Effets Hémodynamiques de la Ventilation Non-Invasive

Pr E. L'Her

CHRU de Brest, Réanimation Médicale et Urgences Adultes, Brest, France ;
LATIM, INSERM UMR 1101, Université de Bretagne Occidentale, Brest, France ;
FHU TechSan

Inserm
Institut national de la santé et de la recherche médicale

UBO
université de bretagne occidentale

TECH-SAN
TECHNOLOGIES POUR LA SANTÉ

CHRU BREST
CENTRE HOSPITALIER REGIONAL UNIVERSITAIRE

Conflits d'Intérêt

ELH est co-inventeur du brevet FreeO_2 et membre fondateur d'Oxy'nov Inc

Consultant Air Liquide Médical Systems

L'utilisation de la ventilation non invasive (CPAP à haute débit) au cours de l'OAP cardiogénique débute avec …

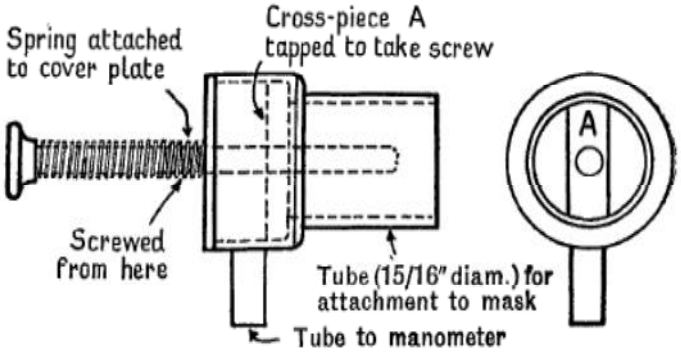
Un aspirateur !

LEFT-SIDED HEART FAILURE WITH PULMONARY ŒDEMA

ITS TREATMENT WITH THE "PULMONARY PLUS PRESSURE MACHINE"

By E. P. POULTON, D.M. Oxon., F.R.C.P. Lond.
PHYSICIAN TO GUY'S HOSPITAL, LONDON

The machine as eventually designed consists of a blower—an Electrolux or Hoover vacuum cleaner answers the purpose, or the smaller Hoover "dustette" might be adapted—which supplies air under positive pressure through an opening to a mask; the air escapes through a valve which is fitted into another opening in the mask. The valve* (see Figure)



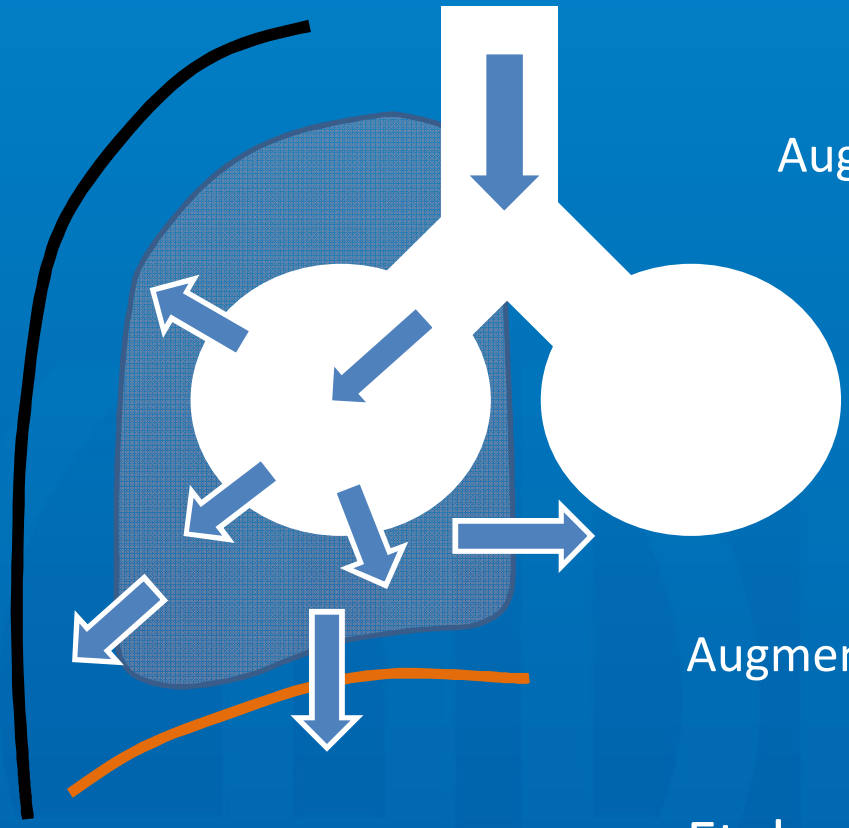
The pressure in the air passages is regulated by the strength of the spring and by the rate of flow, and the two should be adjusted so that there is an insignificant fall in pressure in the manometer during inspiration. A plus pressure of 6 in. is about the maximum that can be tolerated;

~ 16 cm H_2O

CASE 3.—Man, aged 56. (National Hospital for Diseases of the Heart, under care of Dr. Campbell, June, 1935.) Mitral stenosis, hyperpiesia, auricular fibrillation beginning three years back. Kahn test negative. Severe attack at night was relieved. Used the apparatus too much the next day, when he was not very breathless, and this brought on a severe attack of angina.

Effets hémodynamiques généraux

Conséquences de la ventilation en pression positive



Augmentation des volumes pulmonaires

Augmentation de la pression pleurale

Augmentation de la pression intra-abdominale

Et donc... Effet hémodynamique ... !

L’importance de ces conséquences mécaniques dépend de la compliance thoraco-pulmonaire et des résistances bronchiques

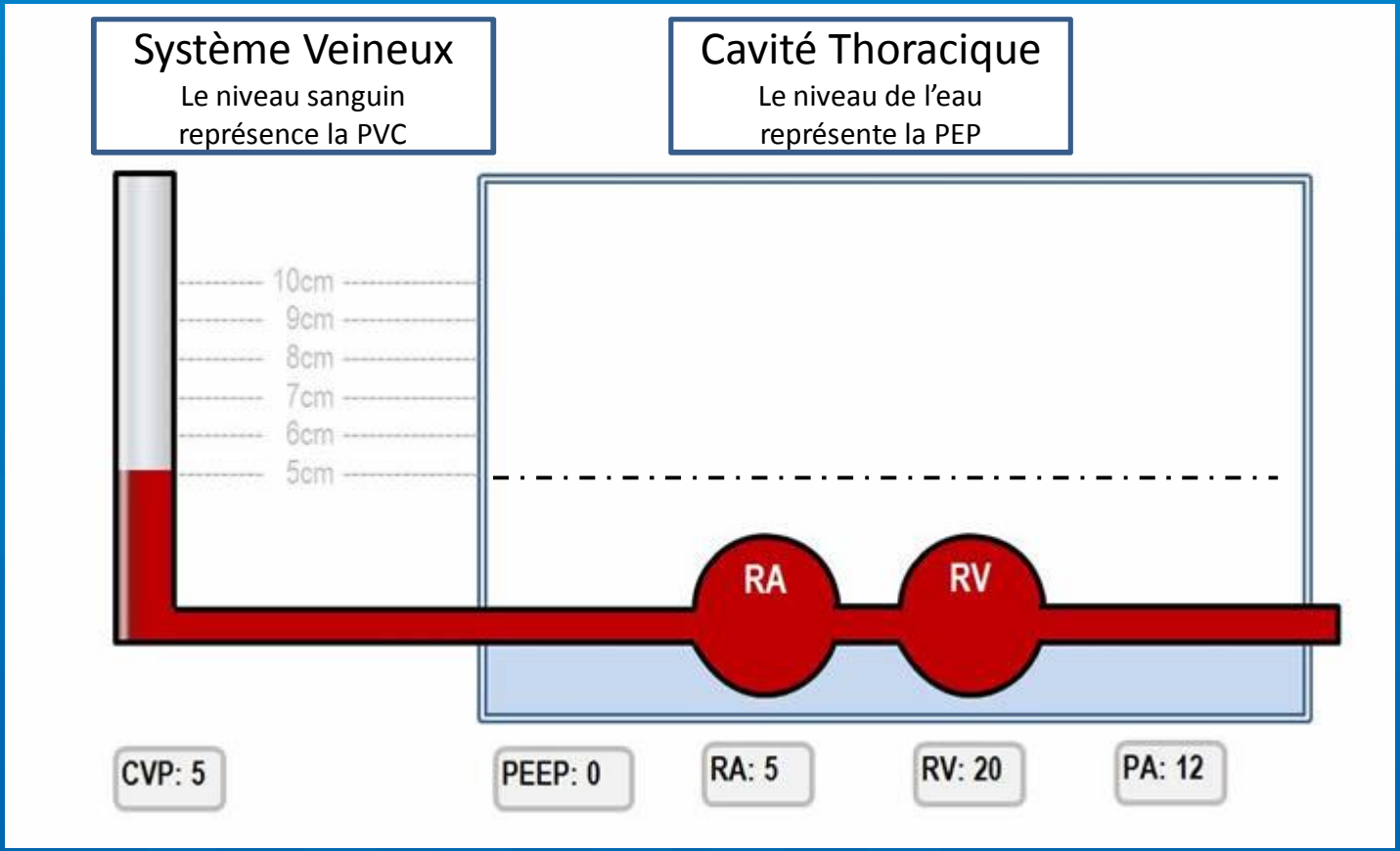
CTP basse (OAP): plus grande transmission des ΔP

CTP et RB élevée (BPCO): plus grande variation des volumes pulmonaires

Les effets hémodynamiques dépendent de l’état clinique du patient

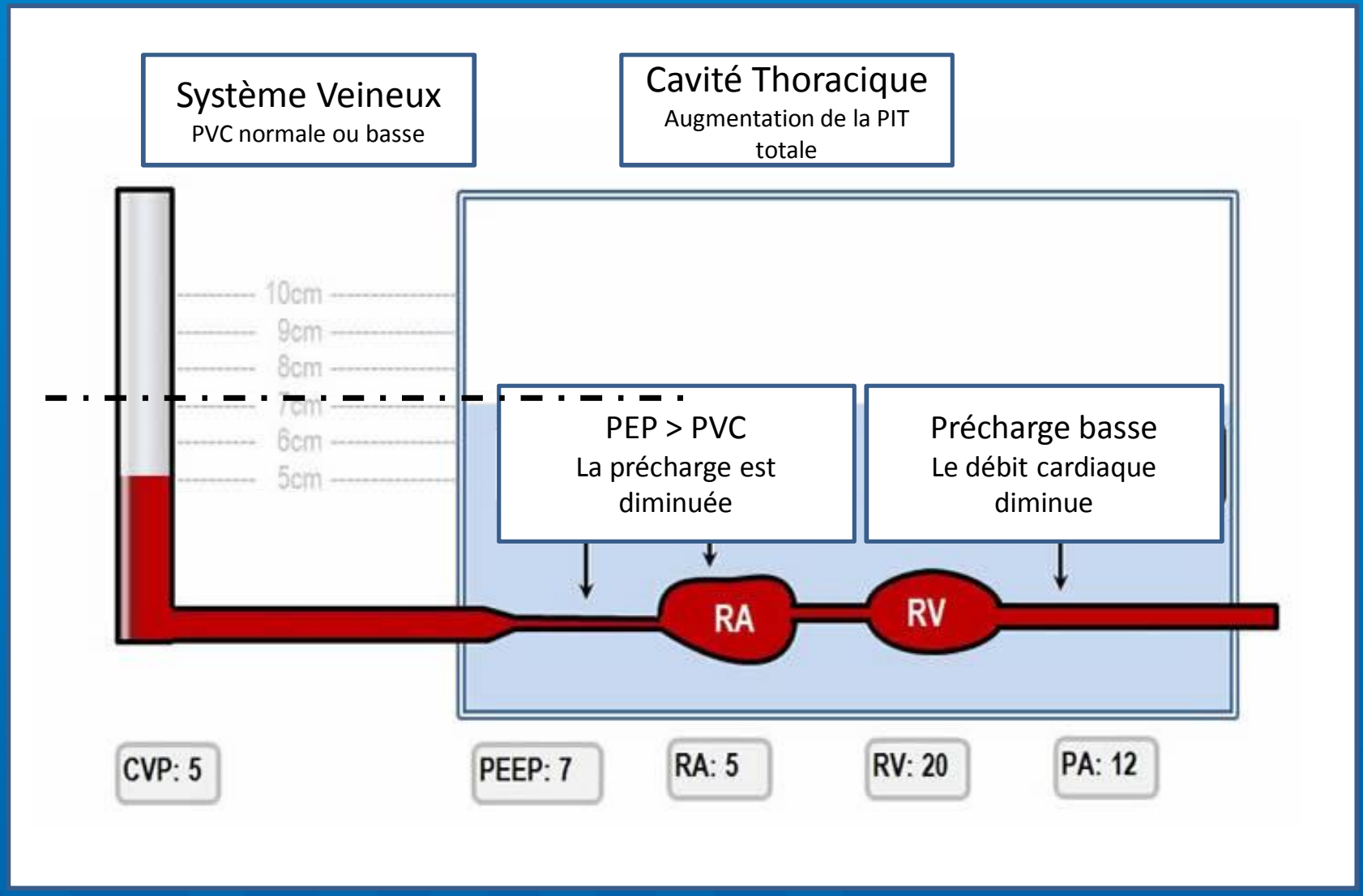
Les effets hémodynamiques sont majorés en cas d’hypovolémie

... Fréquente lors de l’OAP...

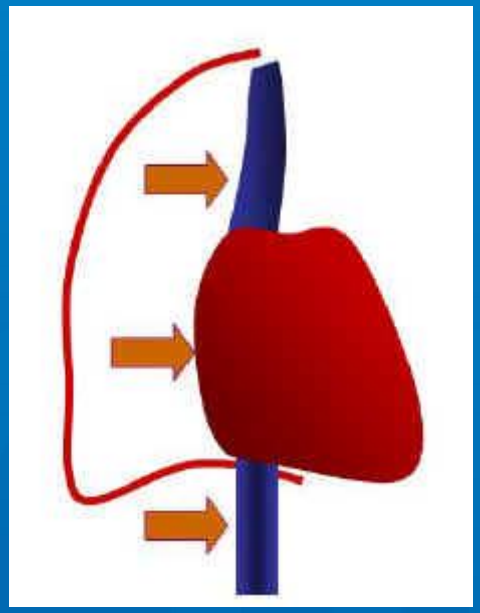


PEEP ~ Pression Intrathoracique Téléexpiratoire

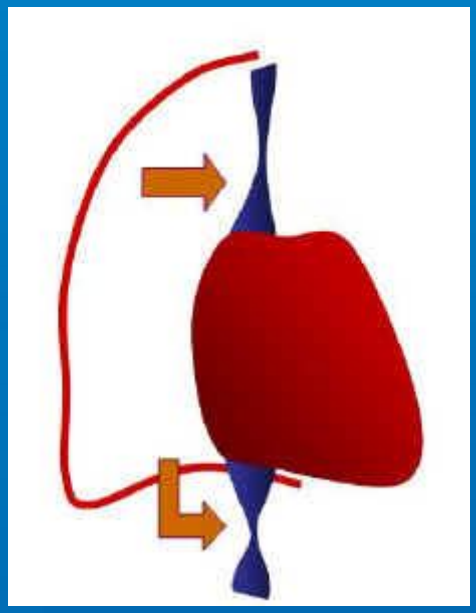
Chez un patient à mécanique respiratoire normale, même discrètement hypovolémique, Le retour veineux reste adéquat car la PVC est supérieure à la pression intrathoracique (le plus souvent discrètement négative)



L'augmentation de la PIT peut être liée aux réglages du ventilateur et/ou à la mécanique respiratoire du patient

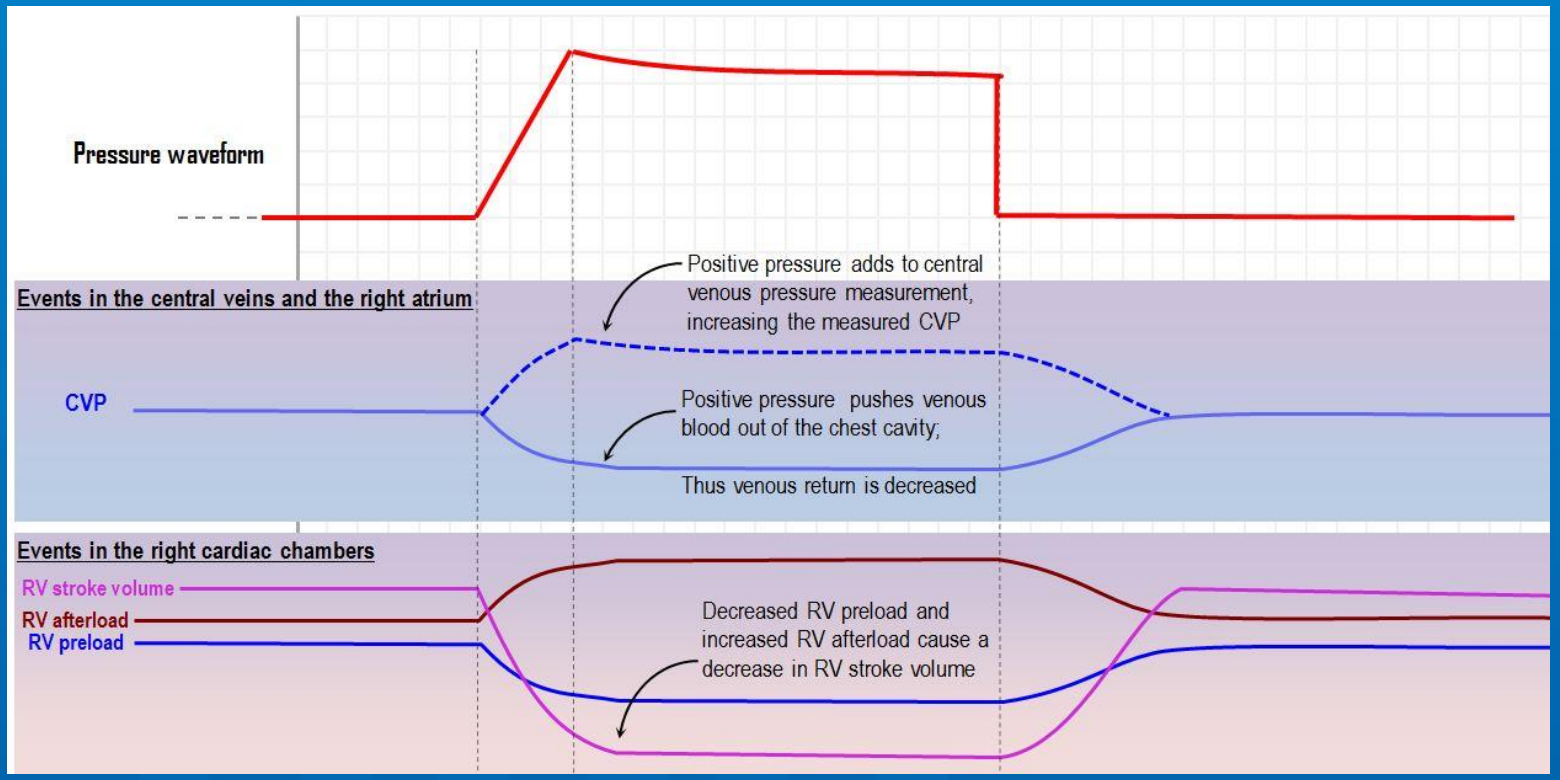


En cas de normovolémie: le retour veineux chute peu lorsque la pression intrathoracique est positive



En cas d'hypovolémie: le retour veineux chute

Cinétique des effets hémodynamiques



Un effet continu lié à la PIT en téléexpiratoire

Un effet séquentiel lié au cycle du ventilateur

Intensive Care Med (2003) 29:1426–1434
DOI 10.1007/s00134-003-1873-1

CLINICAL COMMENTARY

François Jardin
Antoine Vieillard-Baron

Right ventricular function and positive pressure ventilation in clinical practice: from hemodynamic subsets to respirator settings

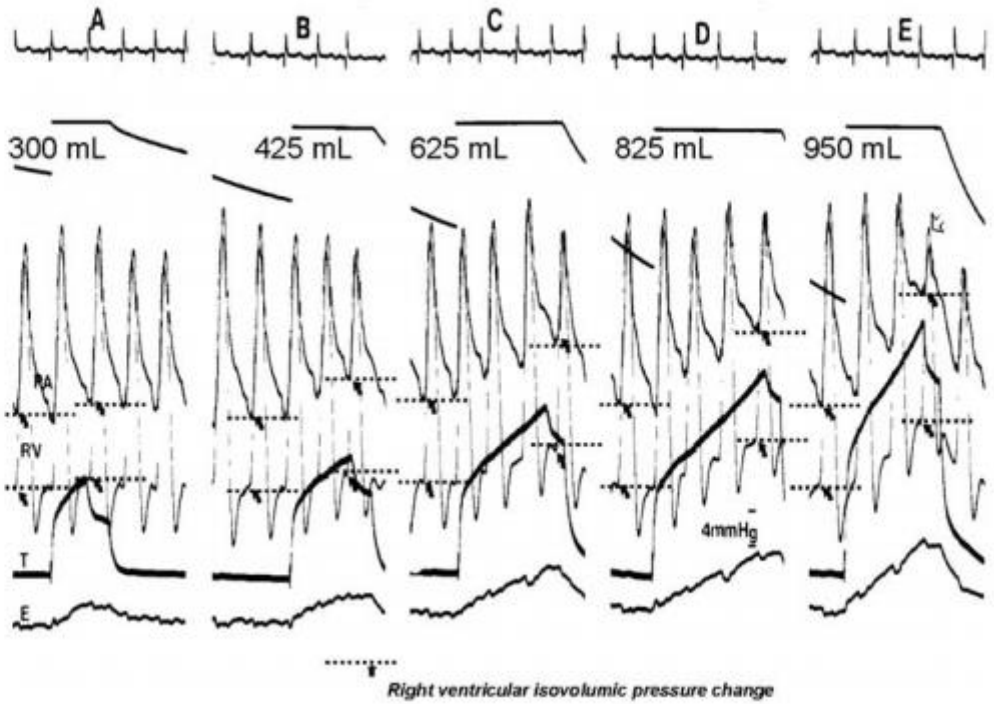
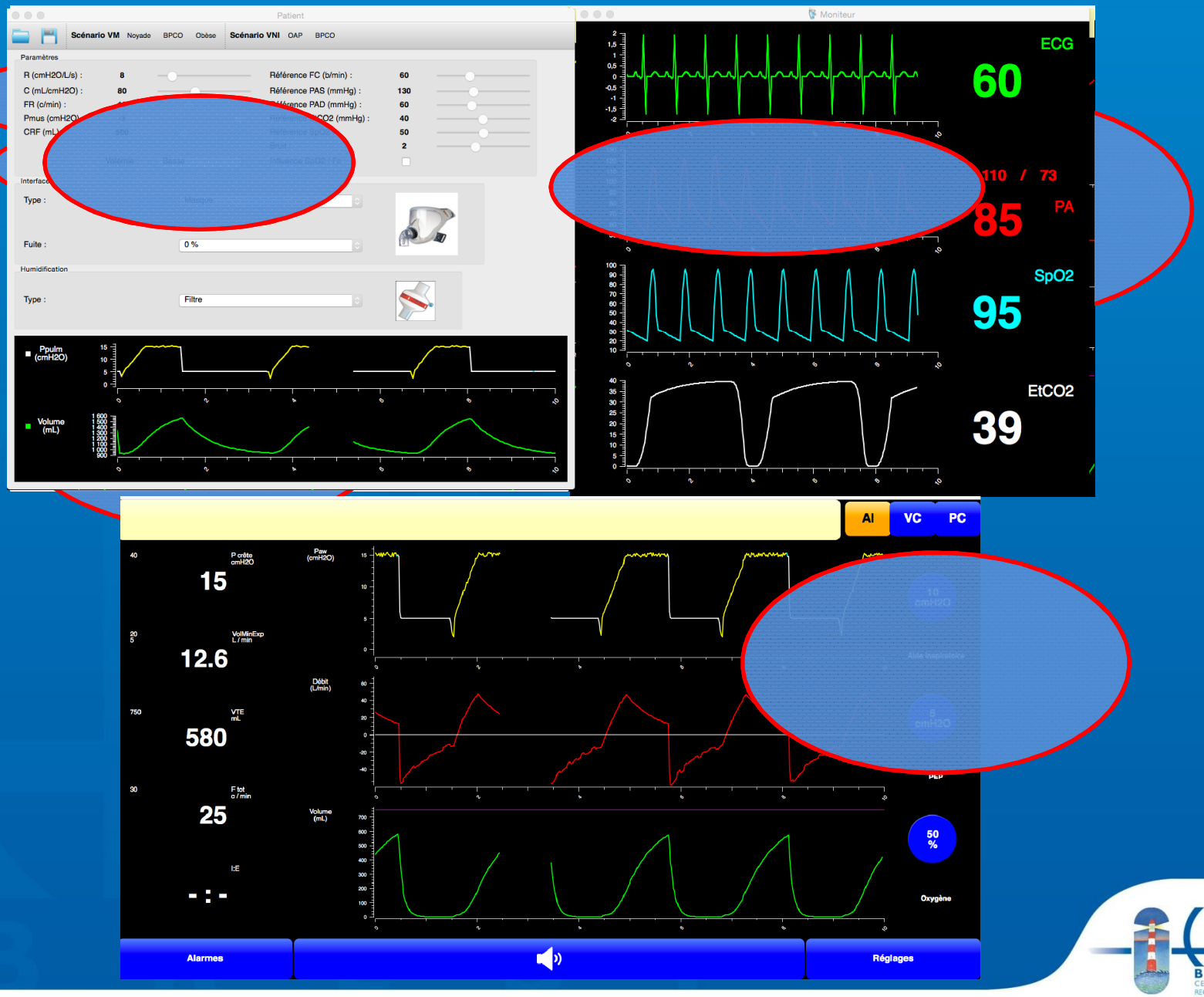
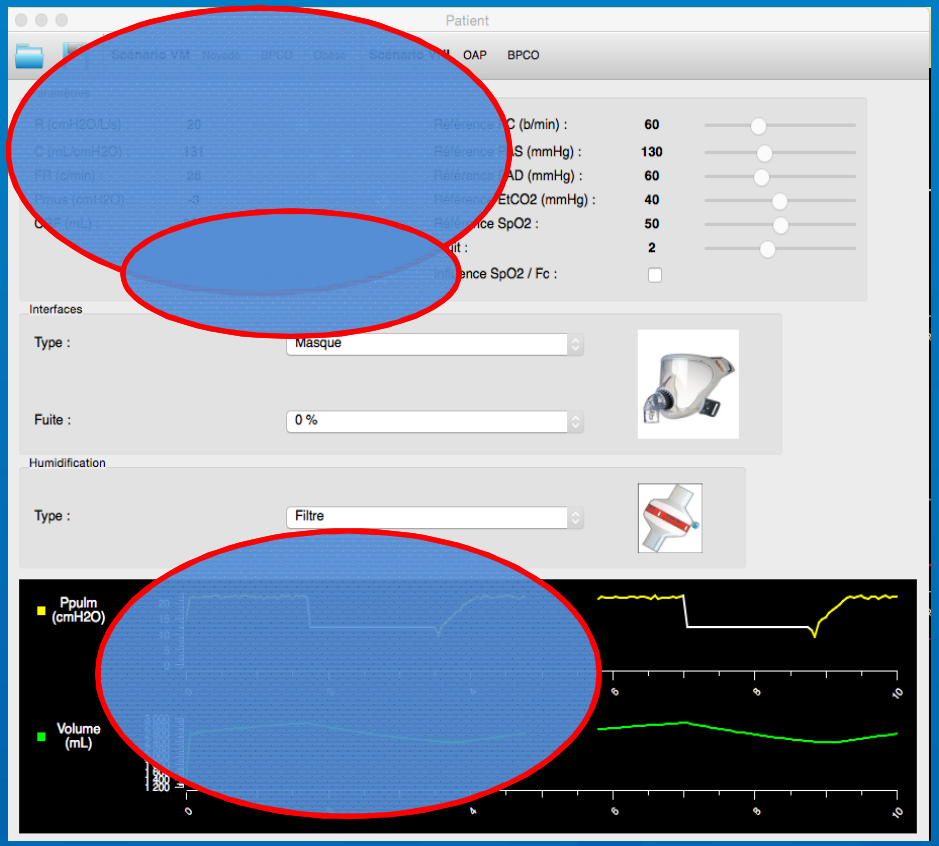
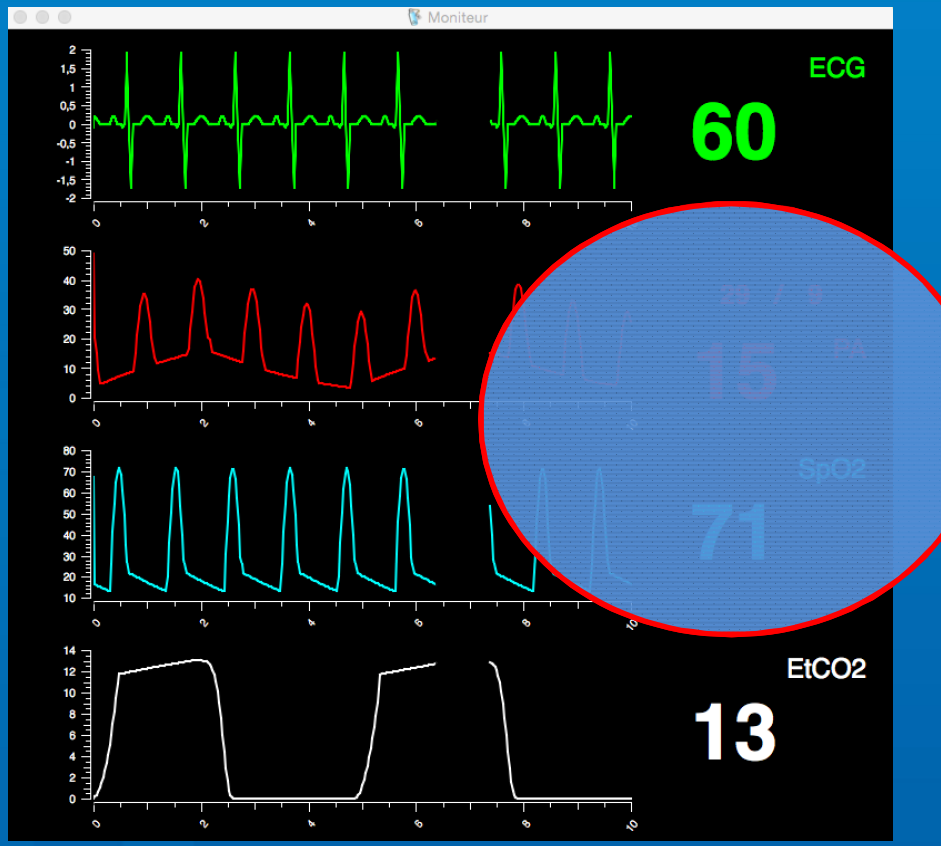


Fig. 3 Simultaneous recordings of expiratory volume (*EV*, ml), pulmonary artery pressure (*PA*, mmHg), right ventricular pressure (*RV*, mmHg), tracheal pressure (*T*, mmHg) and esophageal pressure (*E*, mmHg), during a progressive increase in tidal volume from 300 to 950 ml. This progressive increase in tidal ventilation required a progressive increase in the pressure developed by the RV during its isovolumetric contraction to open the pulmonic valve (i.e., the difference between pulmonary artery diastolic pressure, *small closed arrow*, and right ventricular end-diastolic pressure, *small closed arrow*). Note also that, with the highest tidal volume (*right panel*, *E*), pulmonary artery pulse became negligible (*small open arrow*)

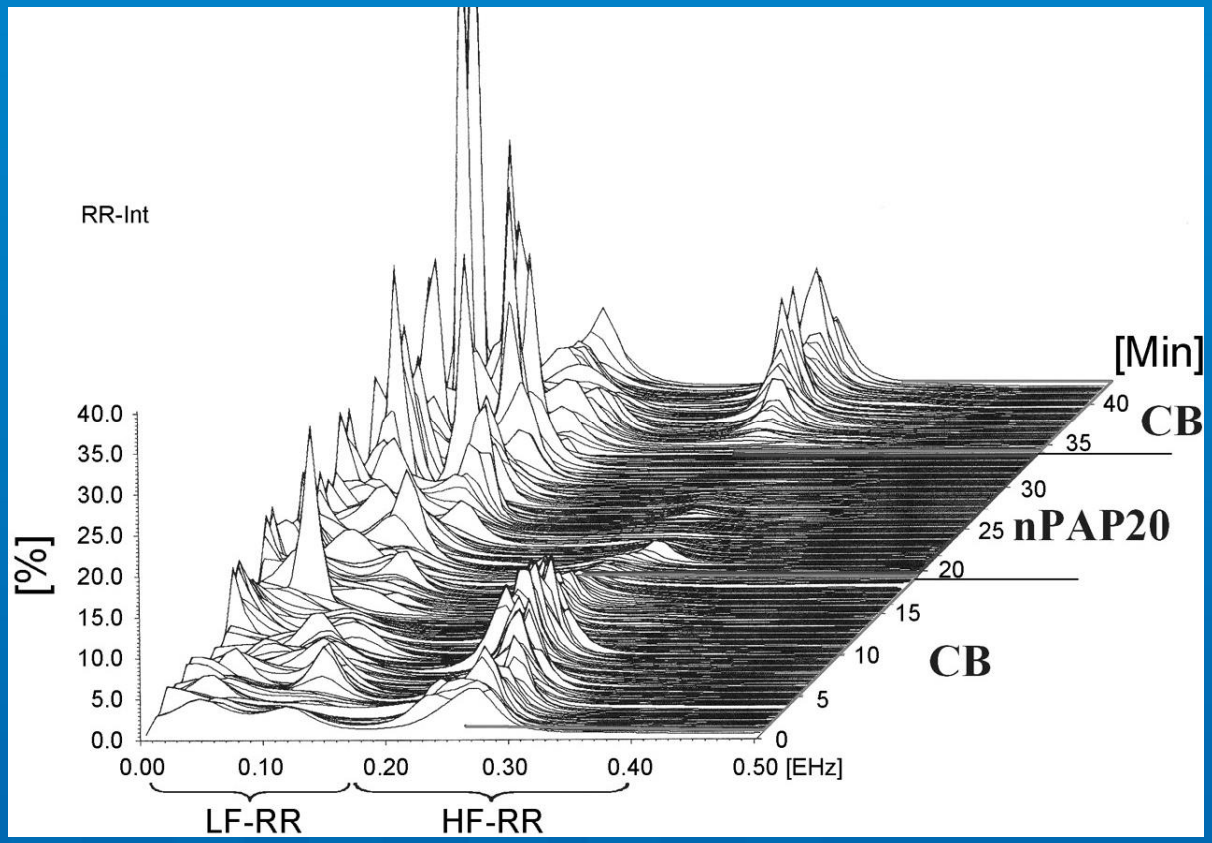
VentiSIM


Patient
Scénario VM
Noyade
BPCO
Obèse
Scénario VNI
OAP
BPCO
Paramètres
R (cmH2O/L/s) :
8
C (mL/cmH2O) :
80
FR (c/min) :
Pmus (cmH2O)
CRF (mL)
Référence FC (b/min) :
60
Référence PAS (mmHg) :
130
Référence PAD (mmHg) :
60
40
50
2
Type :
Masque
Fuite :
0 %
Humidification
Type :
Filtre
Ppulm (cmH2O)
Volume (mL)
Moniteur
ECG
60
110 / 73
PA
85
SpO2
95
EtCO2
39
AI
VC
PC
P crête cmH2O
15
Paw (cmH2O)
VolMinExp L / min
12.6
Débit (L/min)
VTE mL
580
F tot c / min
25
Volume (mL)
I:E
- : -
50 %
Oxygène
Alarmes
Réglages


Patient
OAP
BPCO
C (b/min) :
60
S (mmHg) :
130
AD (mmHg) :
60
EtCO2 (mmHg) :
40
ce SpO2 :
50
it :
2
ence SpO2 / Fc :
Interfaces
Type :
Masque
Fuite :
0 %
Humidification
Type :
Filtre
Ppulm (cmH2O)
Volume (mL)


Moniteur
ECG
60
SpO2
71
EtCO2
13

Effets hémodynamiques en clinique

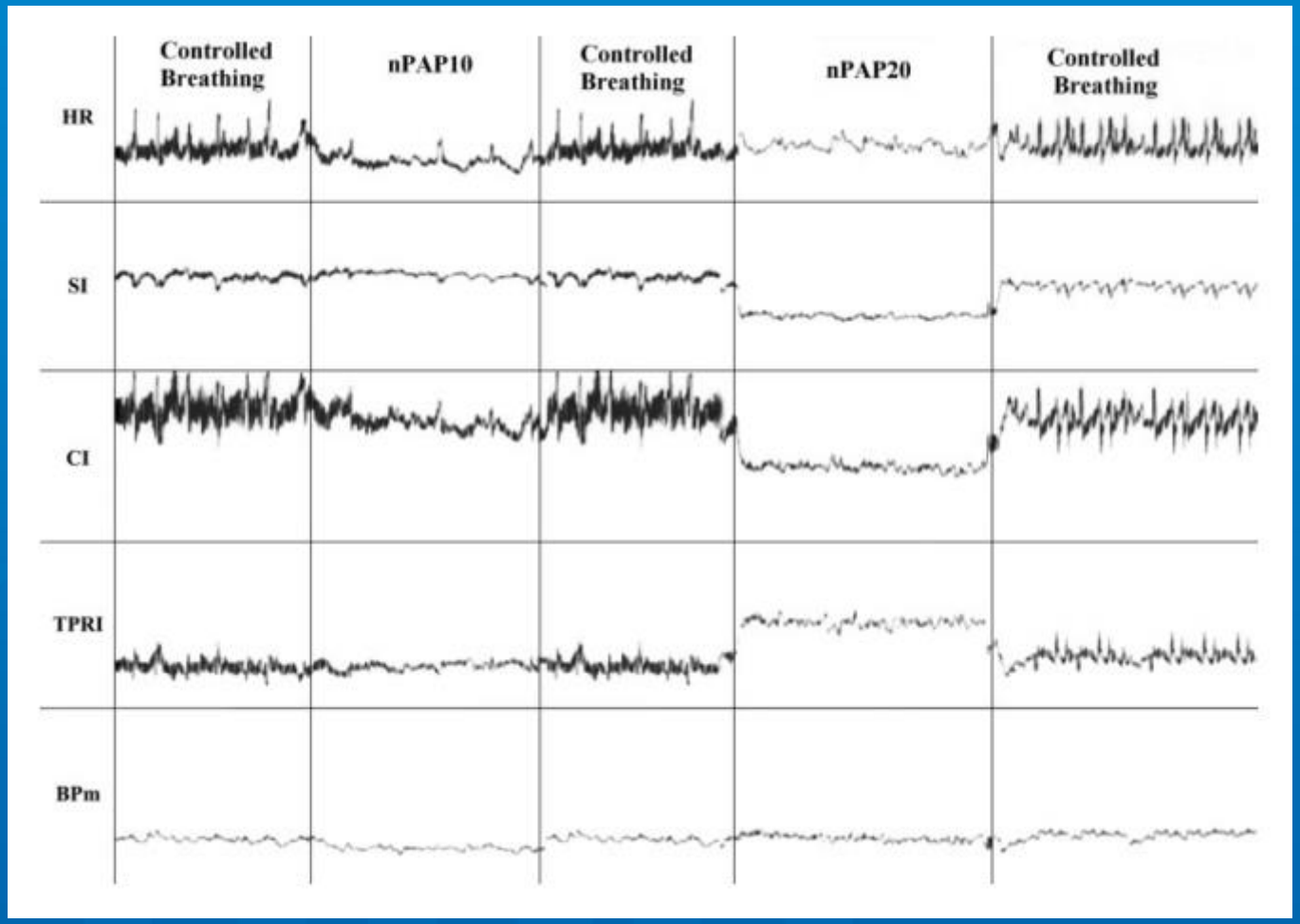


Analyse spectrale de l'intervalle R-R sur l'ECG

Effets hémodynamique de la pression positive (~10 cm H_2O) chez des volontaires sains:

Modulation du baroréflexe artériel sur la fréquence cardiaque
Diminution de la variabilité FC
Diminution du VES

Valipour A, J Appl Physiol 99: 2137–2143, 2005.



Tracé caractéristique chez un volontaire sain

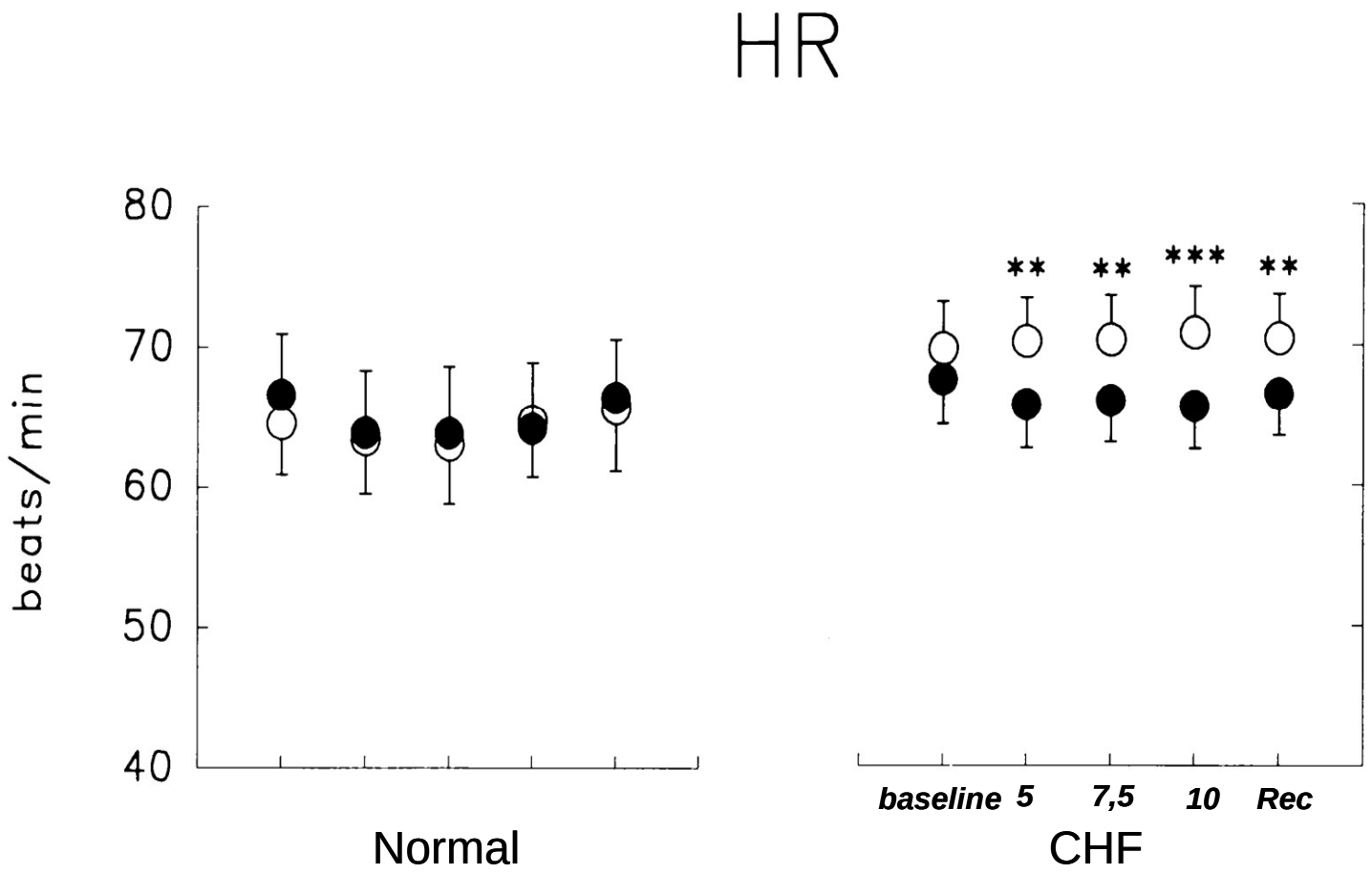
Diminution significative de la variabilité de la FC, SANS diminution du rythme

Diminution significative IC et SVI

Augmentation résistances vasculaires périphériques

Valipour A, J Appl Physiol 99: 2137–2143, 2005.

Effets de la CPAP sur les paramètres hémodynamiques (CHF)



Naughton 1995

Circulation

American Heart Association®
Learn and Live℠

Effects of NIV on Hemodynamic Parameters (CHF)

Variable	Group	Baseline	6 h	12 h	24 h
MAP (mm Hg)	CPAP	91 ± 33	85 ± 23	81 ± 23	82 ± 15
	Oxygen	92 ± 12	84 ± 12*	83 ± 12**	83 ± 16
HR (bpm)	CPAP	107 ± 19	95 ± 20	97 ± 18*	90 ± 14**†
	Oxygen	103 ± 19	102 ± 15	102 ± 16	104 ± 16
MPAP (mm Hg)	CPAP	39 ± 16	27 ± 7*	25 ± 7**	23 ± 7**†
	Oxygen	35 ± 8	29 ± 5	30 ± 9	29 ± 7
PAWP (mm Hg)	CPAP	29 ± 12	20 ± 5*	17 ± 6**	16 ± 5**
	Oxygen	26 ± 6	18 ± 4**	21 ± 7*	20 ± 6*
CVP (mm Hg)	CPAP	15 ± 10	11 ± 5	9 ± 4*	8 ± 3**
	Oxygen	11 ± 3	10 ± 3	11 ± 5	10 ± 3
CI ($L \cdot min^{-1} \cdot m^{-2}$)	CPAP	3.1 ± 0.5	3.0 ± 0.9	3.1 ± 1.0	3.5 ± 1.0
	Oxygen	3.2 ± 0.8	3.4 ± 0.8	3.0 ± 0.4	3.3 ± 0.6
SVI (mL/m^2)	CPAP	30 ± 7	33 ± 10	33 ± 11	39 ± 10**
	Oxygen	31 ± 8	34 ± 7	30 ± 6	33 ± 7

Each value represents the mean ± SD.

MAP = mean arterial pressure, HR = heart rate, MPAP = mean pulmonary artery pressure, PAWP = pulmonary artery wedge pressure, CVP = central venous pressure, CI = cardiac index, SVI = stroke volume index, CPAP = continuous positive airway pressure.

Differences from baseline: *$P < 0.05$, **$P < 0.01$. Differences between both groups: †$P < 0.05$.

Takeda 1997 ANESTHESIA & ANALGESIA

Physiol. Res. 56: 527-533, 2007

Blood Pressure and Heart Rate Variability Response to Noninvasive Ventilation in Patients with Exacerbations of Chronic Obstructive Pulmonary Disease

P. SKYBA, P. JOPPA, M. OROLÍN, R. TKÁČOVÁ

Table 2. Blood pressure, heart rate and power spectral density of heart rate variability indexes before noninvasive positive-pressure ventilation initiation (Pre-NPPV), during NPPV therapy after 60 min of its application (NPPV), and 30 min after NPPV was discontinued (Post-NPPV).

Variable	Pre-NPPV	NPPV	Post-NPPV	P (ANOVA)
Systolic BP (mm Hg)	147 ± 3	138 ± 3*$^{+}$	145 ± 3	<0.001
Diastolic BP (mm Hg)	86 ± 2	[illegible]	[illegible]	<0.001
Heart rate (beats/min)	85 ± 3	75 ± 2*	76 ± 3*	<0.001
ln LF (ms^2/Hz)	6.5 ± 0.4	[illegible]	[illegible]	0.011
ln HF (ms^2/Hz)	6.4 ± 0.5	7.4 ± 0.6*	7.6 ± 0.5*	0.004
ln VLF (ms^2/Hz)	4.3 ± 0.9	[illegible]	6.3 ± 0.8	0.670

NPPV, noninvasive positive-pressure ventilation, BP, blood pressure, LF, low frequency, HF, high frequency, VLF, very low frequency. Data are expressed as mean ± S.E.M. * $p<0.05$ compared to Pre-NPPV, $^{+}$ $p<0.05$ compared to Post-NPPV

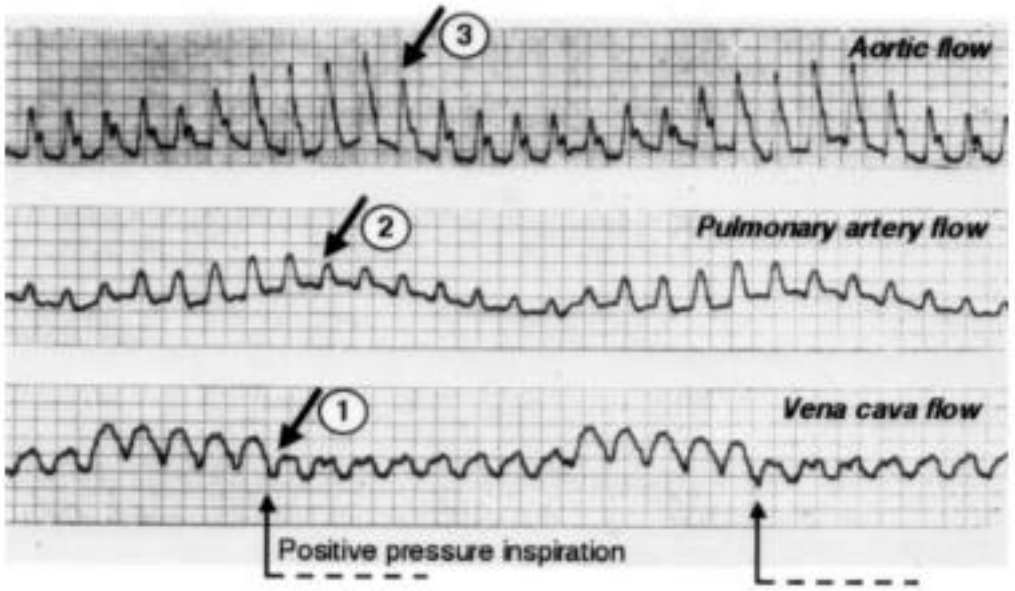
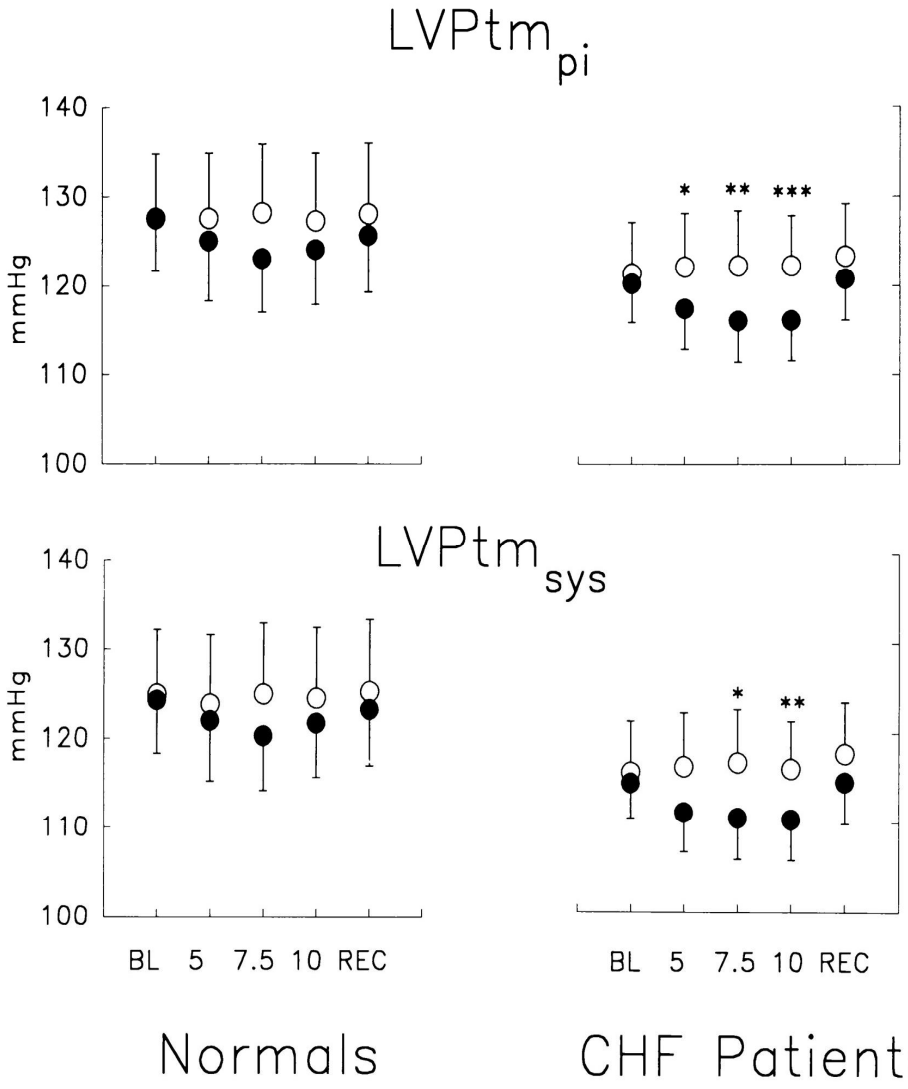


Fig. 2. Phasic flow tracings of vena cava blood flow, pulmonary artery blood flow, and aortic blood flow. Positive-pressure inspiration induces successively a decrease in vena cava blood flow (*1*), a decrease in pulmonary artery blood flow (*2*), and a decrease in aortic blood flow (*3*). From Morgan *et al.* [31]; used with permission.

F Michard, Anesthesiology 2005; 103:419–28

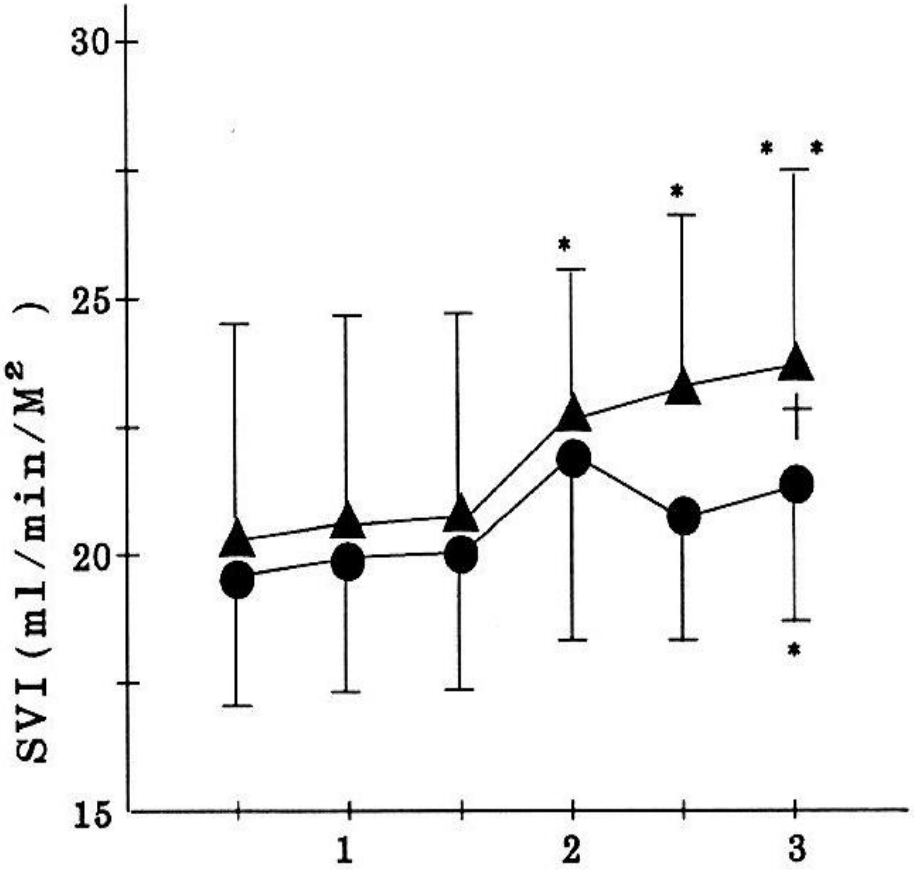
Effets de la CPAP sur les paramètres hémodynamiques (CHF)



Naughton 1995 **Circulation**

American Heart Association®
Learn and Live℠

Effets de la CPAP sur les paramètres hémodynamiques (CHF)



Lin 1995

AMERICAN COLLEGE OF CHEST PHYSICIANS

Effets de la CPAP sur les paramètres hémodynamiques (CHF)

Table 3—*Effects of CPAP on Hemodynamic, Respiratory, and Doppler Echocardiographic Parameters**

Variables	Preserved LV Systolic Function (n = 4)		Decreased LV Systolic Function (n = 5)	
	Baseline	CPAP	Baseline	CPAP
RR, breaths/min	37 ± 5	28 ± 4†	32 ± 5	24 ± 4†
Arterial blood pH	7.41 ± 0.07	7.41 ± 0.04	7.38 ± 0.03	7.39 ± 0.02
Pao_2, mm Hg	71 ± 8.5	134 ± 25†	69 ± 12	120 ± 30†
$Paco_2$, mm Hg	39 ± 3	40 ± 3	37 ± 3	38 ± 2
Spo_2, %	89 ± 2	97 ± 1†	87 ± 3	96 ± 1†
Heart rate, beats/min	101 ± 19	83 ± 11	105 ± 13	98 ± 21
MAP, mm Hg	91 ± 13	72 ± 6†	64 ± 4	63 ± 3
LV end-diastolic volume, mL	107 ± 4	98 ± 3†	148 ± 4	128 ± 8†
LVEF, %	49 ± 2	51 ± 2	29 ± 6	38 ± 6†

Si IC diastolique, la CPAP diminue la précharge

Si IC systolique, l'effet de la CPAP est lié à la fois à la diminution de la précharge et l'augmentation de la FEVG

Bendjelid 2005

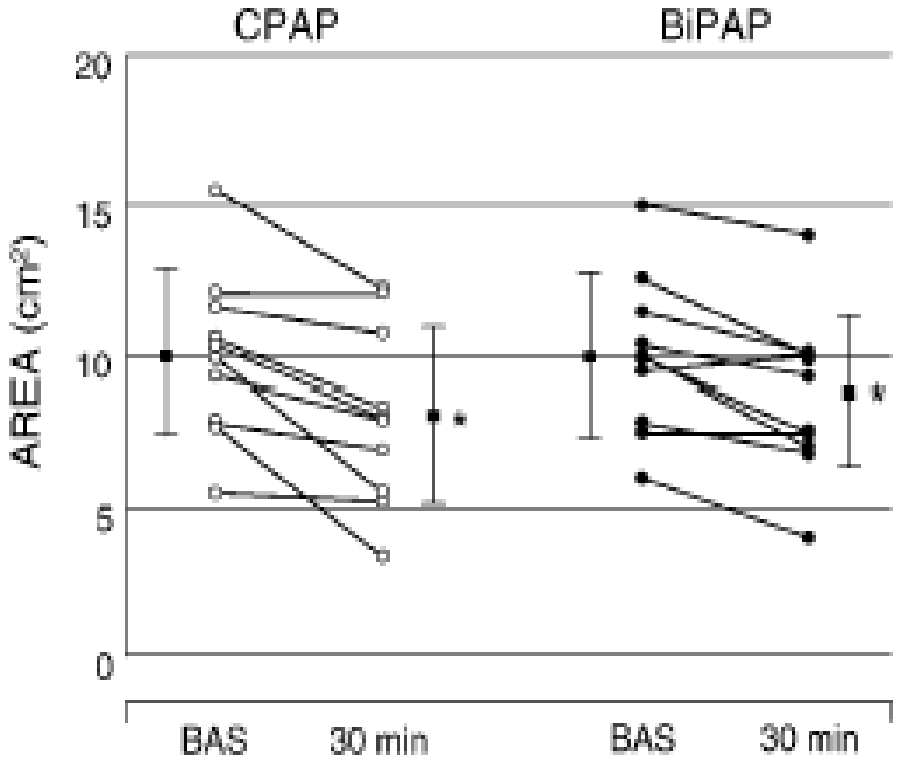
AMERICAN COLLEGE OF CHEST PHYSICIANS

Intensive Care Med (2002) 28:1348–1350
DOI 10.1007/s00134-002-1424-1

BRIEF REPORT

Andrea Bellone
Andrea Barbieri
Caterina Ricci
Emilio Iori
Mario Donateo
Monica Massobrio
Stefano Bendinelli

Acute effects of non-invasive ventilatory support on functional mitral regurgitation in patients with exacerbation of congestive heart failure



Conclusion: In patients with exacerbation of severe CHF and functional MR, both modalities of non-invasive ventilation (CPAP and BiPAP) significantly improved ejection fraction and were equally effective in reducing MR.

Effets Hémodynamiques de la VNI

En Résumé…

Potentiellement délétère en aigu:

- Chute tensionnelle liée à la diminution du retour veineux

Potentiellement bénéfiques en aigu ou en chronique:

- Diminution Précharge et Postcharge
- Augmentation QC et FEVG dans l'ICA congestive
- Diminution Tachycardie par effet sur le baroréflexe artériel
- Diminution Variabilité FC
- Diminution PAPs

Ces effets hémodynamiques, en aigu, dépendent de l'état clinique du patient et de sa mécanique respiratoire

CHRU BREST
CENTRE HOSPITALIER REGIONAL UNIVERSITAIRE