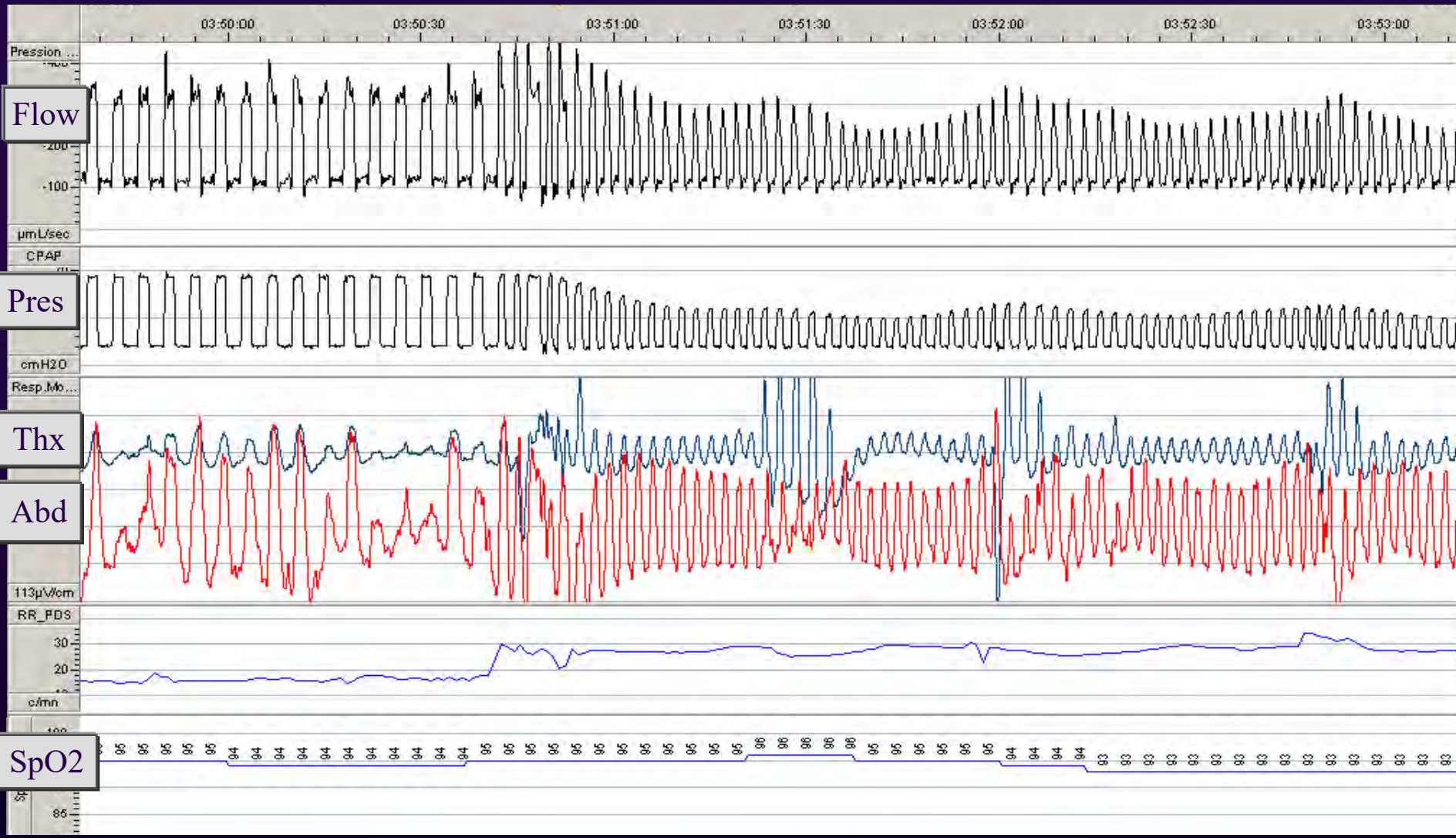
- Hypoventilation

- Induction de respiration périodique et microéveils

- Variations de pression
  - Fuites non intentionnelles (> pression)
  - Asyncronie

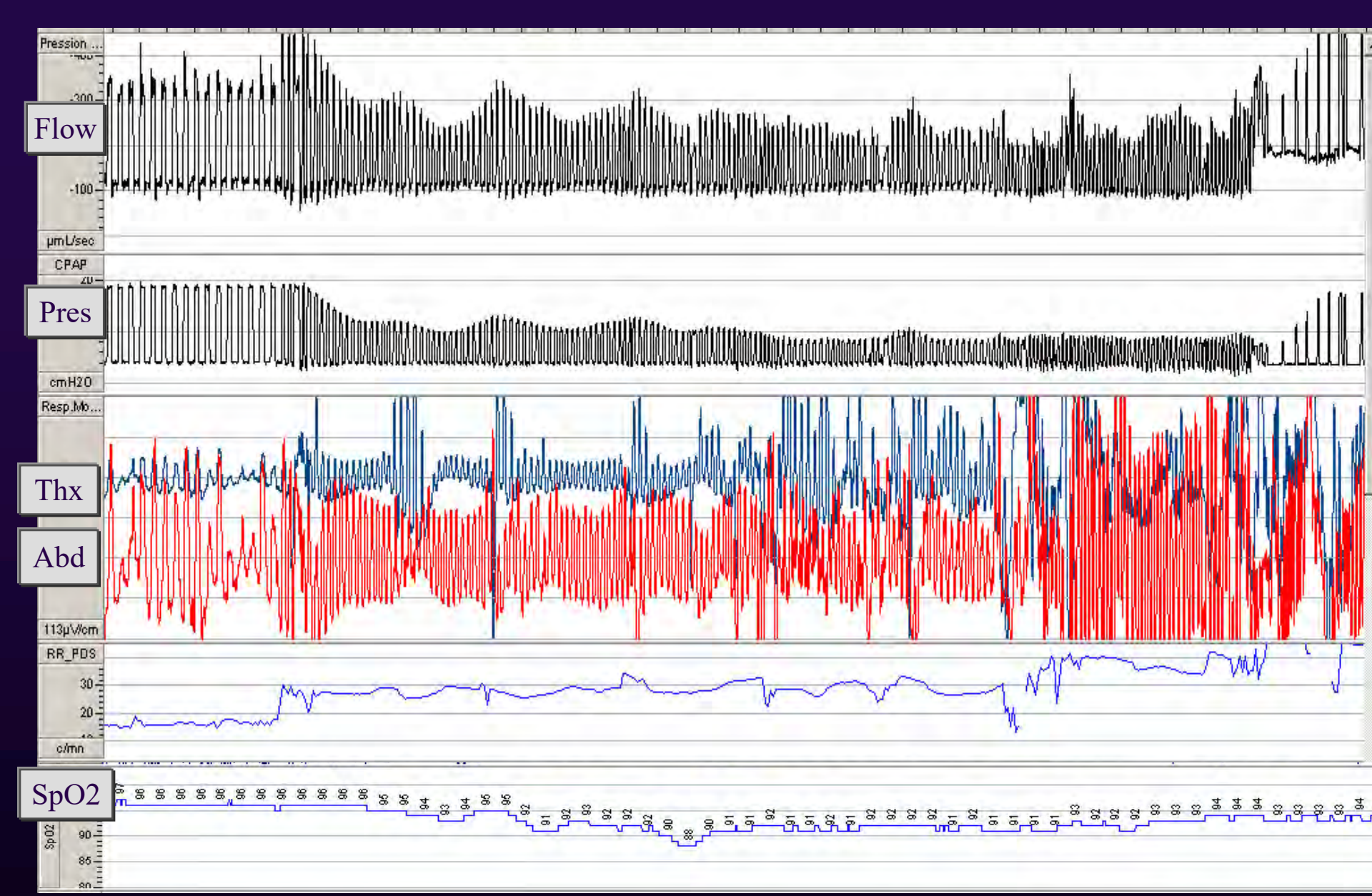

Pression
Débit
Sangles
SaO2
CPAP_P...
cmH2O
Pression ...
mmL/sec
Abdomen
µV
XFlow_PDS
mV/s
SpO2 - %
Phase_P...
Opérations
Diagnostic
Gold Sortie Machine
Therapeutique Gold
Therapeutique Normal
TTT Normal Sortie Machine
Abdomen
50 Hz
maric, jeanne
7h 9s
TAC
NUM

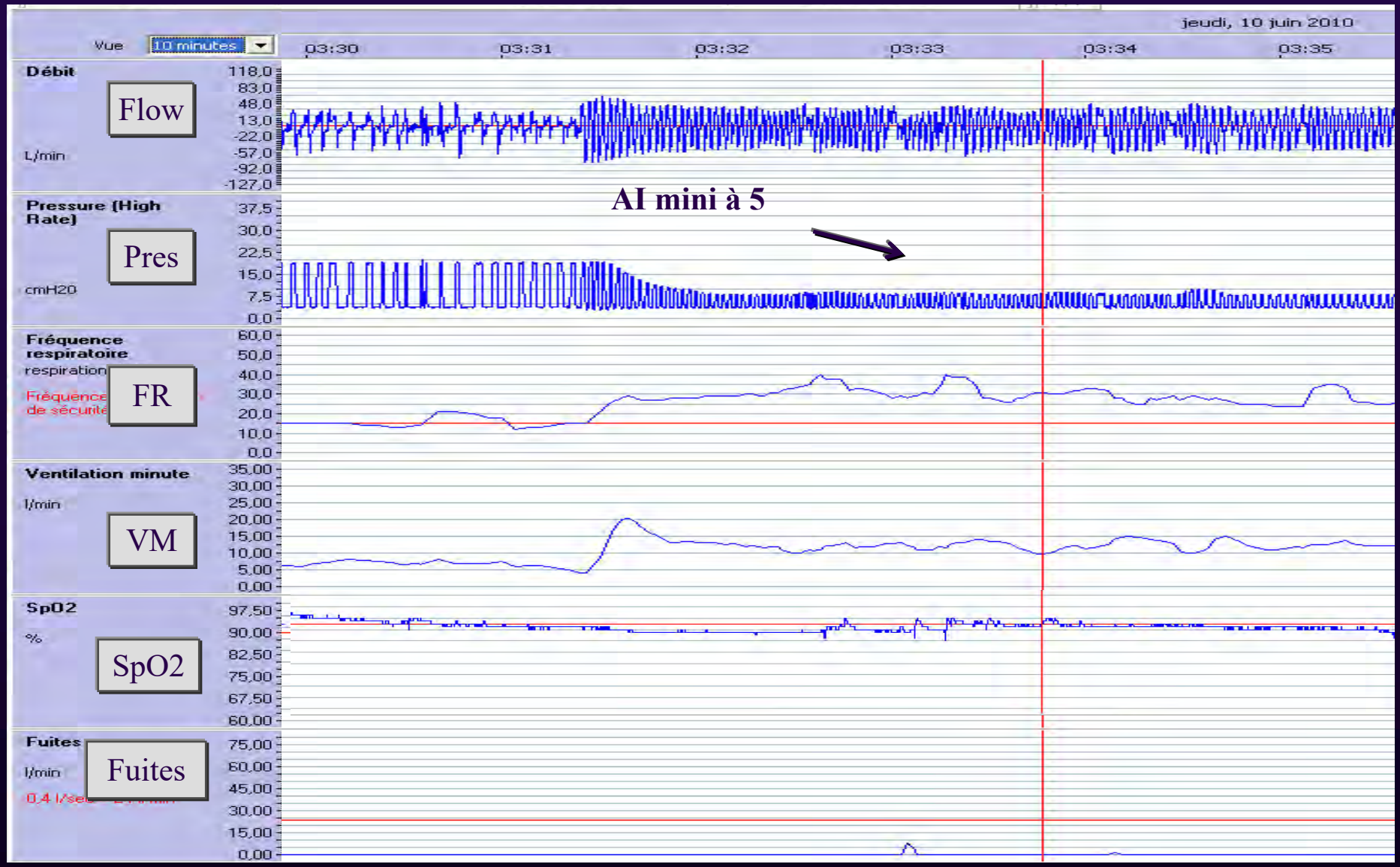

ST
PIP 19
AI 11
PEP 8
PEP: 8
AI: 11
FR : 15
a)
27
19
AI
10
9
17
PEP: 8
AI:
(ST-2→ +8)
FR cb 22
b)
21
13
AI
8
5
13
PEP: 8
AI:
(ST± 3)
FR cb 22
c)
24
16
AI
5
11
19
PEP: 8
AI:
(ST→ +5)
FR cb 22
d)
24
16
AI
5
11
19
PEP: 8
AI:
(ST→ +5)
FR cb 22

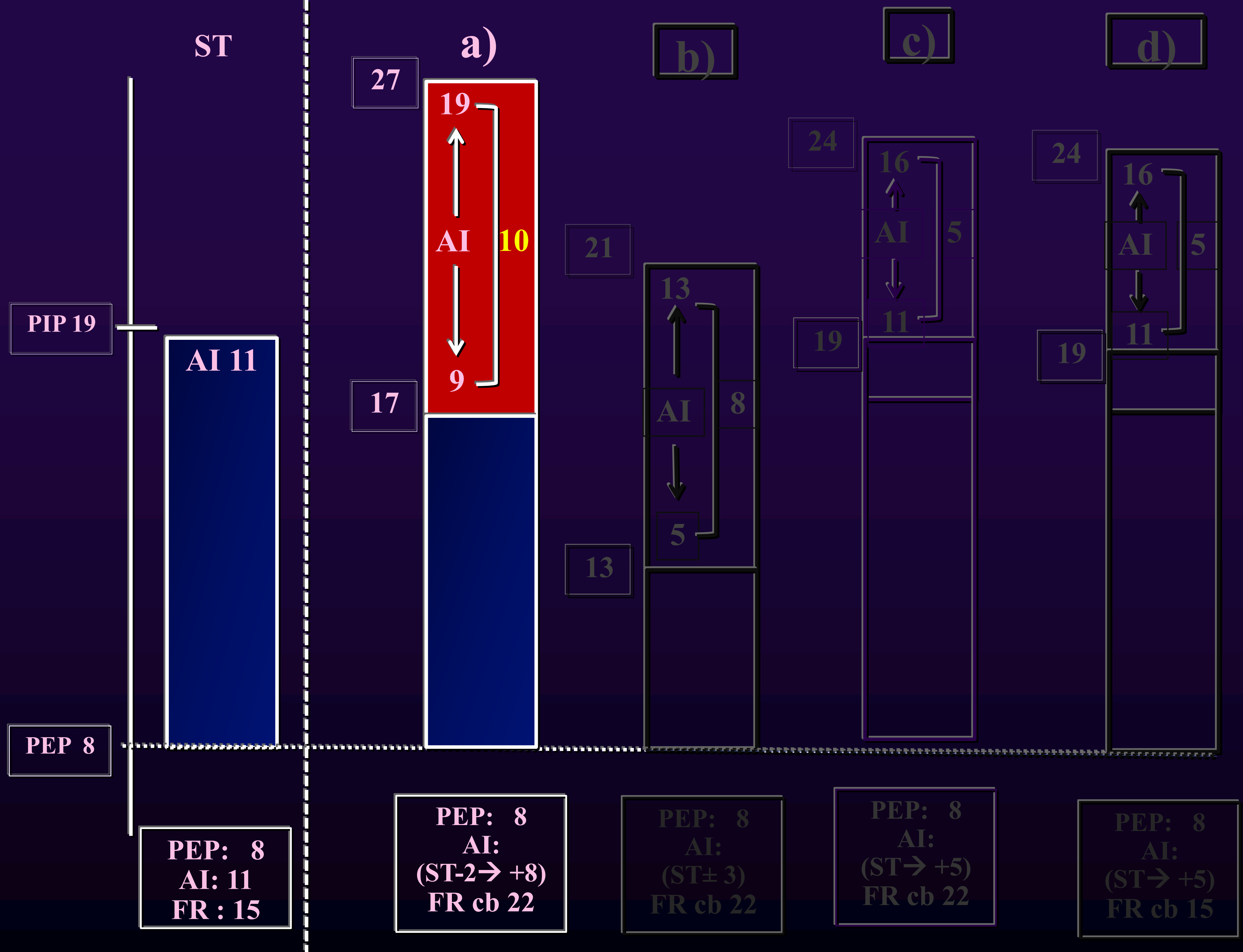


PEP 8, PIP variable entre 13 et 19 (AI 5→13), FR cible 20

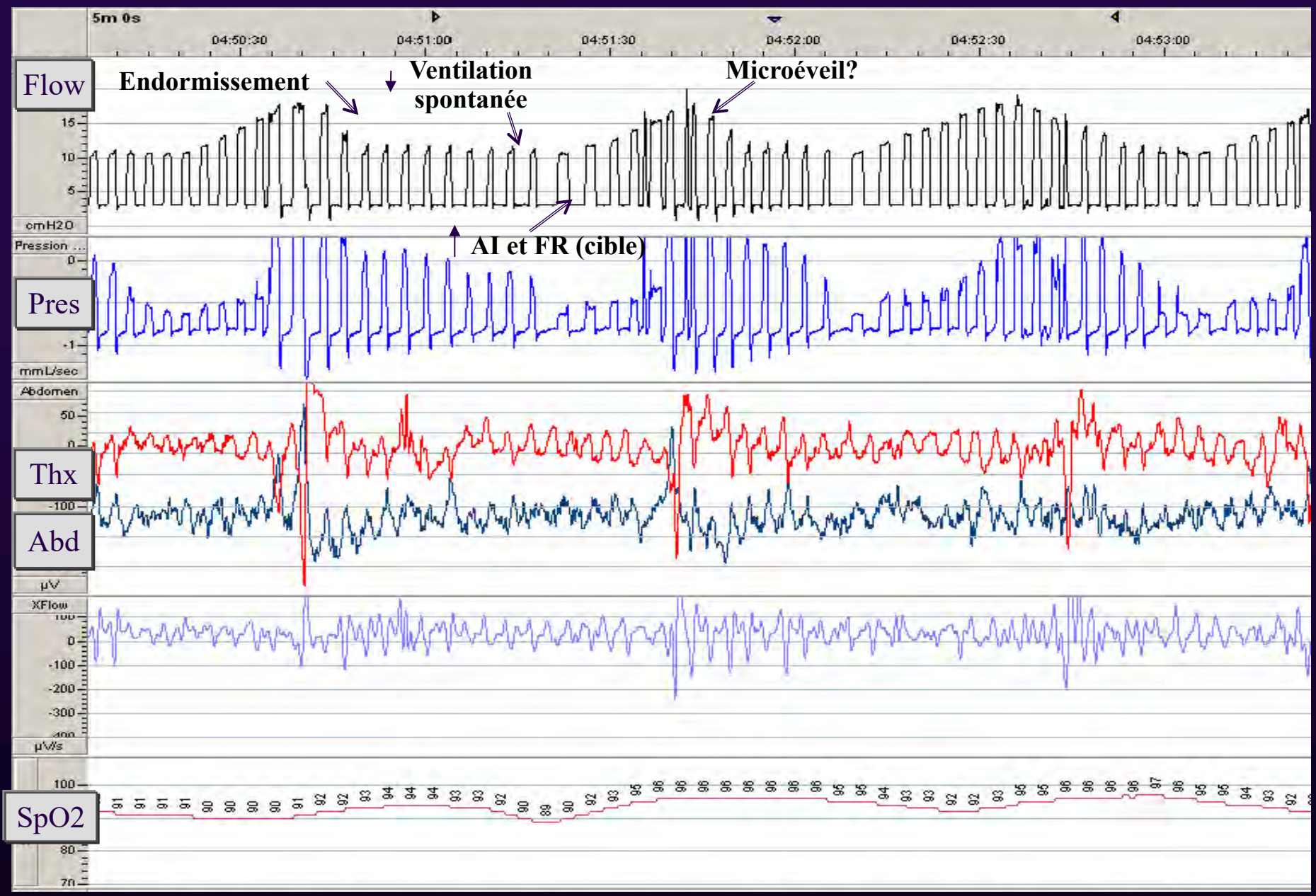
→ Lorsque la FR augmente l'AI reste au minimum (la cible est atteinte avec la FR-→ respiration rapide et superficielle


Flow
Pres
Thx
Abd
SpO2
Pression ...
-300
-100
µmL/sec
CPAP
cmH2O
Resp.Mo...
113µV/cm
RR_PDS
30
20
c/mn
SpO2
90
85

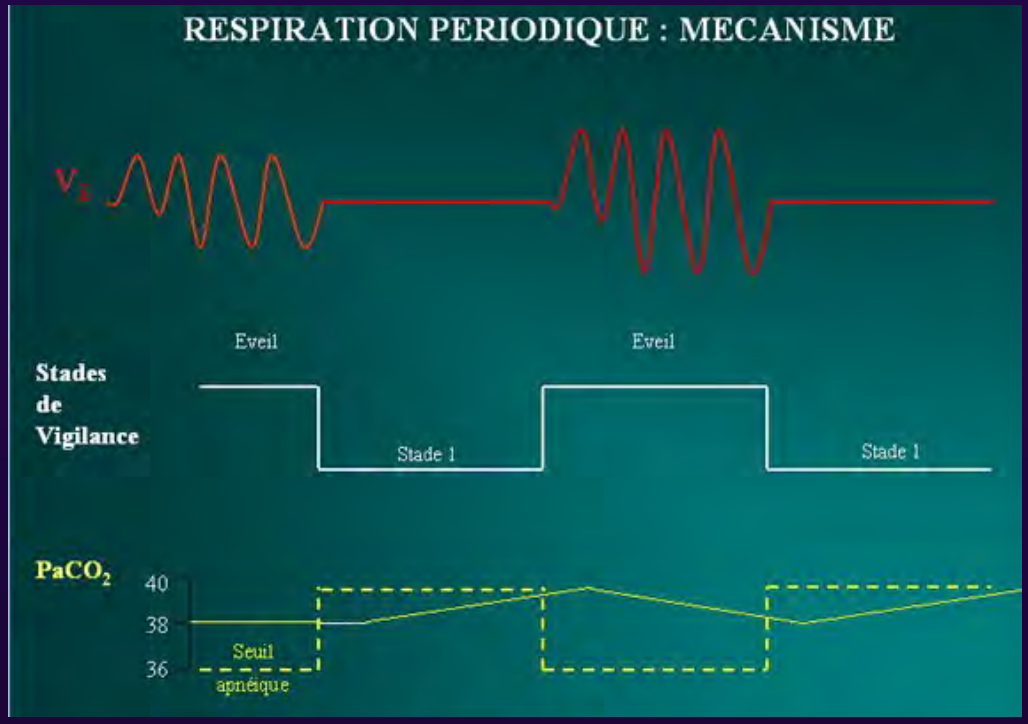

jeudi, 10 juin 2010
Vue
10 minutes
03:30
03:31
03:32
03:33
03:34
03:35
Débit
Flow
L/min
118,0
83,0
48,0
13,0
-22,0
-57,0
-92,0
-127,0
AI mini à 5
Pressure (High Rate)
Pres
cmH2O
37,5
30,0
22,5
15,0
7,5
0,0
Fréquence respiratoire
respiration
Fréquence de sécurité
FR
60,0
50,0
40,0
30,0
20,0
10,0
0,0
Ventilation minute
l/min
VM
35,00
30,00
25,00
20,00
15,00
10,00
5,00
0,00
SpO2
%
SpO2
97,50
90,00
82,50
75,00
67,50
60,00
Fuites
l/min
Fuites
75,00
60,00
45,00
30,00
15,00
0,00

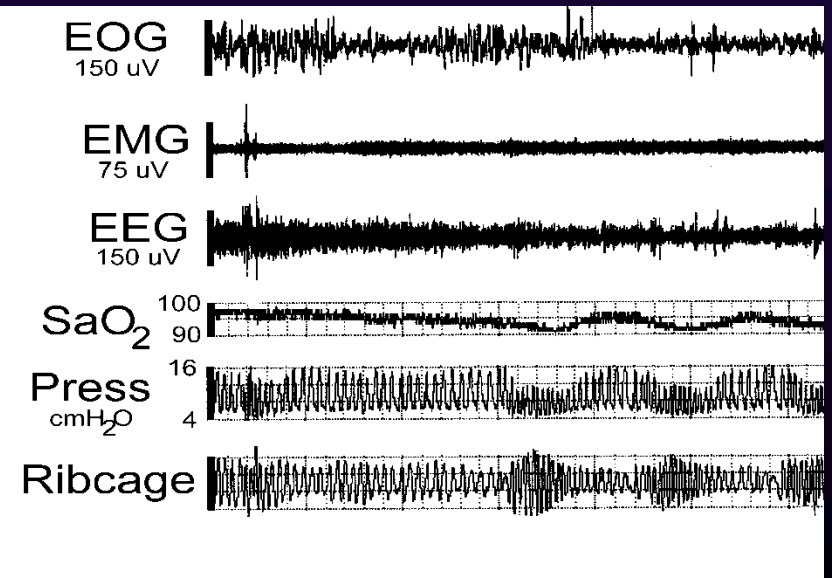


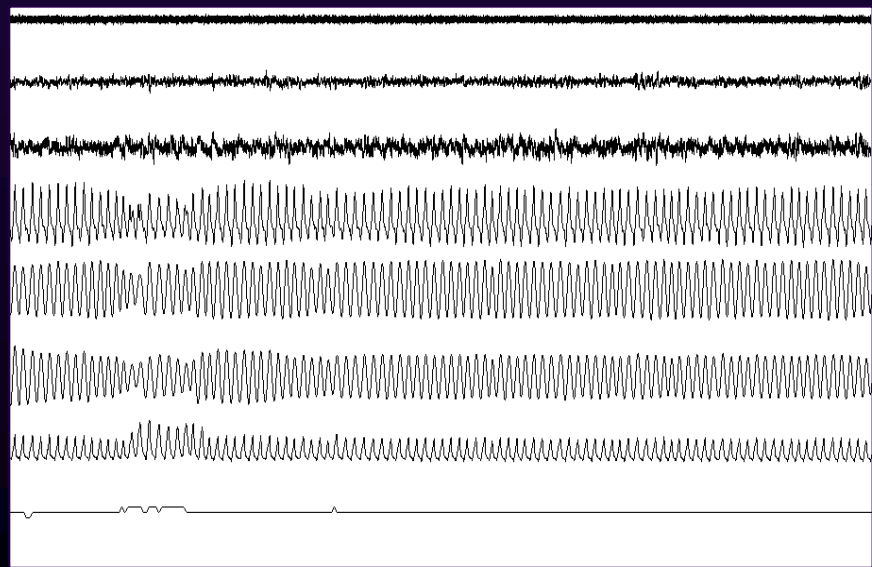
ST
PIP 19
AI 11
PEP 8
PEP: 8
AI: 11
FR : 15
a)
27
19
AI
10
9
17
PEP: 8
AI:
(ST-2→ +8)
FR cb 22
b)
21
13
AI
8
5
13
PEP: 8
AI:
(ST± 3)
FR cb 22
c)
24
16
AI
5
11
19
PEP: 8
AI:
(ST→ +5)
FR cb 22
d)
24
16
AI
5
11
19
PEP: 8
AI:
(ST→ +5)
FR cb 15

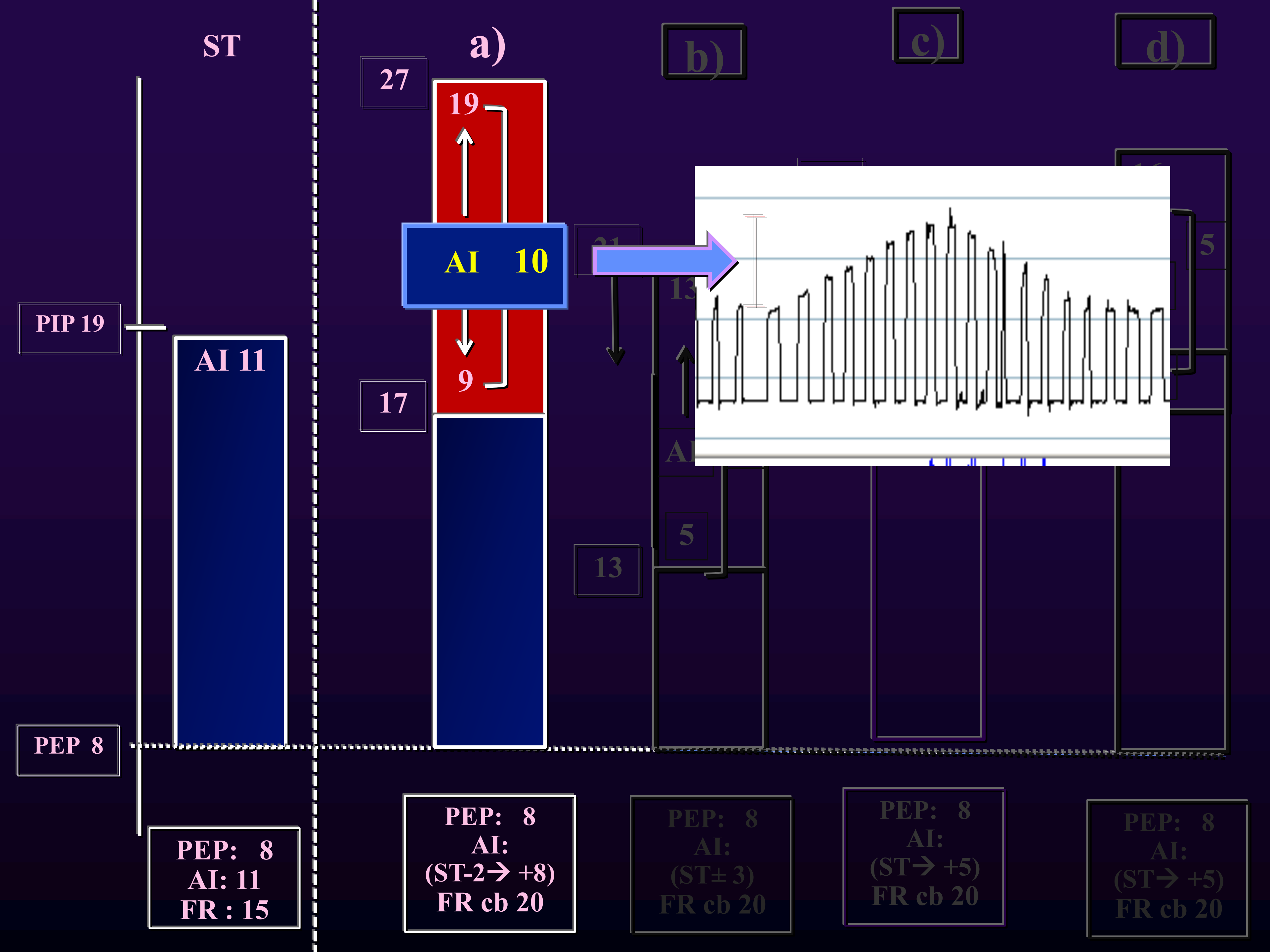

5m 0s
04:50:30
04:51:00
04:51:30
04:52:00
04:52:30
04:53:00
Flow
Endormissement
Ventilation spontanée
Microéveil?
cmH2O
AI et FR (cible)
Pression ...
Pres
mmL/sec
Abdomen
Thx
Abd
µV
XFlow
µV/s
SpO2

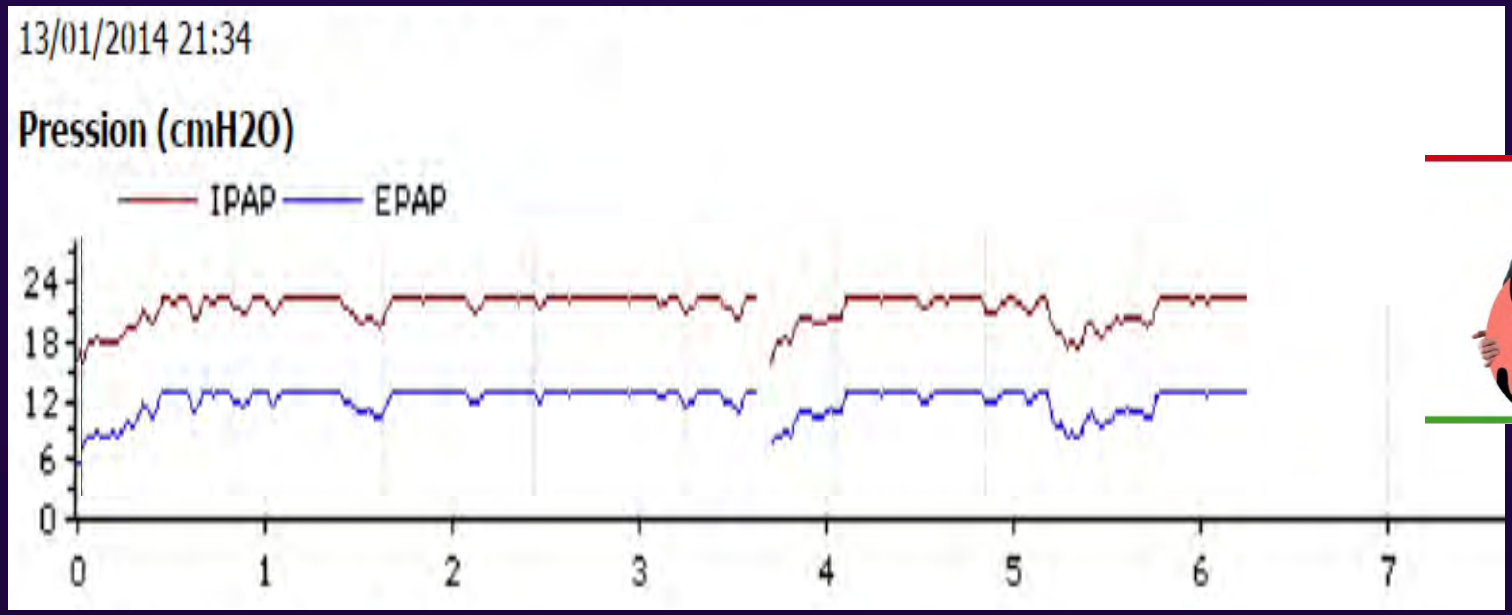
Hypothèse?


RESPIRATION PERIODIQUE : MECANISME
V_E
Eveil
Eveil
Stades de Vigilance
Stade 1
Stade 1
$PaCO_2$
40
38
36
Seuil apnéique

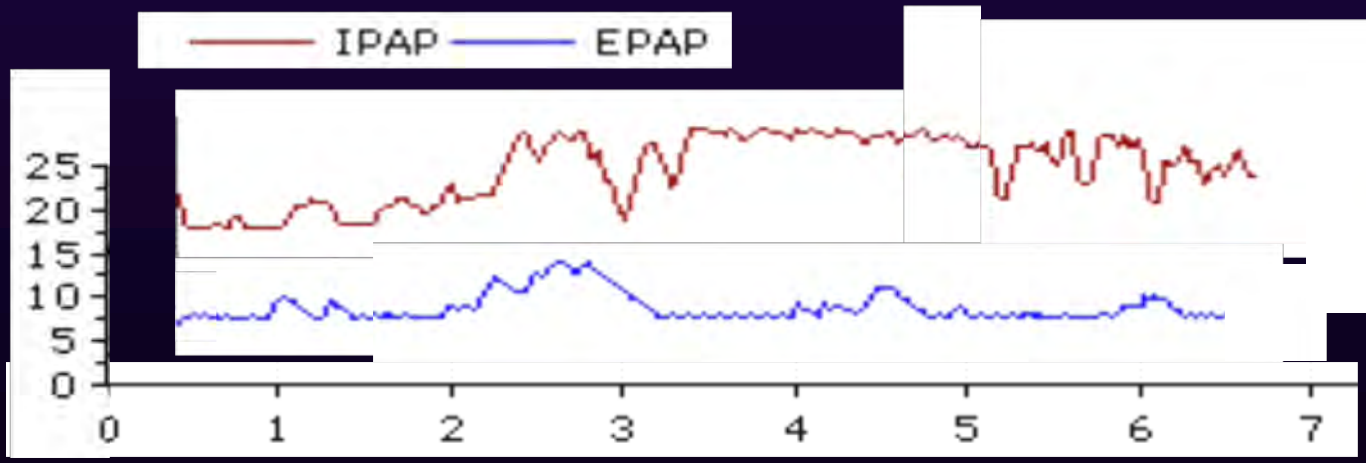

EOG
150 uV
EMG
75 uV
EEG
150 uV
SaO_2
100
90
Press
cmH_2O
16
4
Ribcage

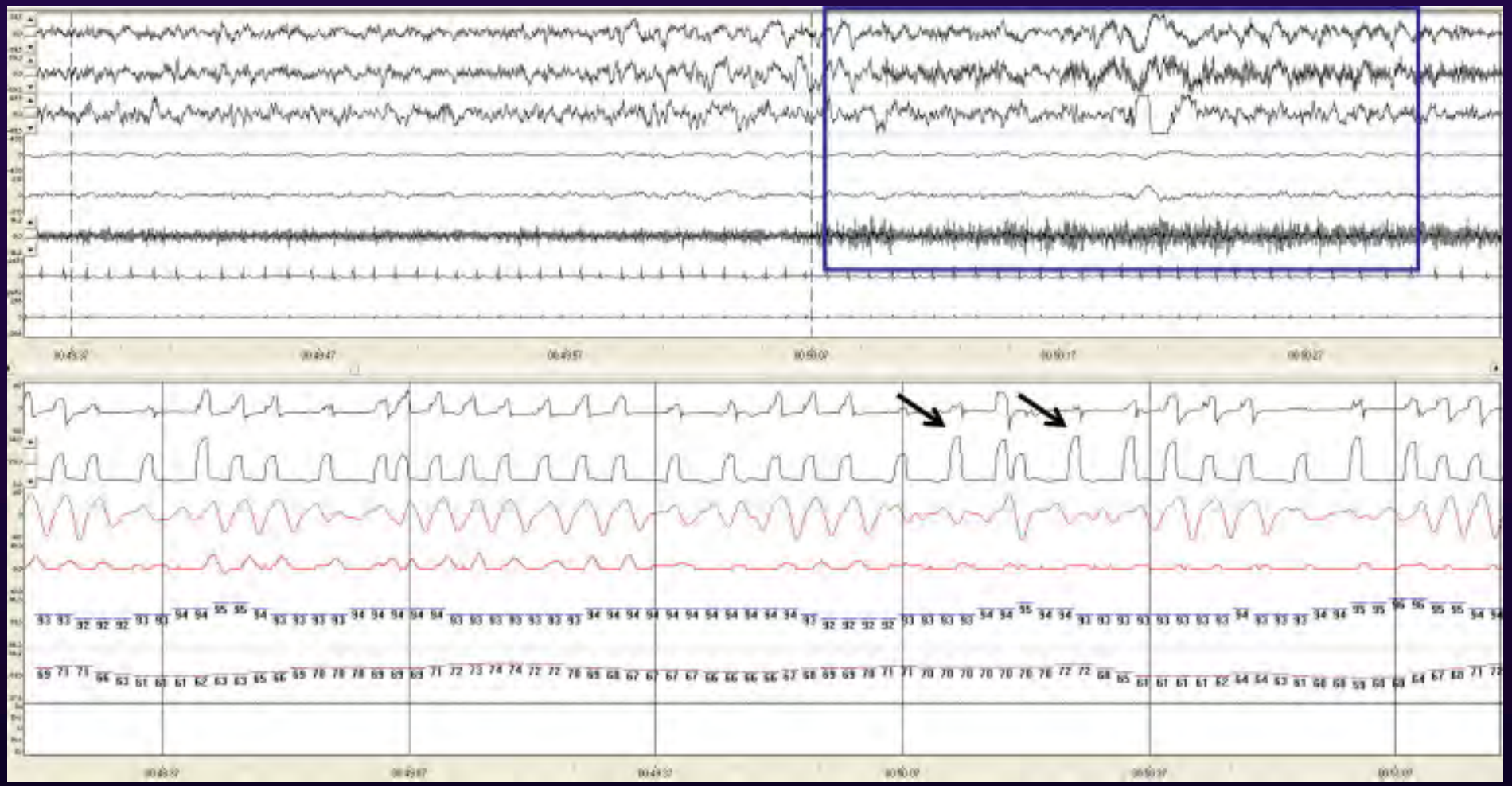



ST
a)
b)
c)
d)
PIP 19
AI 11
PEP 8
27
19
AI 10
9
17
13
5
PEP: 8
AI: 11
FR : 15
PEP: 8
AI:
(ST-2→ +8)
FR cb 20
PEP: 8
AI:
(ST± 3)
FR cb 20
PEP: 8
AI:
(ST→ +5)
FR cb 20
PEP: 8
AI:
(ST→ +5)
FR cb 20


13/01/2014 21:34
Pression (cmH2O)
IPAP
EPAP
24
18
12
6
0
0
1
2
3
4
5
6
7


Si


IPAP
EPAP
25
20
15
10
5
0
0
1
2
3
4
5
6
7



Carlucci, Sleep Med 2012

Inconvenients potentiels d'une mode dit « intelligent »

- Le problème de la variabilité
- Le problème de la fiabilité
  - Calcul du Vt
  - Algorithmes
  - Réponse en présence des fuites
  - Configuration des circuits
- Le problème du paramétrage
  - Quel Vt cible
  - Quels plages d'AI, FR, PEP

Le Vt (et les fuites) que le patient reçoit est le même que la machine calcule??

Contal O. Chest 2012

Table 4—*Results Obtained From Bench Test and Test of Ventilator Software for Seven Ventilators*

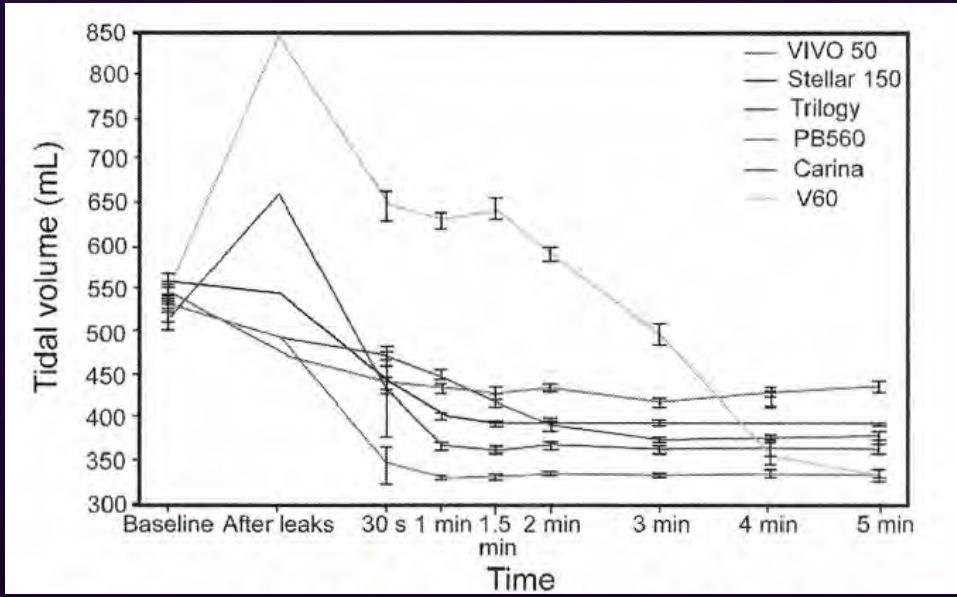
	Unintentional leak, 0 L/min					
Device	VT Bench, mL[a]	VT Software, mL[b]	[VT Bench] − [VT Software], mL	Leaks on Bench, L/min[c]	Leaks from Software, L/min[d]	[Leaks on Bench] − [Leaks from Software], L/min
A	912	711	201	52.8	45.0	7.8
B	968	840	128	40.1	35.0	5.1
C	886	797	89	44.8	46.0	−1.2
D	1,033	705	328	38.1	26.2	11.9
E	809	690	119	40.5	20.2	20.3
F[e]	1,015	750	265	0.0	1.2	−1.2
G[e]	1,032	820	212	0.0	2.4	−2.4
	Unintentional leak, 60 L/min					
A	668	547	121	76.8	62.0	14.8
B	800	700	100	65.5	60.0	5.5
C	923	826	97	74.3	75.0	−0.7
D	1,116	712	404	96.2	68.2	28.0
E	763	580	183	91.3	38.2	53.1
F[e]	1,062	900	162	30.4	31.2	−0.8
G[e]	1,228	1,100	128	32.5	33.6	−1.1

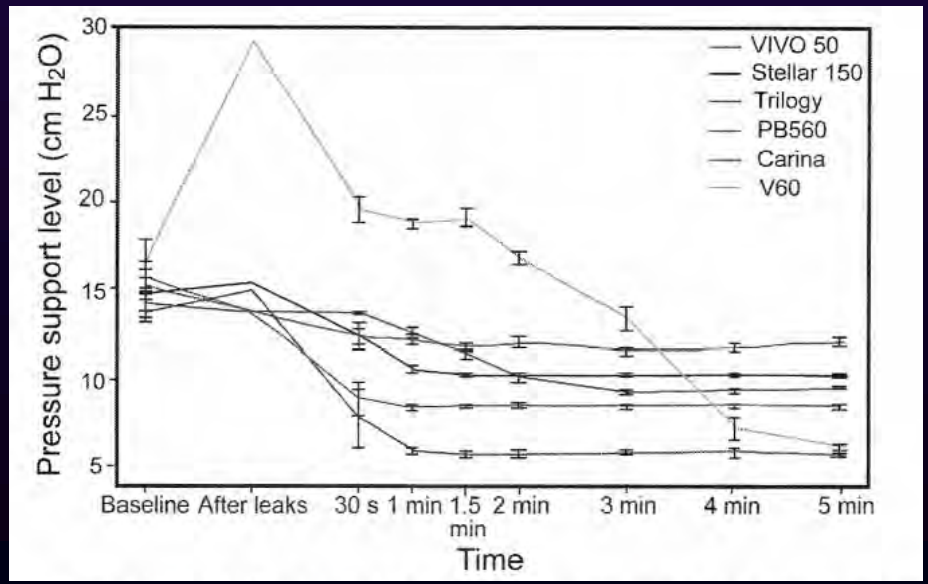
Or, si elle se trompe dans le calcul *(jusqu'à 400 ml d'écart…),* comment on le peut faire confiance pour asservir un Vt?

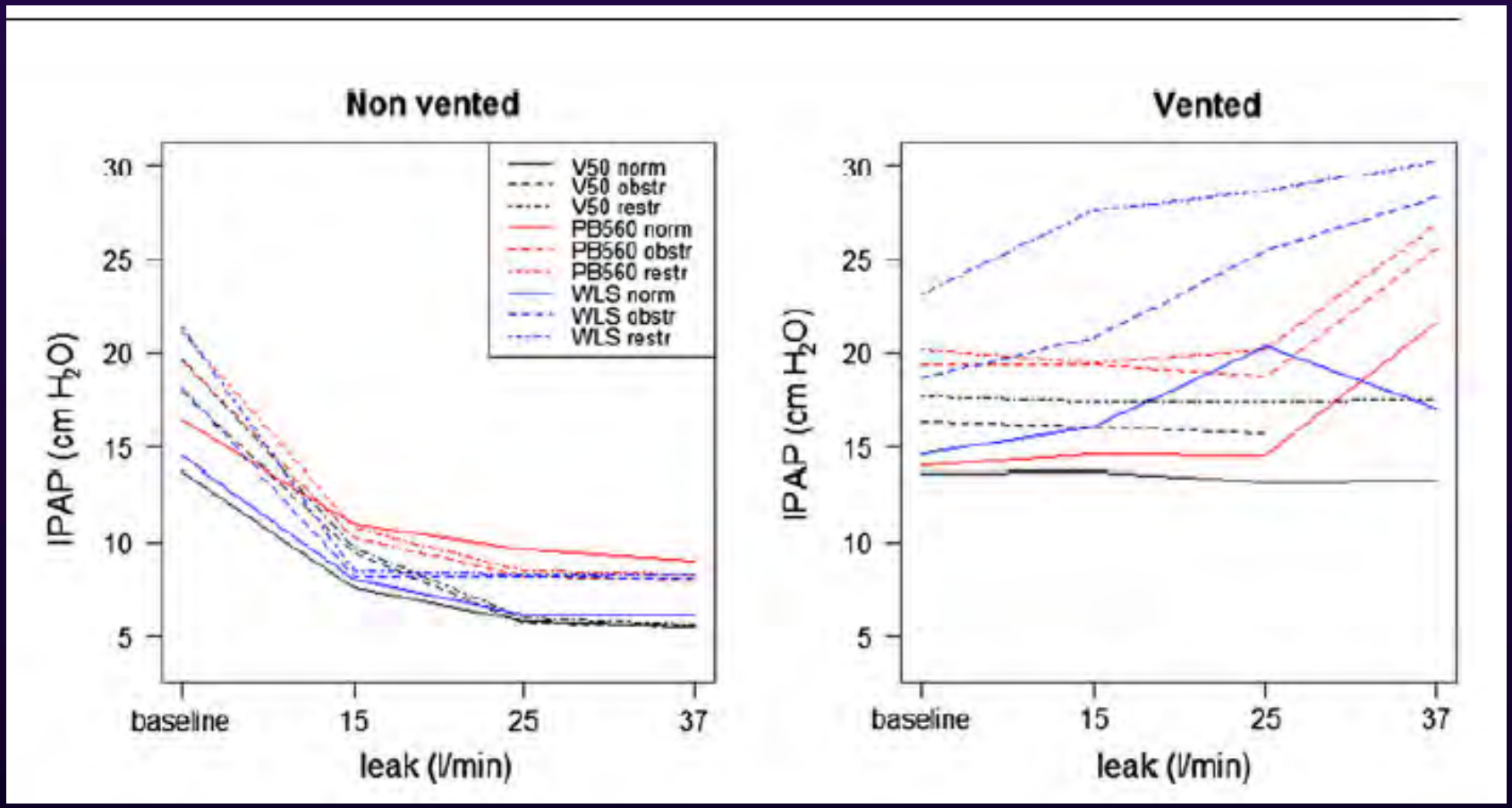
Influence of Dynamic Leaks in Volume-Targeted Pressure Support Noninvasive Ventilation: A Bench Study

Manel Luján MD PhD, Ana Sogo MD, Carles Grimau MD, Xavier Pomares MD, Lluís Blanch MD PhD, and Eduard Monsó MD PhD

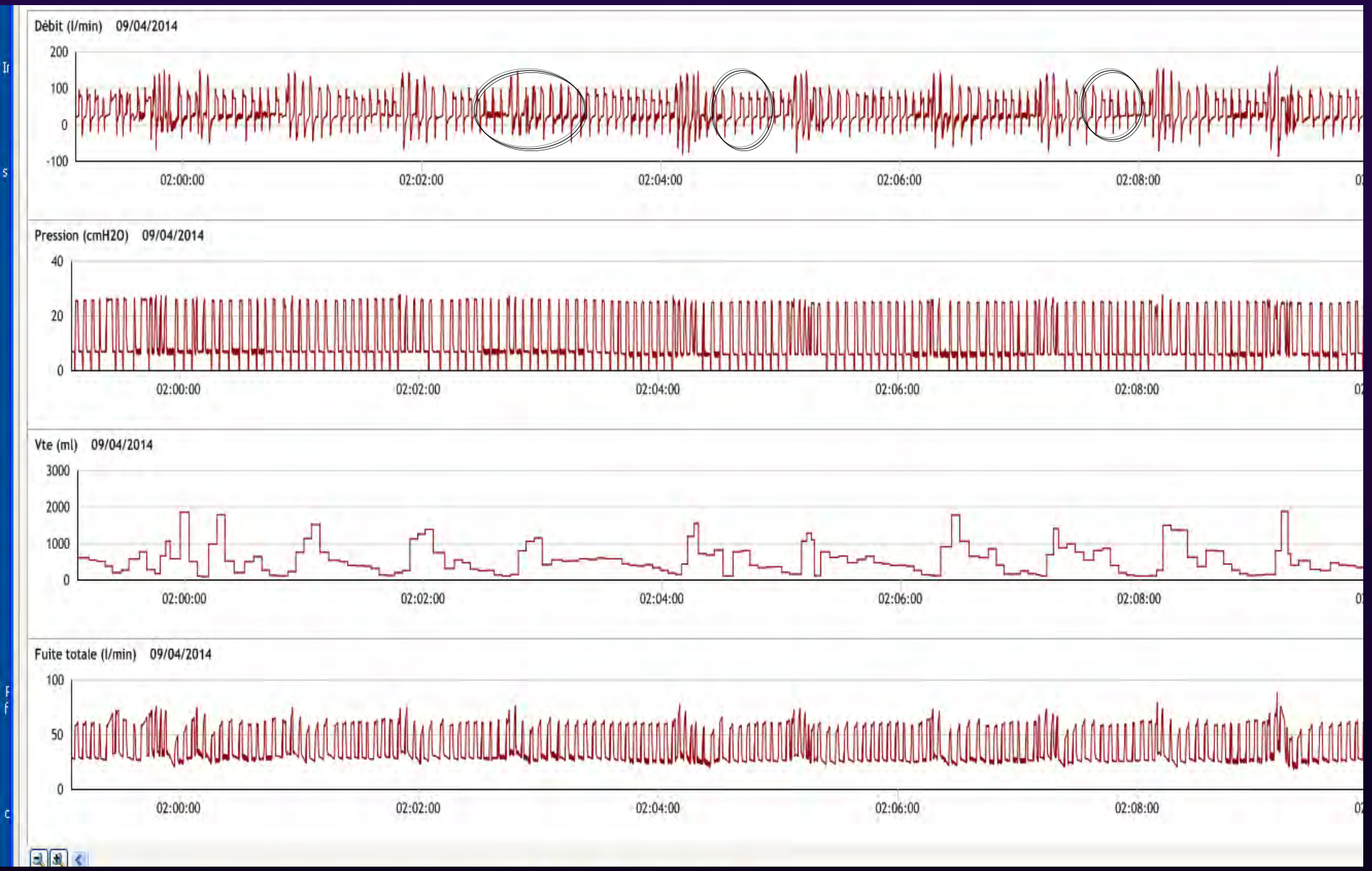
RESPIRATORY CARE • FEBRUARY 2015 VOL 60 NO 2





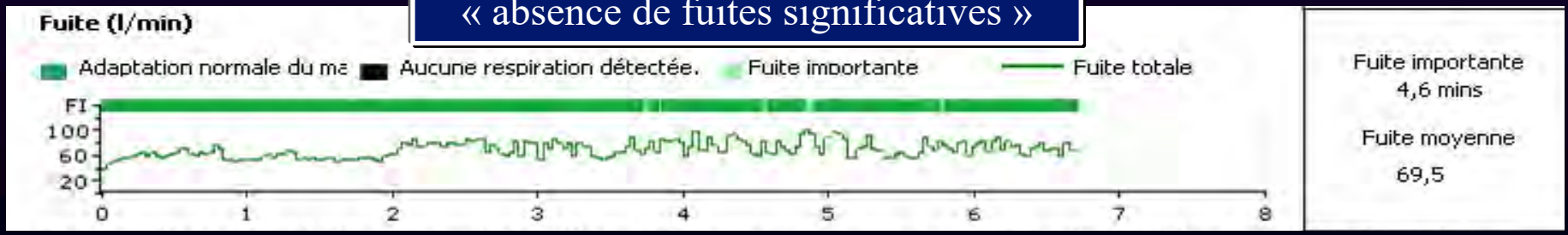


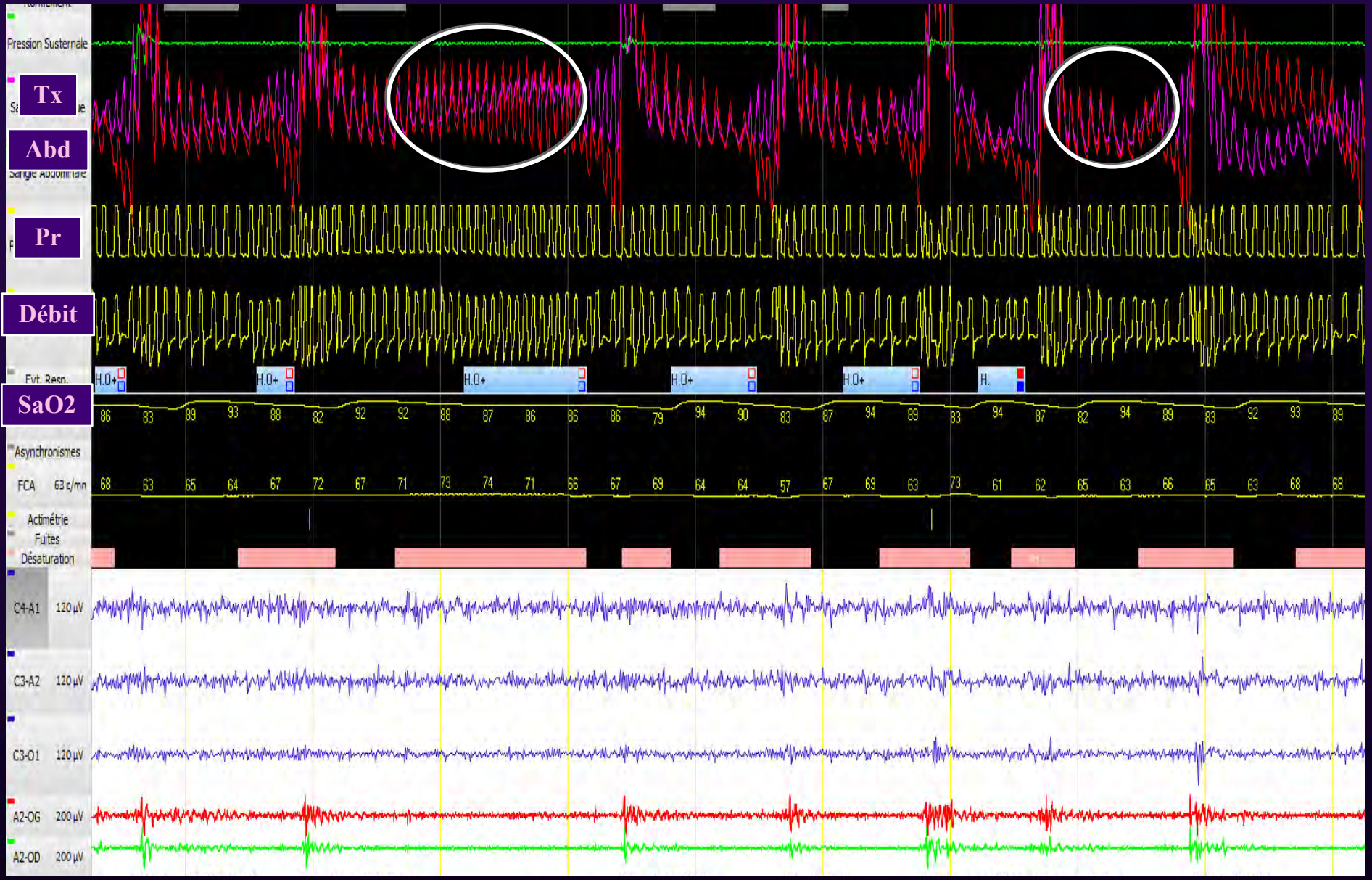
Carlucci, ICM 2013



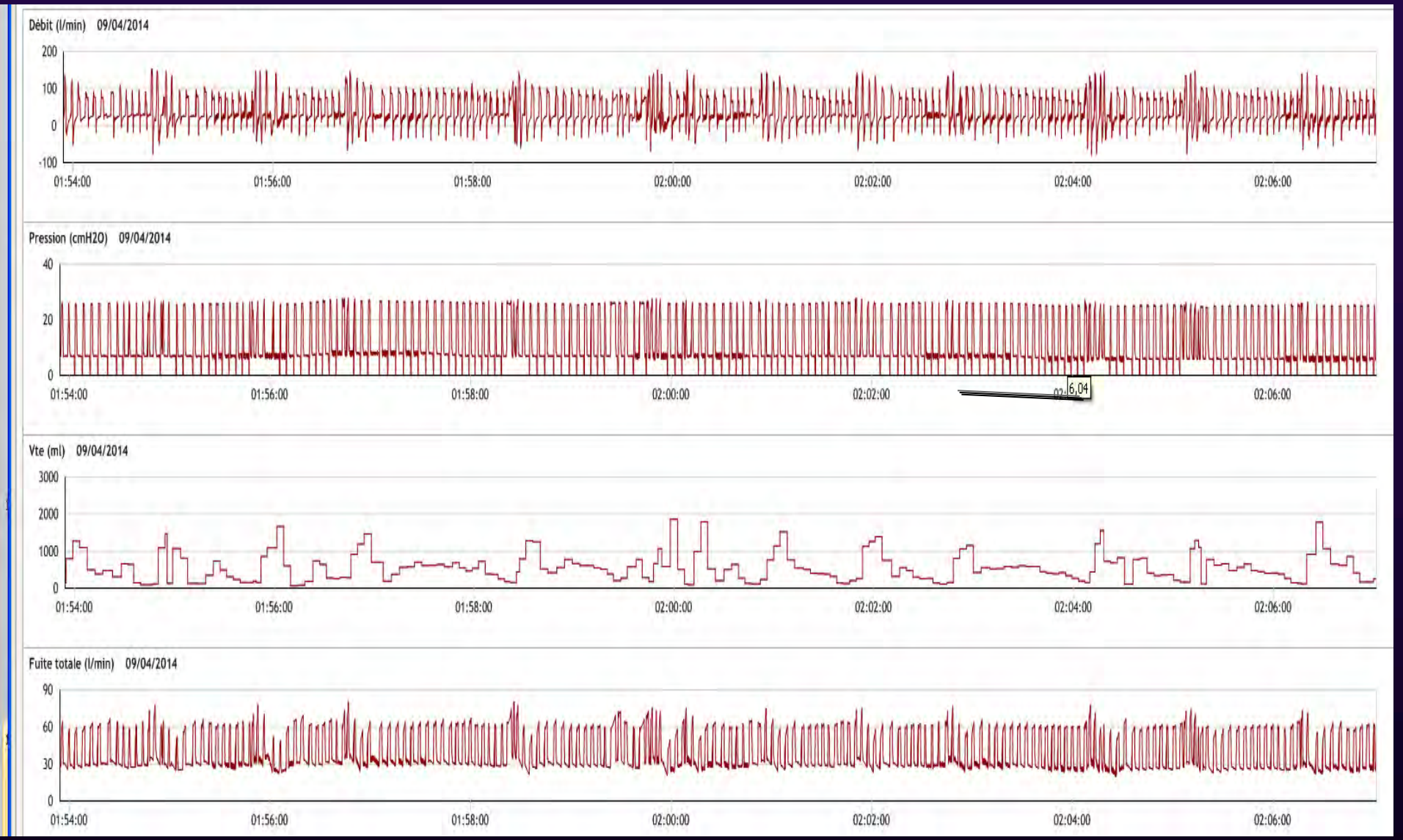
Evènements répétés… la PEP dort…

« absence de fuites significatives »

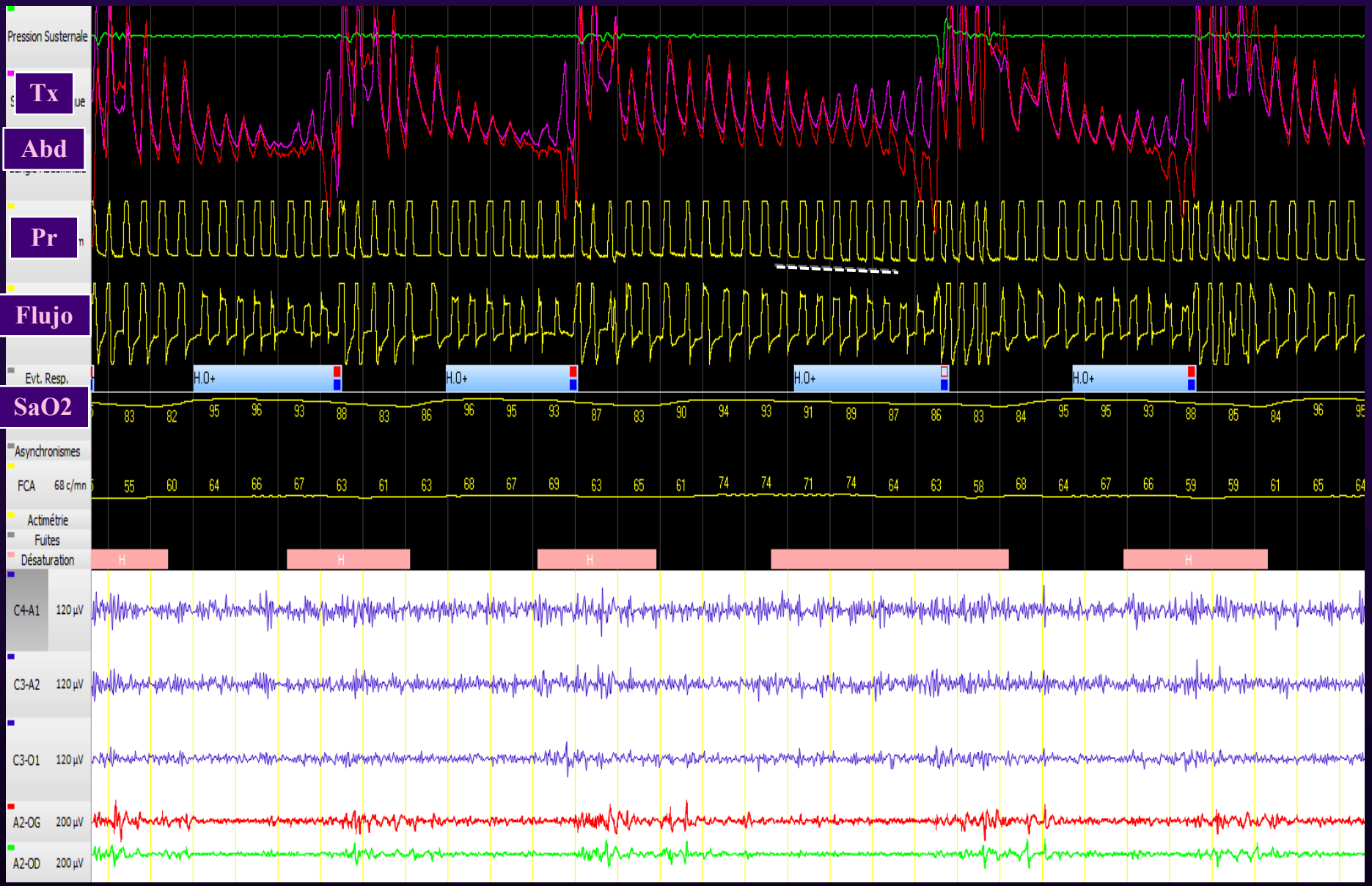




Ce sont bien des événements obstructifs…



.. Parfois elle se reveille, et même s'il y a des apnées elle baisse la pression,



Et ce sont toujours des événements obstructifs…

Inconvenients potentiels d'une mode dit « intelligent »

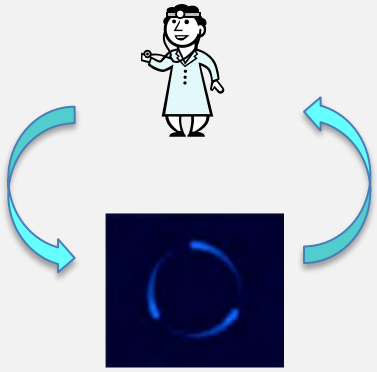
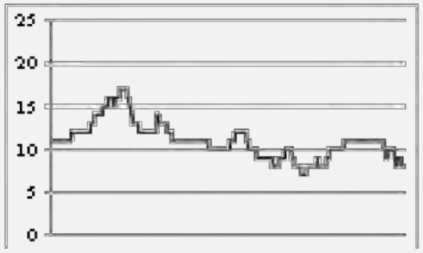
Le problème de la variabilité

Le problème de la fiabilité

- Calcul du Vt
- Algorhitmes
- Réponse en présence des fuites
- Configuration des circuits

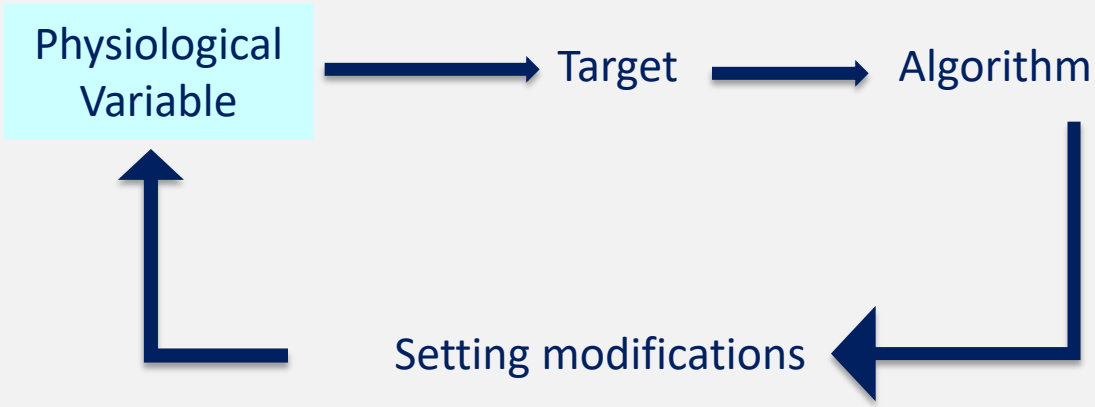
- Le problème du paramétrage
  - Quel Vt cible
  - Quels plages d'AI, FR, PEP

Et le futur?

	Modes Conventionelles	Modes Automatiques
Cible		
Reglage		
Resultats		

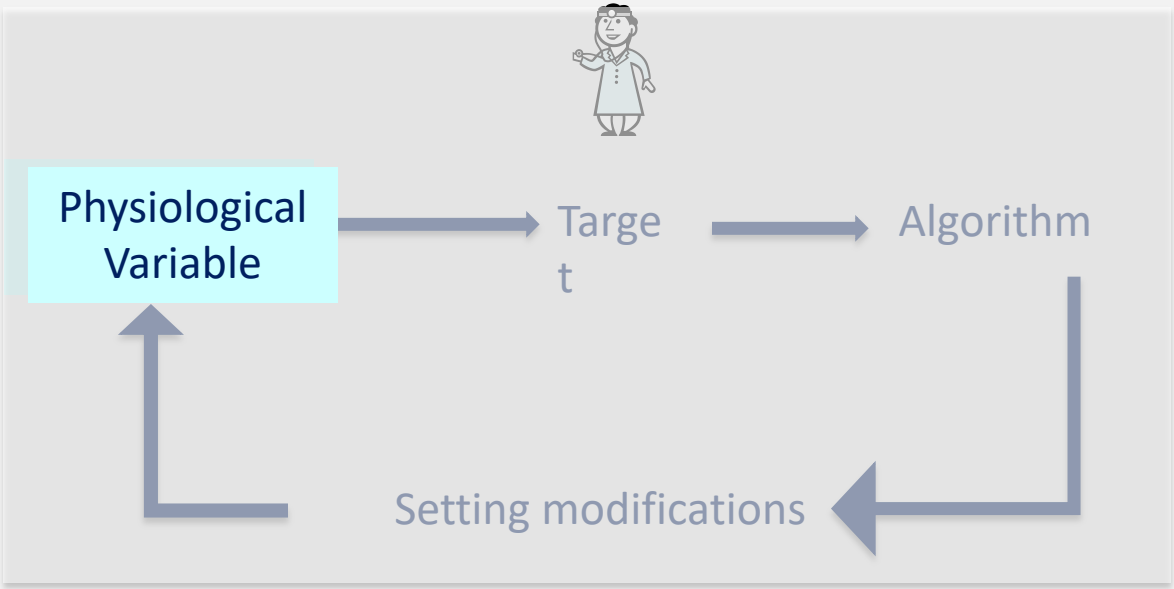
Thanks to JM Arnal

Boucle fermée en ventilation



Thanks to JM Arnal

Boucle fermée en ventilation

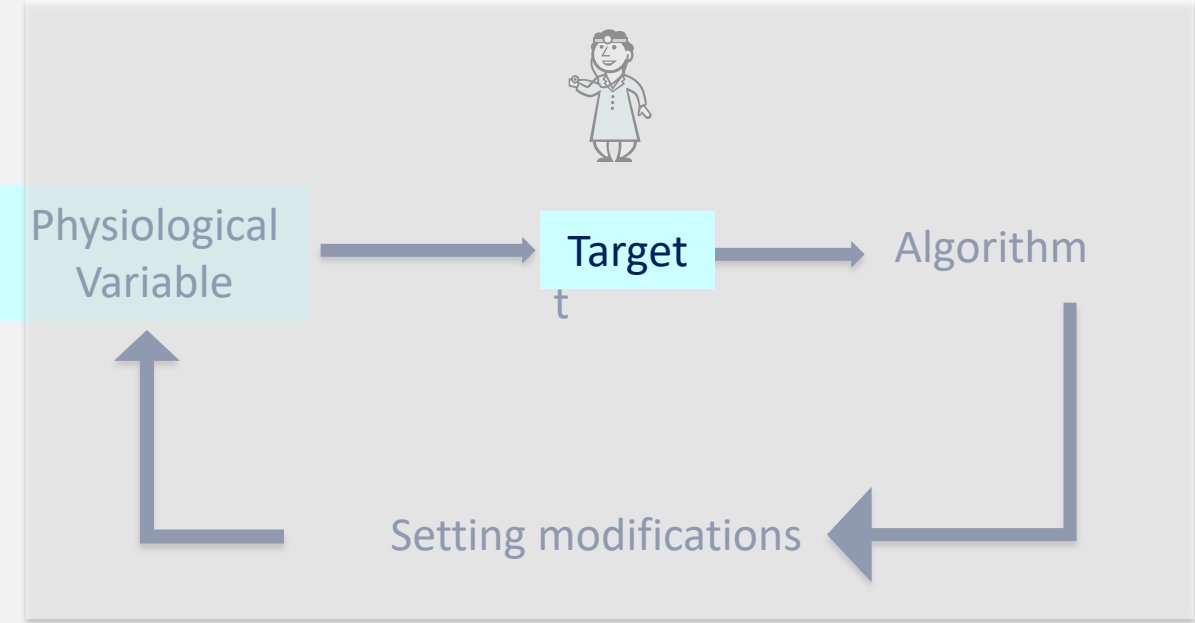


Variables en ventilation

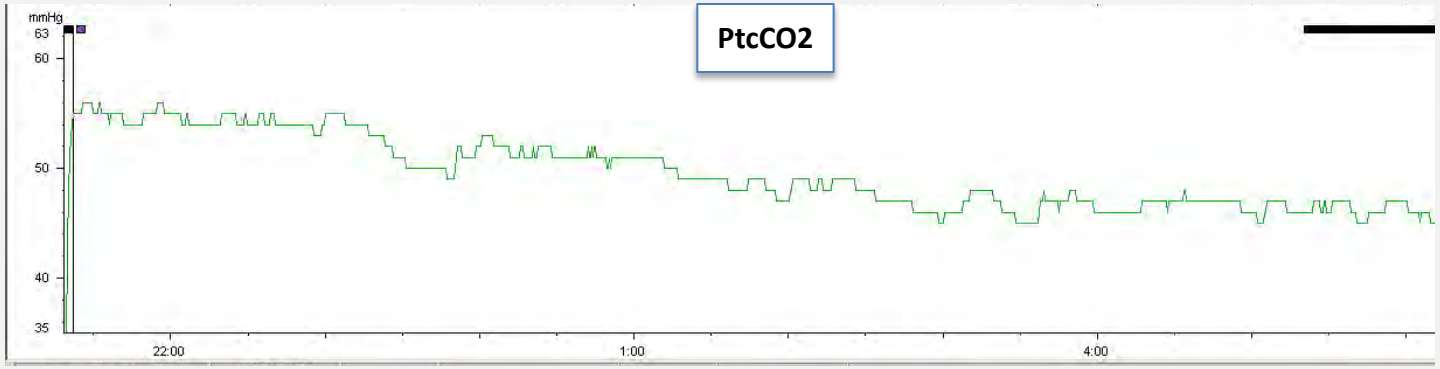
	FR	VT	SpO2	PtcCO2	Effort	Synch	EMG	P_{ESO}
Accurate	±	±	±	±	X	±	x	x
Reproductible	X	X	X	±	X	X	X	X
All patients	X	X	X	X	X			
Comprehensible	X	X	X	**X**	X	X	X	X
Facile à mésurer	X	X	X	±	X			
Non invasive	X	X	X	X	X	X	X	
Technologie accessible	X	X	X	X	X			
Pas de capteur additionnel	X	X			X?			

Thanks to JM Arnal

Boucle fermée en ventilation

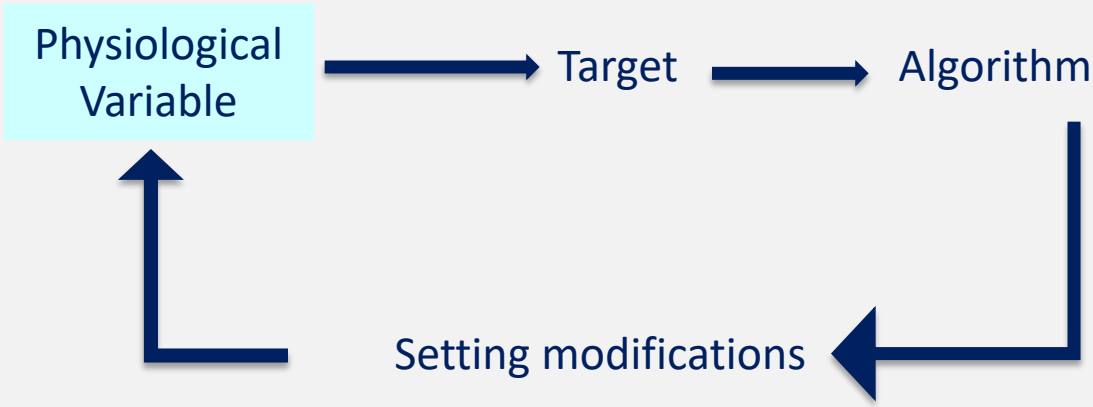


Target

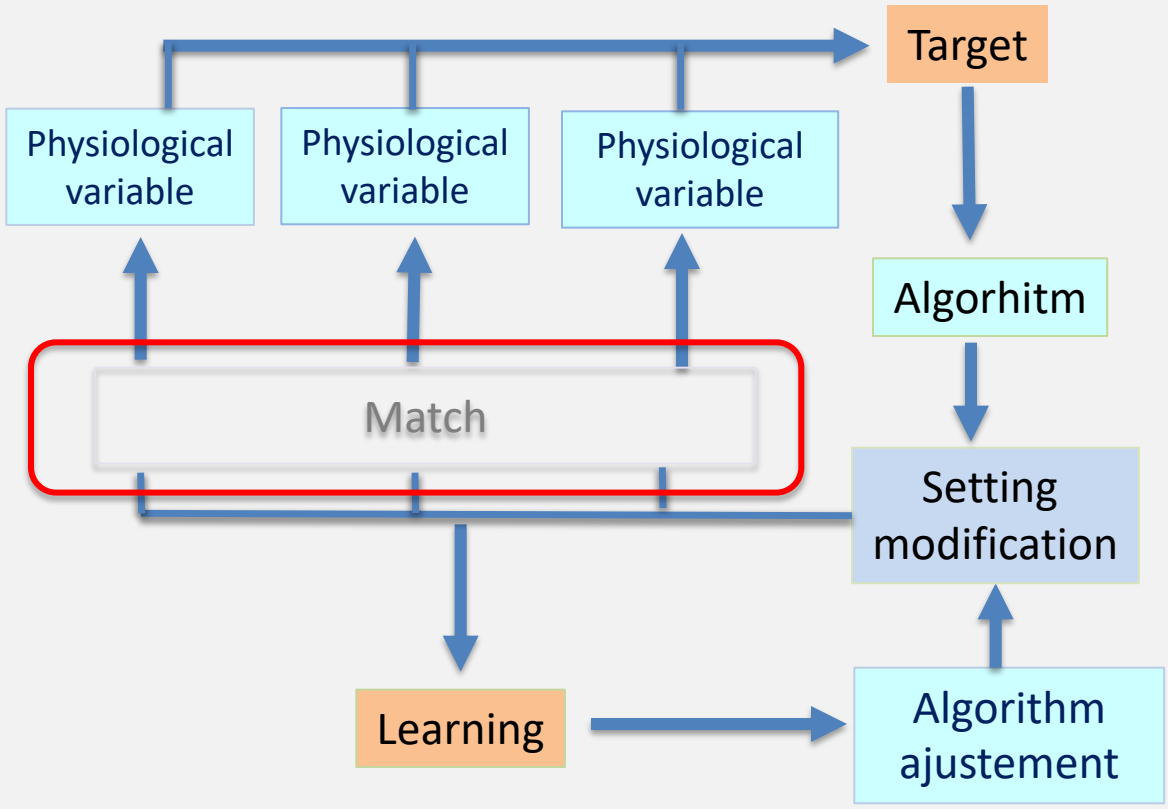


Automatisme

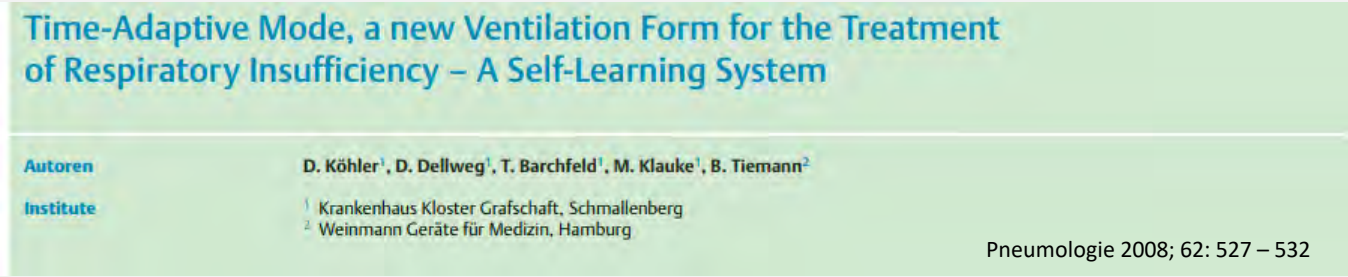
Stimuli → Response



Intelligence
Capacité à apprendre et s'adapter

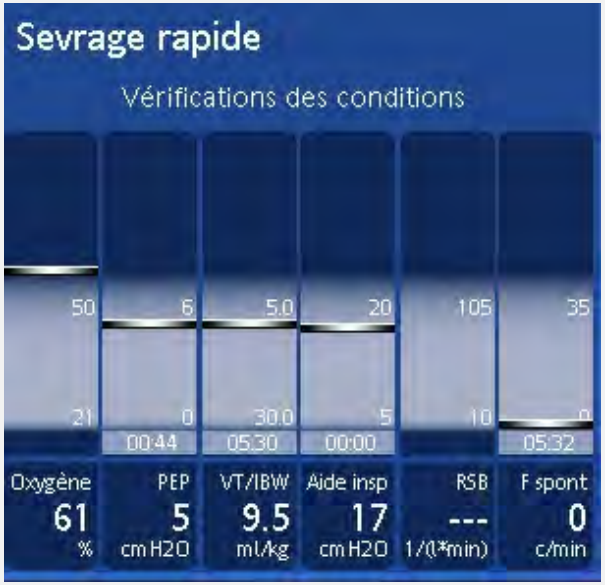


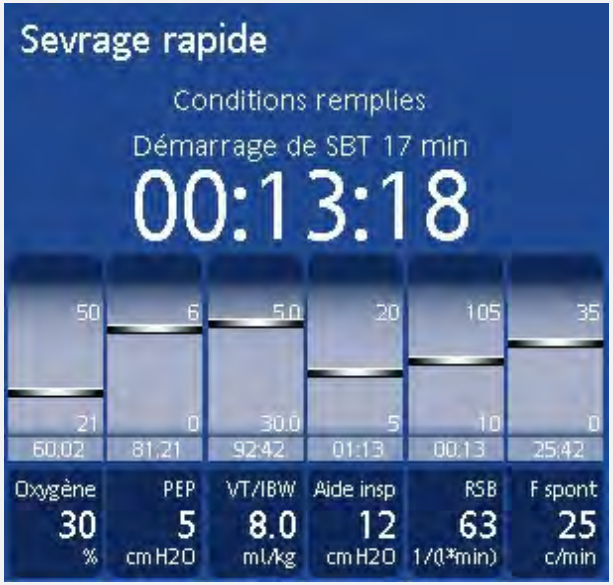
Stroke Vasc Neurol. 2017



“The term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving. Through ‘machine learning, AI provides techniques that uncover complex associations which cannot easily be reduced to an equation.”

The ICU model: multivariable analysis





Exemple de variables physiologiques potentiellement utiles en VNI

- Asynchronie
- Fuites
- PCO2
- SaO2
- Effort inspiratoire (EMG…)

…et al

Comment le regler?
(pas de recommandations…conseil d'ami…)

1) *Large plage de PEP*
   - Aucun risque si le systéme réagit de façon approprié
2) *Régler un volume cible par poids théorique (7-9 mg kg)*
   - Sous risque d'hyperventilation, fuites et al,
3) *Limiter la plage de AI à pas plus de ± 5 cm H20*
   - Sous risque d'induire respiration périodique
4) *Eviter un niveau d'AI mini trop bas*
   - Sous risque d'hypoventiler le patient
5) *Monitorage polygraphique <u>systématique</u> du résultat*

Question non resolues

1) *Place de ces outils dans l'arsenal thérapéutique*

2) *Fiabilité des algorithmes*

Nécessité de:

- Séquences de réponse « compréhensibles » et mécanisme de « auto- désactivation » de l'algorithme face à certains événements
- Evaluation dans des différentes situations cliniques/ groupes étiologiques
- Feed back ingénieurs-experts cliniques→ evolution des version sur la base de tests et des résultats

2) *Intérêt d''une évaluation de ces systèmes par des équipes indépendants*

Pour conclure..

Laissons parler les experts…

Thorax 2012

Target volume settings for home mechanical ventilation: great progress or just a gadget?

Wolfram Windisch, Jan Hendrik Storre

modes for nocturnal HMV. Controlled ventilation, however, can be achieved by all classical modes. In this regard, target volume appears to be more of a gadget than a great progressive tool.

Review

Paedriat Resp Rev 2016

New modes in non-invasive ventilation

Claudio Rabec [1,2,*], Guillaume Emeriaud [3], Alessandro Amadeo [4,5,6], Brigitte Fauroux [4,5,6], Marjolaine Georges [1,2]

There is no evidenced-based benefit of these modes as compared to conventional modes. Even if these modes might give the impression of an improved control of NIV and are proposed by some manufacturers as powerful "fully automatic modes" that may simplify NIV settings, they should not be used as a first line therapy. Some individual patients may benefit from these modes.

Long-term volume-targeted pressure-controlled ventilation: sense or nonsense?

ERJ 2017

Maria Paola Arellano-Maric[1,2], Cesare Gregoretti[3], Marieke Duiverman[2,4], Wolfram Windisch[2]

advantages of conventional ventilatory modes. Unfortunately, robust evidence is not yet available to show its superiority over the traditional set-point targeting ventilators. However, clinical experience as well as scientific evidence suggest that individual patients might benefit from these adaptive modes, even though a

Groupe assistance ventilatoire

Groupe GAV

LES CONSEILS DU GAV 2015 SUR LA VENTILATION DE DOMICILE

7

Les ventilateurs utilisant une adaptation automatique des pressions ne doivent pas être utilisés en première intention

Les modes à Vt cible n'ont pas une efficacité démontrée supérieure justifiant un usage systématique, ils peuvent avoir un effet délétère dans certaines pathologies et ne constituent pas une solution de facilité car leur utilisation nécessite un degré d'expertise.

Plusieurs arguments concourent à réserver l'utilisation de ce mode de deuxième intention à des médecins expérimentés dans l'analyse des données de ventilation et l'adaptation des réglages :

- Il n'y a pas de niveau d'évidence concernant la supériorité de ce mode sur un mode ST conventionnel sur l'hypoventilation (Murphy, Thorax 2014) sur le sommeil (Storre Chest 2007, Murphy Thorax 2014), ni sur le confort (Murphy, Thorax 2014). En outre, une étude a montré que le sommeil peut être de moins bonne qualité avec ces modes (Janssens, Resp Med 2009).
- L'évaluation du Vt n'est pas toujours fiable (Contal, Chest 2011). D'ailleurs quel référentiel choisir pour le Vt cible ?
- Il existe des données montrant que le mode à réglages automatiques aboutit à des pressions moyennes identiques aux réglages manuels (Murphy, Thorax 2014)
- Une fourchette importante de variation de la pression inspiratoire peut générer des respirations périodiques, ce mode de ventilation est donc risqué dans certaines pathologies *(insuffisance cardiaque)*
- Il n'est pas conseillé d'utiliser ce mode avec des circuits à valve du fait du risque d'une compensation de fuites inappropriée avec risque d'hypoventilation (Carlucci, Int Care Med 2013).
- L'adaptation des réglages est complexe et nécessite une surveillance rapprochée (Murphy, Thorax 2014)

Une machine purement automatique, complètement fermée sur elle-même, dans un fonctionnement prédéterminé, ne pourrait donner que des résultats sommaires. On comprend alors qu'elle demande, non pas moins de présence humaine – comme il est naïf ou faussement alarmant de le croire – mais, tout au contraire, une présence accrue et attentive

« Du mode d'existence des objets techniques » (p.11)
Gilbert Simondon