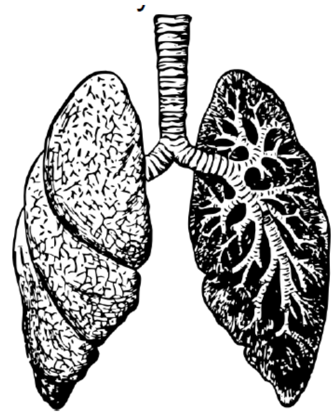
GROUPE HOSPITALIER DU HAVRE



SPLF

Groupe de Travail en Kinésithérapie

Place des bancs d'essais en kinésithérapie respiratoire

Médrinal Clément

CPLF 2016, Lille

Aucun conflit d'intérêt

Google France

banc d'essai

AVEZ-VOUS ESSAYÉ LE NOUVEAU BANC ?

Publié le 4 Janvier 2016 par mairie de Jaujac

Catégories : #Travaux

Contexte actuel

- La stratégie thérapeutique et les techniques de kinésithérapie respiratoire utilisées dans la prise en soins des patients varient selon l'examen clinique et le bilan diagnostique.

- Les avancées cliniques et technologiques offrent aux praticiens de **nombreux** dispositifs pour faciliter ou améliorer la prise en soins des patients.

- L'évaluation scientifique des performances cliniques de ces dispositifs est méthodologiquement limitée par les faibles effectifs étudiés, le manque de reproductibilité, les **variations des caractéristiques pulmonaire** inter-patients….

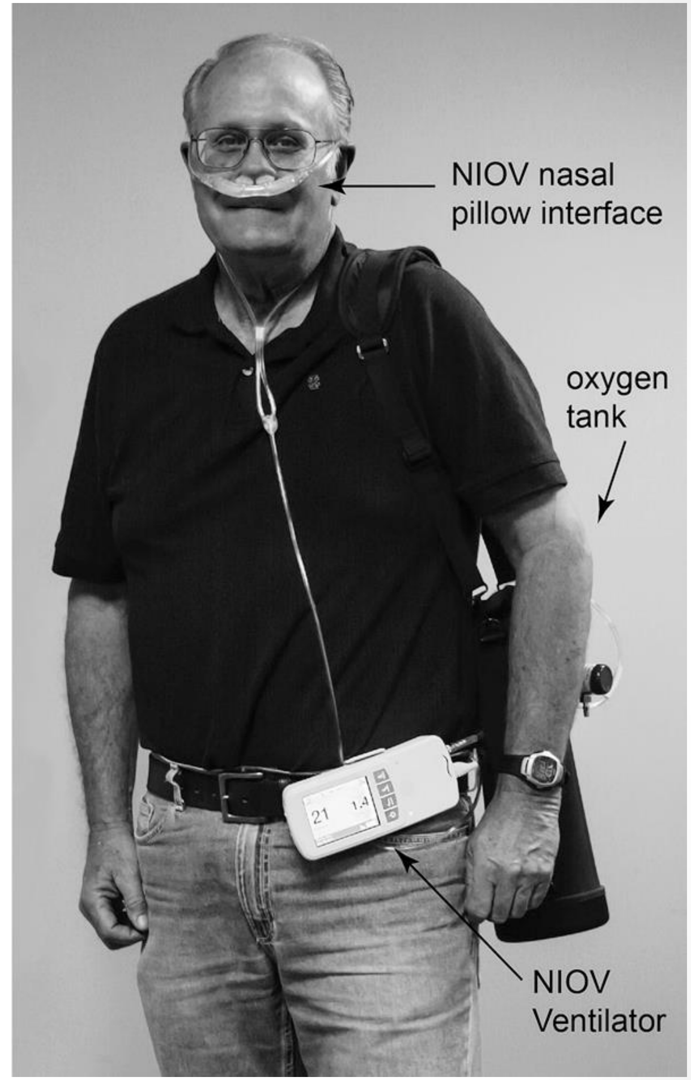
Développement des dispositifs


vivo
Vivo 30
08:25

ResMed

09:41 AM

ResMed



Porszasz, Am J Respir Crit Care Med, 2013

Contexte actuel

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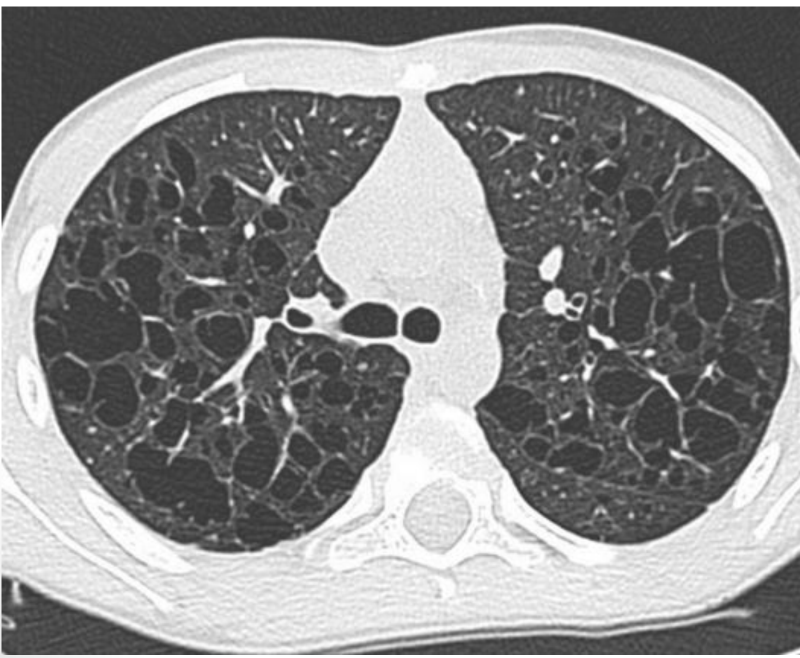
Variabilité inter-patients

Insuffisant Respiratoire Chronique Obstructif
VEMS<50% theor
Compliance?
Résistance?



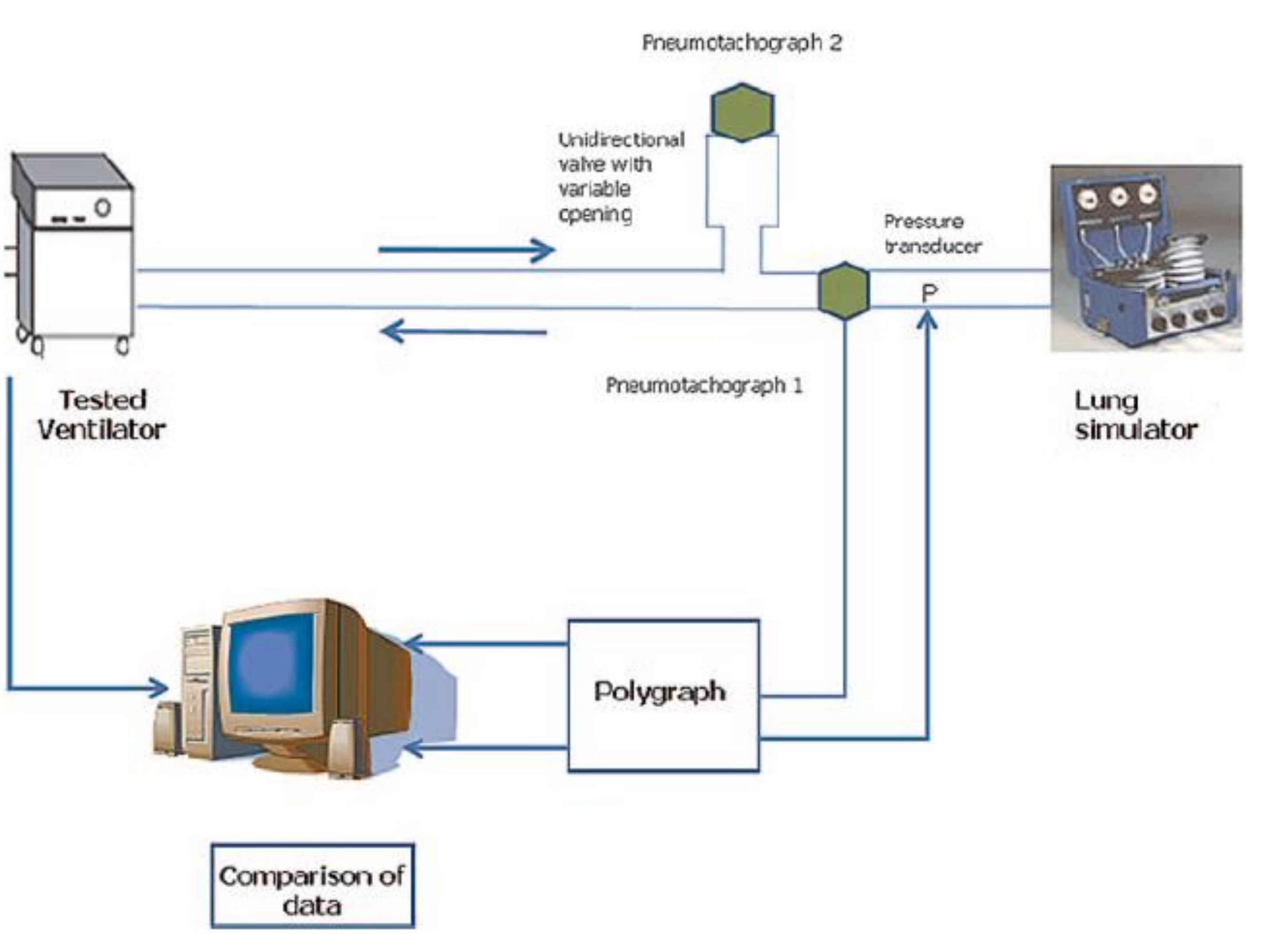
≠

Intérêt d'un poumon mécanique

- Normal: compliance 60 mL/cm H_2O, resistance 7.5 cm H_2O/L/s
- Obstructive: compliance 60 mL/cm H_2O, resistance 25 cm H_2O/L/s
- Restrictive: compliance 30 mL/cm H_2O, resistance 7.5 cm H_2O/L/s

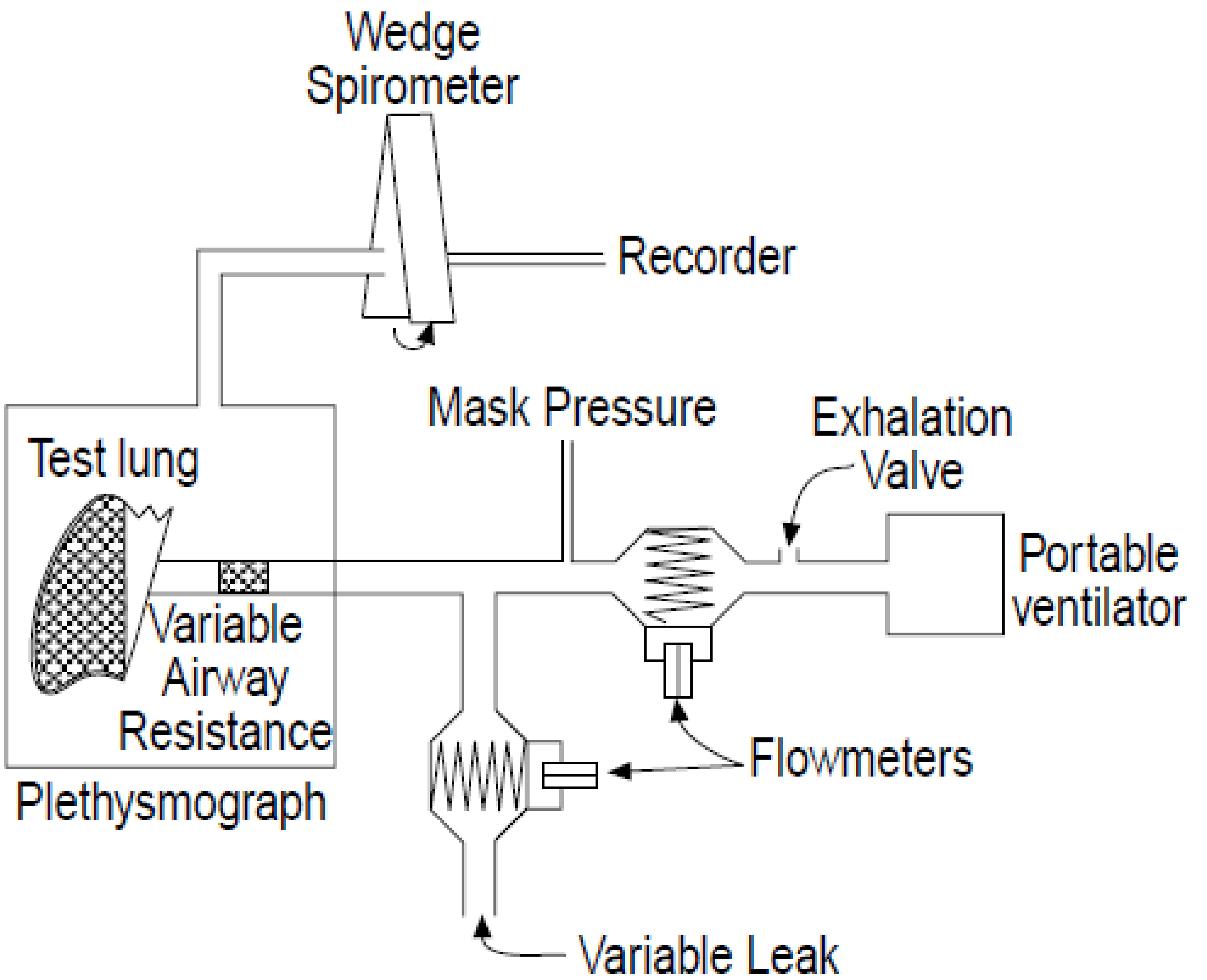
Lujàn, Respir Care, 2013

Schéma d'un banc d'essai



Lujàn, Respir Care, 2013

Quelques exemples…



Mehta, Eur Respir J, 2001

Quelques exemples…

Table 2 Mechanical parameters during pressure-controlled ventilation under different mechanical loading

Experimental settings	Fixed compartment		Experimental settings	Variable compartment		Total		Effective parameters		
	V_T (mL)	τ_F (s)		V_T (mL)	τ_V (s)	V_T (mL)	τ_V/τ_F (%)	E_E (cmH_2O/L)	R_E ($cmH_2O/L/s$)	τ_E (s)
$E = 45$, $R = 20$	538	0.444	$E = 35$, $R = 5$	679	0.143	1218	32.2	20.3	5.1	0.254
	541	0.444	$E = 35$, $R = 20$	642	0.571	1184	128.6	20.7	10.1	0.486
	545	0.444	$E = 35$, $R = 50$	548	1.429	1094	321.6	26.9	16.7	0.621
	556	0.444	$E = 55$, $R = 5$	448	0.091	1004	20.5	26.1	6.8	0.262
	557	0.444	$E = 55$, $R = 20$	449	0.363	1007	81.8	24.6	10.1	0.412
	561	0.444	$E = 55$, $R = 50$	439	0.909	1000	204.7	24.3	15.5	0.636
	581	0.444	$E = 85$, $R = 5$	310	0.059	892	13.3	30.8	8.7	0.284
	572	0.444	$E = 85$, $R = 20$	304	0.235	876	52.9	29.1	10.7	0.369
	569	0.444	$E = 85$, $R = 50$	302	0.588	872	132.4	26.3	14.4	0.550

E, R elastic (cmH_2O/L) and resistive ($cmH_2O/L/s$) loads, respectively; V_T tidal volume; E_E, R_E effective elastance and resistance, respectively; τ_F, τ_V, and τ_E, fixed, variable, and effective time constants, respectively. Measured data represent mean values of three experimental determinations

Luncangelo, Intensive Care Med, 2010

Quelques exemples…

$$\frac{V_{\mathrm{T,VAR}}}{V_{\mathrm{T,FIX}}} = 1.53 - 0.012 \times E \qquad (1)$$

$(P < 0.001;\ R^2 = 0.91)$,

$$\frac{V_{\mathrm{T,VAR}}}{V_{\mathrm{T,FIX}}} = 2.34 - 0.02 \times E \qquad (2)$$

$(P = 0.001;\ R^2 = 0.81)$,

$$\frac{V_{\mathrm{TOT,VAR}}}{V_{\mathrm{TOT,FIX}}} = 0.56 + \frac{5.17}{R} \qquad (3)$$

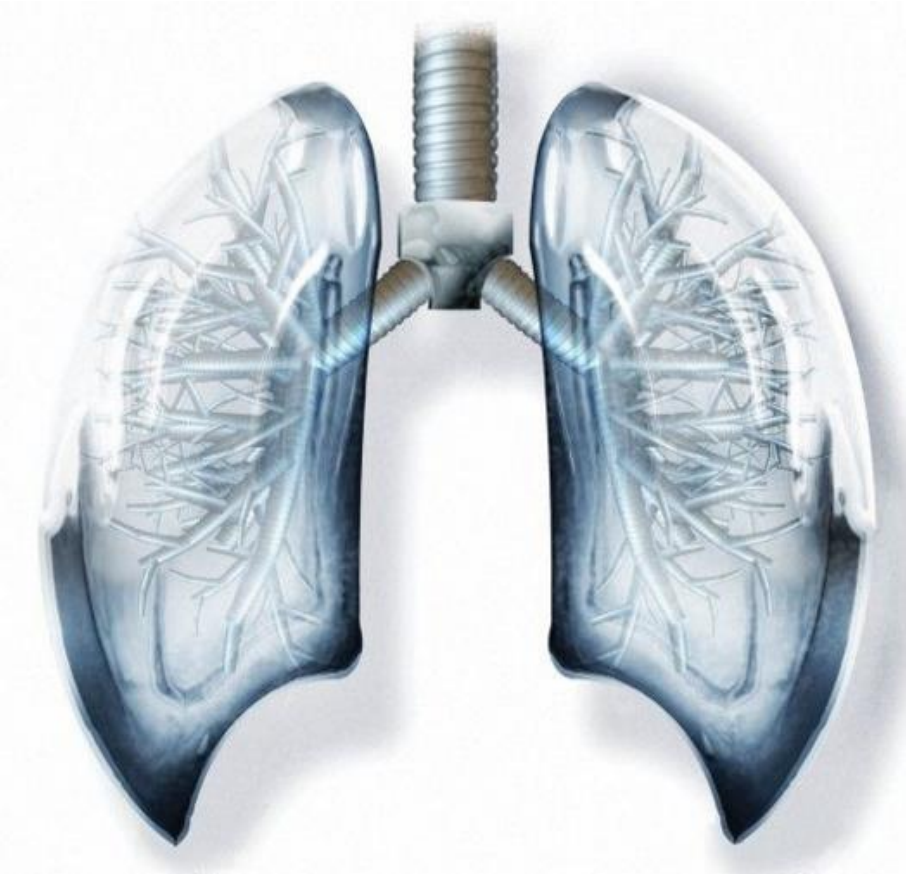
$(P < 0.001;\ R^2 = 0.95)$.

Luncangelo, Intensive Care Med, 2010

En kinésithérapie respiratoire

- Evaluer les performances des différents dispositifs dans des conditions standardisés.
- Comparer les dispositifs selon différents scénario cliniques (ex. Restrictif vs. Obstructif).
- Simuler une situation clinique pour l'enseignement et la compréhension des mécanismes liés à la thérapie respiratoire.

Désencombrement?



Concrètement?

Quelle inclinaison? Quel débit?

Objectifs: Pression moyenne sup à 10 cmH_2O
Fréquence d'oscillations à 12 Hz
La plus grande amplitude oscillatoire

Performance Analysis of the Flutter VRP1 Under Different Flows and Angles

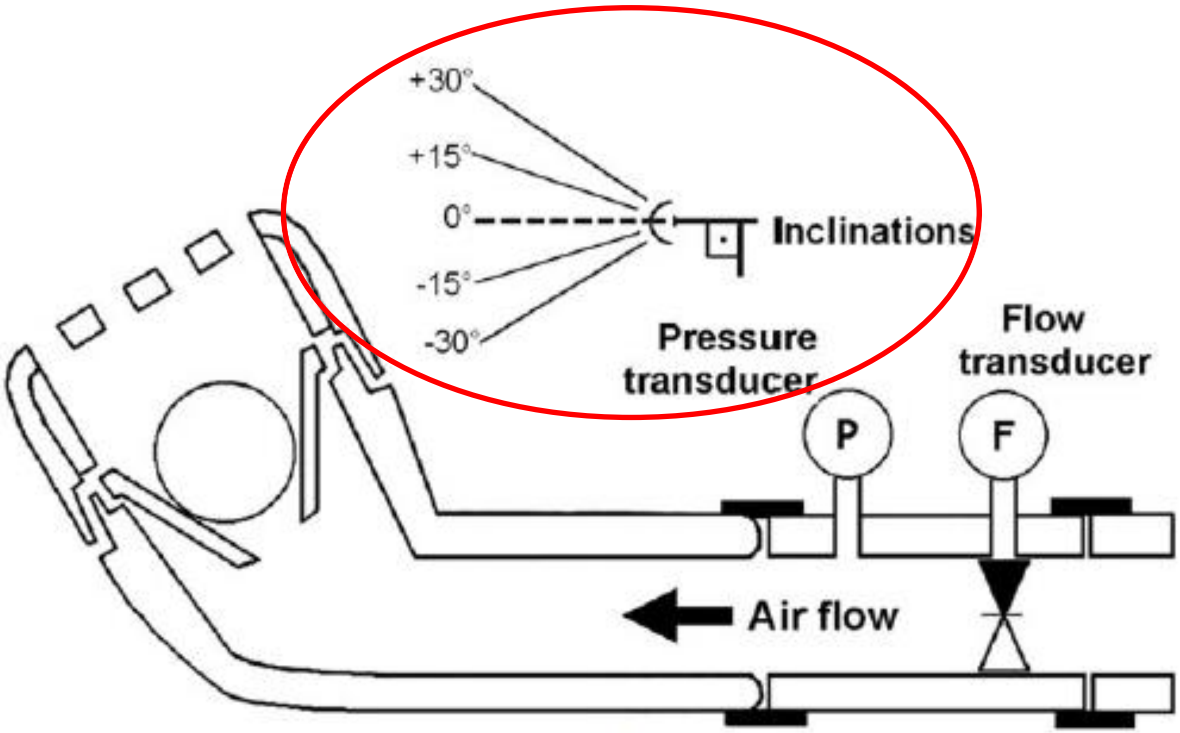
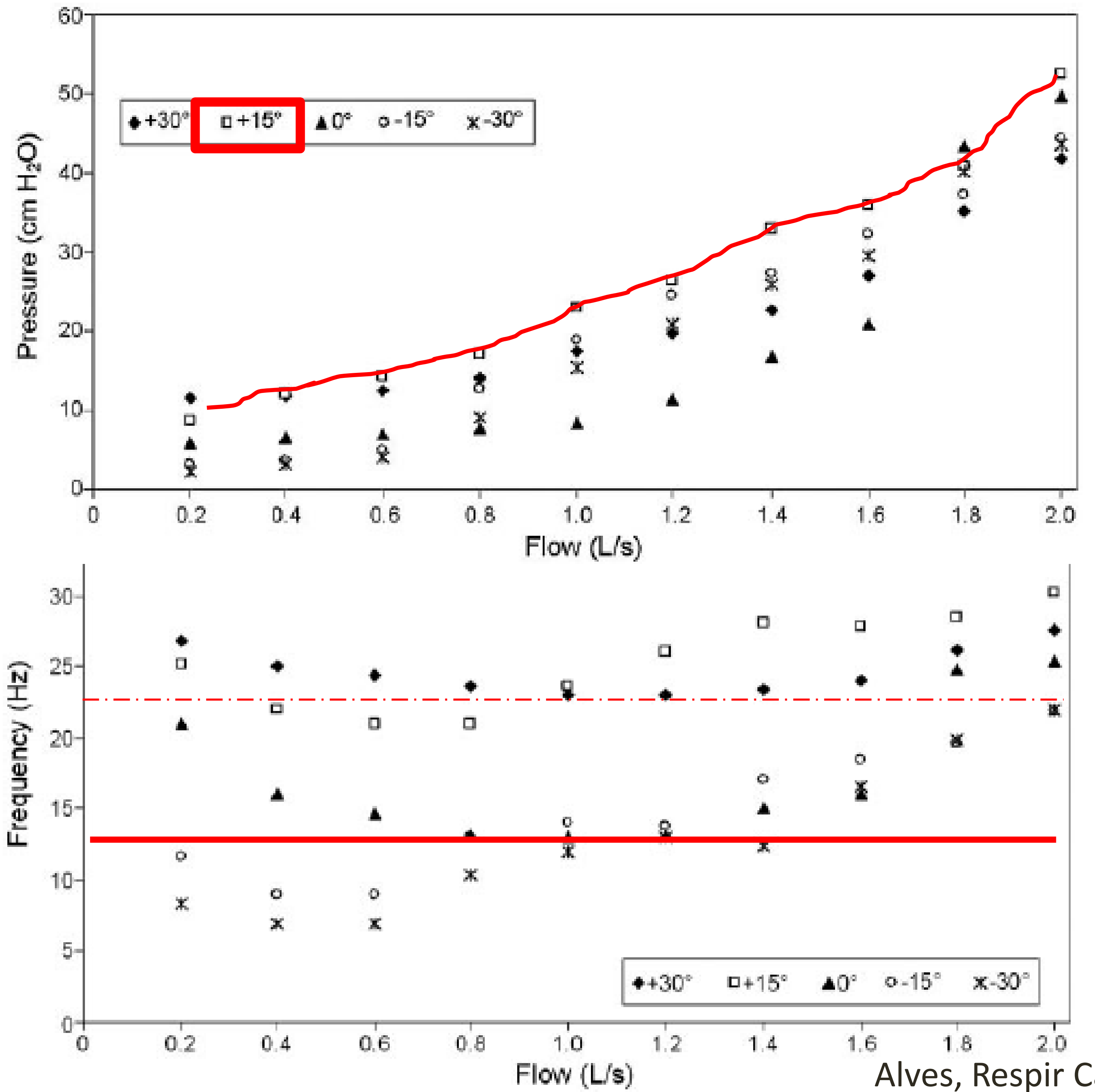


Fig. 1. Characteristics of the equipment and angles of inclination used in the protocol.

Alves, Respir Care, 2008



Alves, Respir Care, 2008

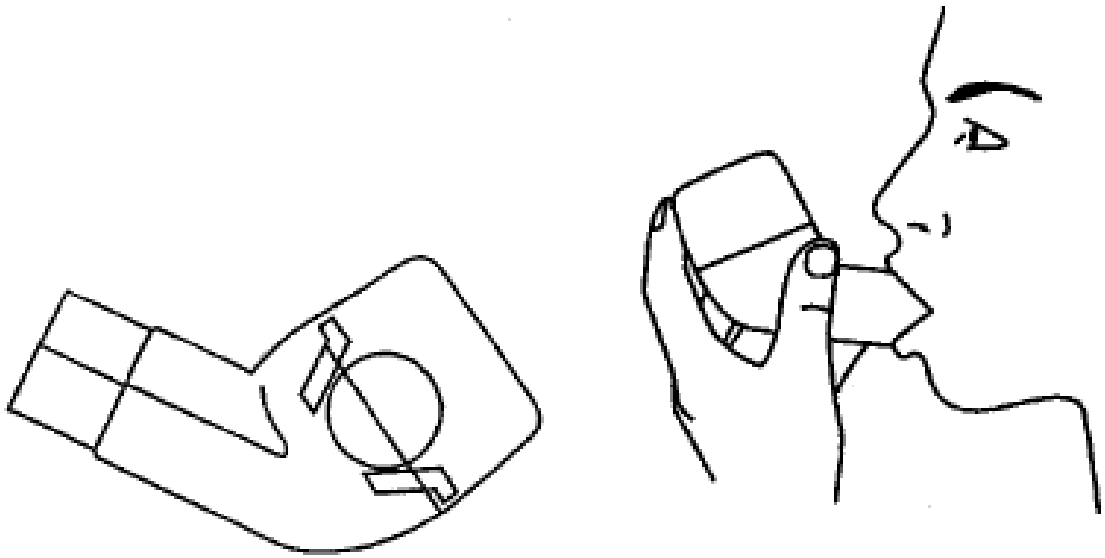
Table 1. Summary of the Relationship Between the Device Physical Variables, Airway Clearance Effects, and Theoretical Best Conditions of Expiratory Flow and Inclination to Optimize the Device Effects

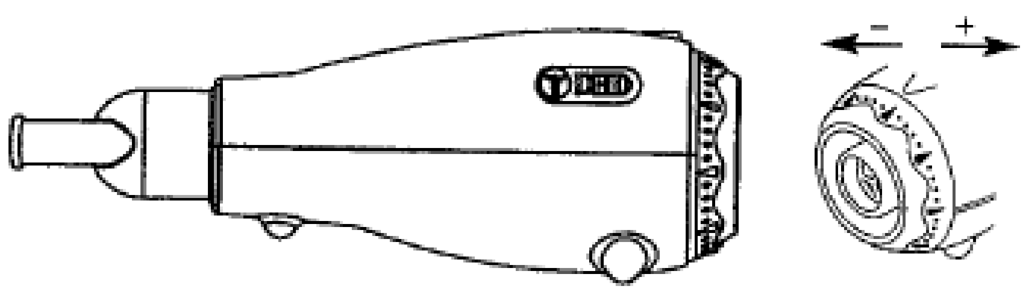
Physical Variable	Airway Clearance Effect	Best Expiratory Flow	Best Inclination
Mean flow	Huff	Lower flows and lower lung volumes for secretions in distal airways Higher flows and higher lung volumes for secretions in proximal airways	−30° +30°
Mean pressure	Positive expiratory pressure (PEP)	0.2 L/s at PEP of 10 cm H_2O and above 1.0 L/s at PEP of 20 cm H_2O	+15°/+30°
Oscillation frequency	High-frequency airway oscillation	≥ 0.2 L/s	All except −30°
Flow amplitude	Flow amplitude	> 1.4 L/s	0°/+15°/+30°

Alves, Respir Care, 2008

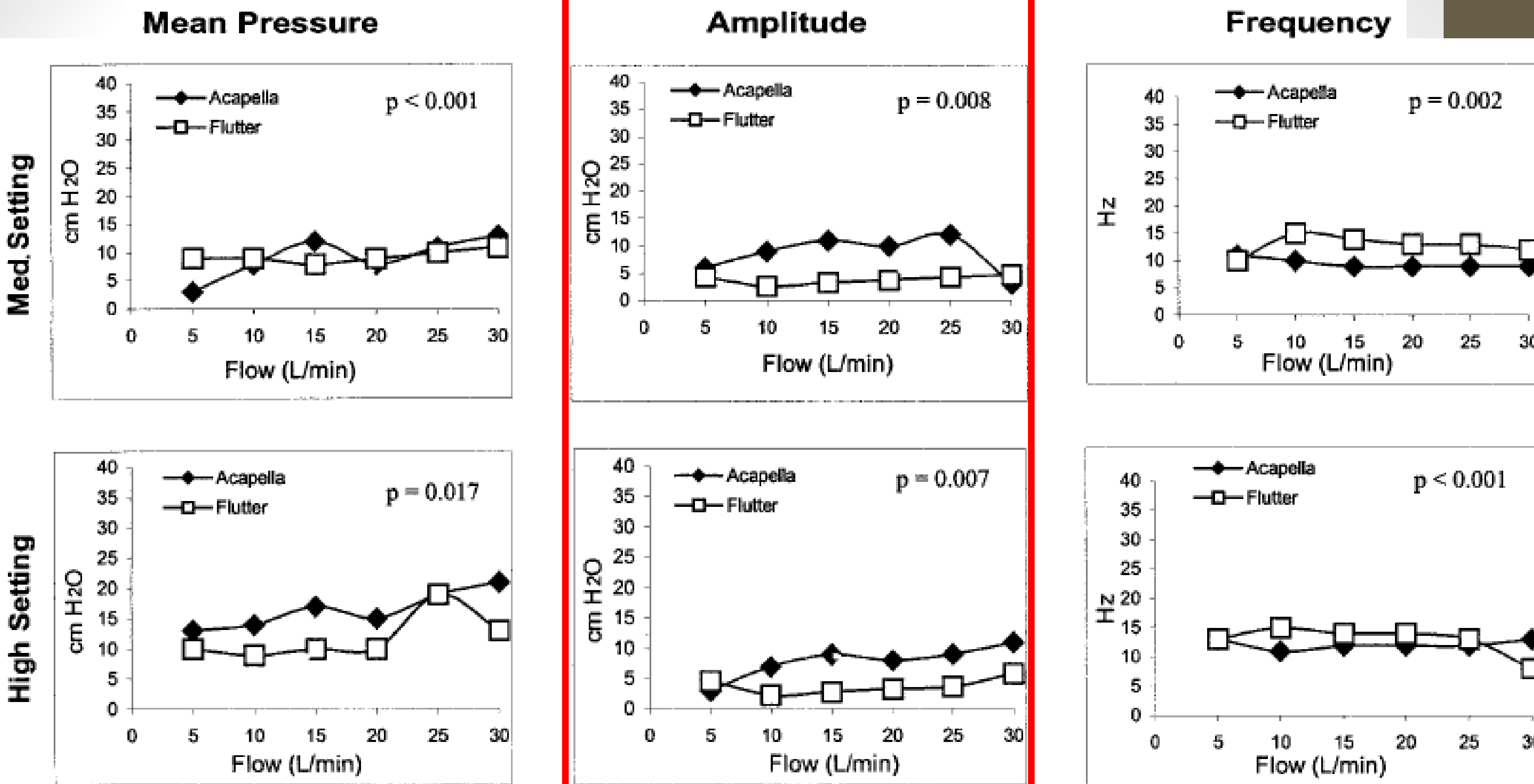
Acapella Versus Flutter

Débit de 5 à 30 L/min



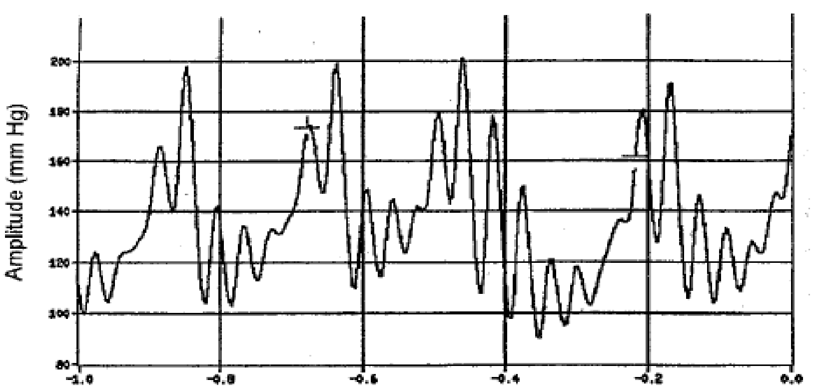


Volsko, Respir Care, 2003



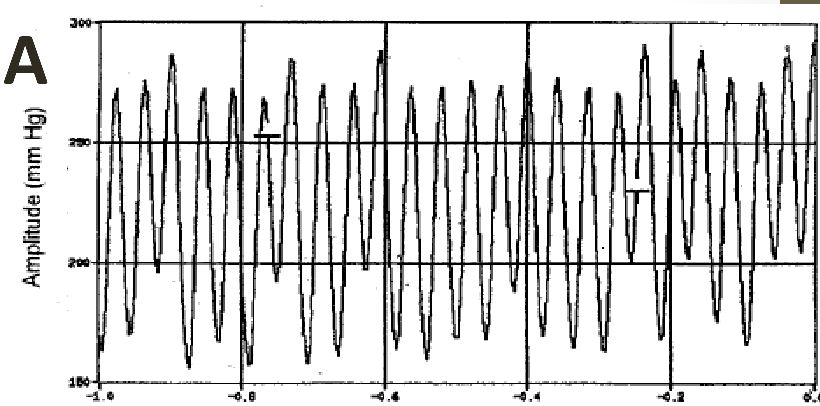
Mean Pressure
Amplitude
Frequency
Med. Setting
High Setting
Acapella
Flutter
p < 0.001
p = 0.008
p = 0.002
p = 0.017
p = 0.007
p < 0.001
cm H2O
Hz
Flow (L/min)

F



Amplitude (mm Hg)

A



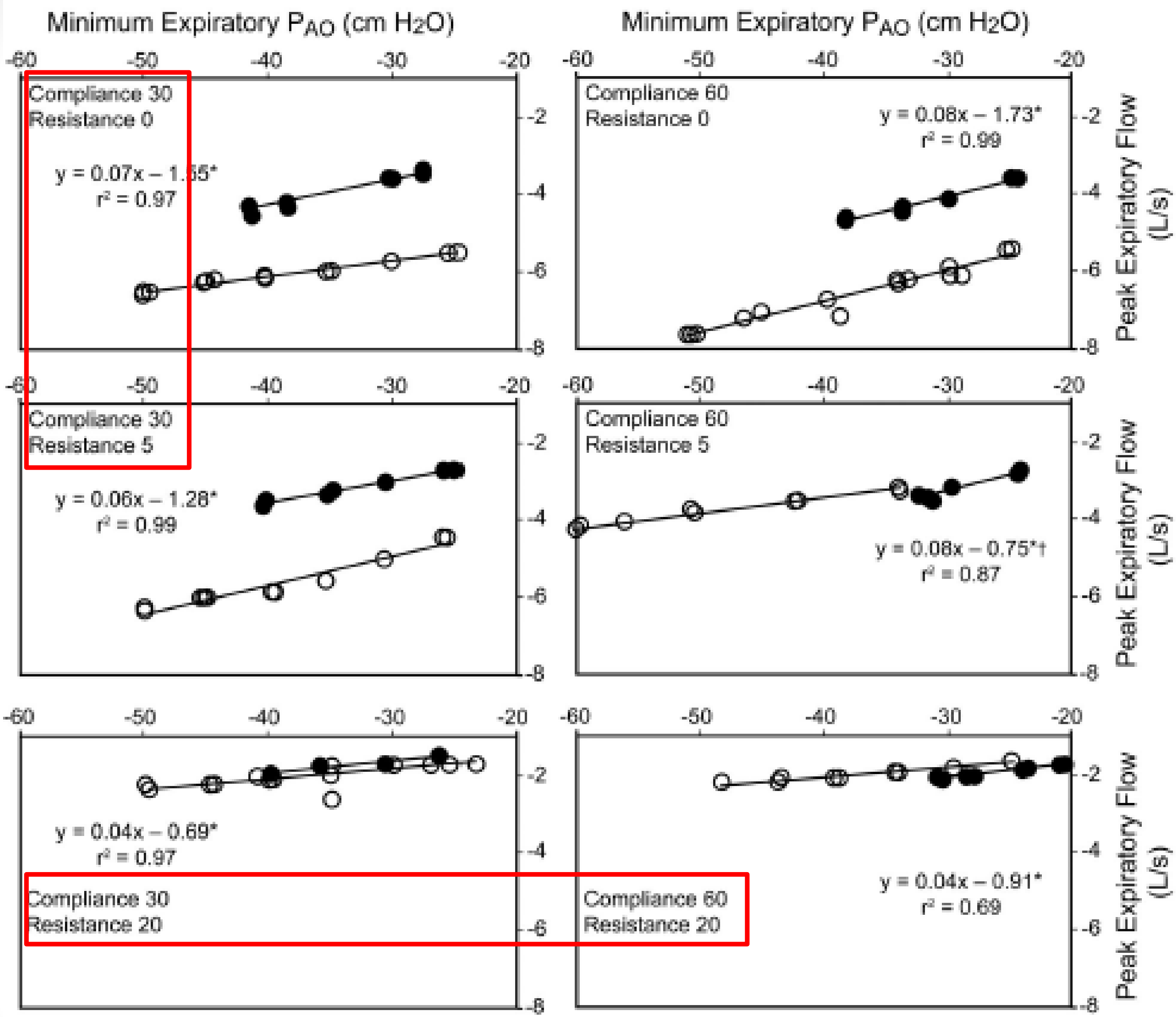
Amplitude (mm Hg)

Evaluation des nouveaux dispositifs

Bench Assessment of a New Insufflation-Exsufflation Device

Véronique Porot MD and Claude Guérin MD PhD

Porot, Respir Care, 2013



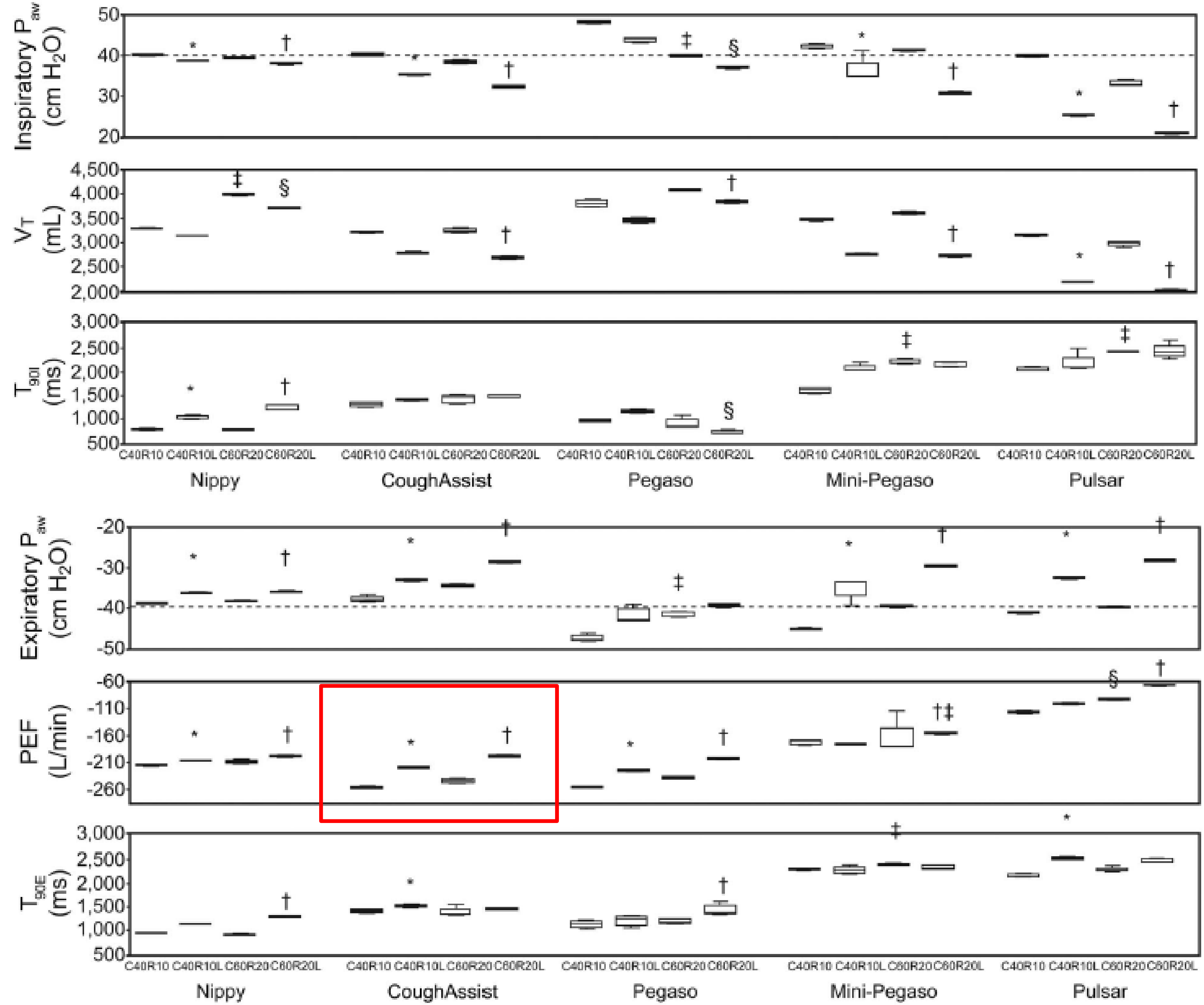
Porot, Respir Care, 2013

Bench Comparative Assessment of Mechanically Assisted Cough Devices

Table 1. Mechanically Assisted Cough Devices Tested in This Study

Ventilator	Manufacturer
Nippy cough assistor	B&D Electromedical (Warwickshire, UK)
CoughAssist	Philips Healthcare (Best, The Netherlands)
New Negavent DA-3 PLUS Pegaso	Dima Italia (Bologna, Italy)
New Negavent DA-3 PLUS Mini Pegaso	Dima Italia
Pulsar	Siare Engineering International Group (Bologna, Italy)

Frigerio, Respir Care, 2015



Inspiratory P_{aw} (cm H_2O)
V_T (mL)
T_{90I} (ms)
C40R10 C40R10L C60R20 C60R20L
Nippy
CoughAssist
Pegaso
Mini-Pegaso
Pulsar
Expiratory P_{aw} (cm H_2O)
PEF (L/min)
T_{90E} (ms)

Recrutement pulmonaire?

Comparison of Alpha 200 and CoughAssist as Intermittent Positive Pressure Breathing Devices: A Bench Study

Table. Values of Intercepts and Slopes Computed From the Estimates of the Coefficients of the Linear Regression Analysis Between Inspired Volume and Maximal Inspiratory Pressure in Each Mechanical Condition, for Each Device and Each Artificial Airway

Artificial Airway	Alpha 200 Flow 1				Alpha 200 Flow 2				Cough Assist			
	Intercept, L		Slope, L/cm H_2O		Intercept, L		Slope, L/cm H_2O		Intercept, L		Slope, L/cm H_2O	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Compliance 30 mL/cm H_2O, Resistance 5 cm H_2O/L/s												
Control	1.280	0.001	0.039	0.0001	1.130	0.002	0.036	0.0001	1.093	0.001	0.030	0.002
ETT 6.5	1.180	0.005	0.038	0.001	1.020	0.001	0.042	0.0001	1.004*	0.002	0.027*	0.005
ETT 7	1.360	0.003	0.044	0.001	1.100	0.003	0.044	0.001	1.048*	0.001	0.033*	0.003
ETT 7.5	1.440	0.001	0.045	0.000	1.140	0.002	0.042	0.0001	1.058*	0.001	0.030*	0.002
ETT 8.0	1.650	0.002	0.052	0.003	1.220	0.004	0.050	0.001	1.030*	0.001	0.022*	0.0001
ETT 8.5	1.720	0.003	0.053	0.001	1.260	0.005	0.046	0.001	1.060*	0.002	0.030*	0.004
Trach 6.0	1.720	0.002	0.057	0.0001	1.180	0.003	0.050	0.001	0.990*	0.001	0.028*	0.003
Trach 7.0	1.770	0.004	0.055	0.001	1.270	0.004	0.049	0.001	1.010*	0.001	0.029*	0.004
Trach 8.0	1.830	0.003	0.055	0.0001	1.320	0.004	0.047	0.001	1.033*	0.001	0.029*	0.004
Compliance 60 mL/cm H_2O, Resistance 5 cm H_2O/L/s												
Control	2.600	0.003	0.078	0.001	2.300	0.004	0.070	0.001	2.093	0.002	0.063*	0.004
ETT 6.5	2.490	0.002	0.080	0.0001	2.060	0.0001	0.090	0.004	1.950*	0.001	0.048*	0.003
ETT 7	2.690	0.002	0.088	0.001	2.180	0.003	0.090	0.001	2.020*	0.002	0.055*	0.004
ETT 7.5	3.010	0.004	0.097	0.001	2.340	0.004	0.090	0.001	2.060*	0.003	0.051*	0.006
ETT 8.0	3.300	0.002	0.106	0.0001	2.410	0.007	0.100	0.001	2.080*	0.001	0.060*	0.003
ETT 8.5	3.520	0.006	0.112	0.001	2.560	0.006	0.090	0.001	2.080*	0.002	0.057*	0.007
Trach 6.0	3.450	0.002	0.114	0.0001	2.350	0.002	0.111	0.0001	1.950*	0.001	0.051*	0.003
Trach 7.0	3.580	0.003	0.114	0.001	2.530	0.003	0.100	0.001	2.020*	0.001	0.055*	0.003
Trach 8.0	3.680	0.002	0.117	0.001	2.630	0.003	0.097	0.001	2.060*	0.002	0.058*	0.004

Bourdin, Respir Care, 2012

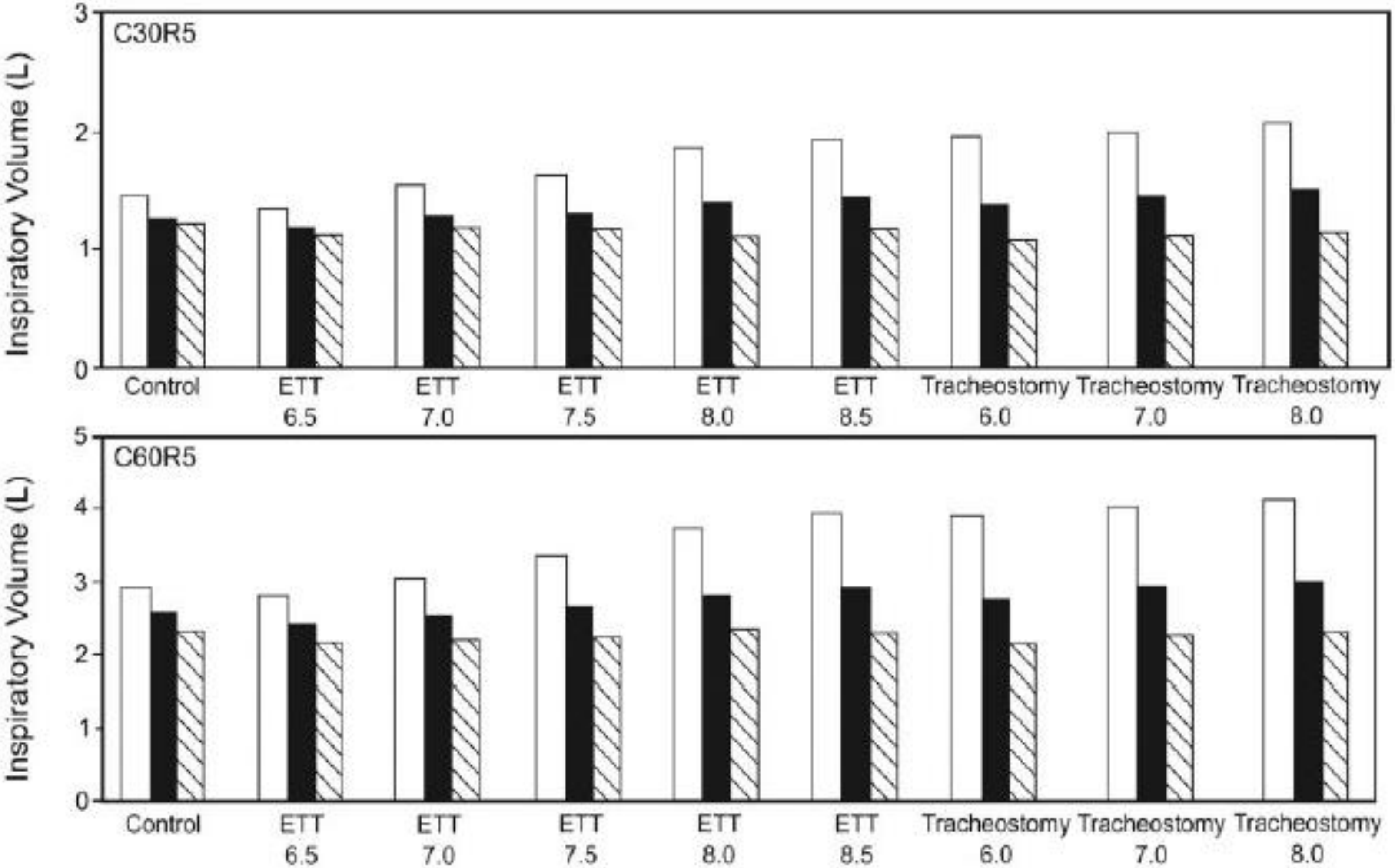


Fig. 2. Mean values of computed inflation volume for a pressure of 40 cm H_2O from Alpha 200 at low (black bars) and high (white bars) flows and from CoughAssist (hatched bars) for compliance of 30 mL/cm H_2O and resistance of 5 cm H_2O/L/s (C30R5) and compliance of 60 mL/cm H_2O and resistance of 5 cm H_2O/L/s (C60R5) mechanical conditions across control condition and the presence of artificial airways (size range 6.5–8 mm). ETT = endotracheal tube.

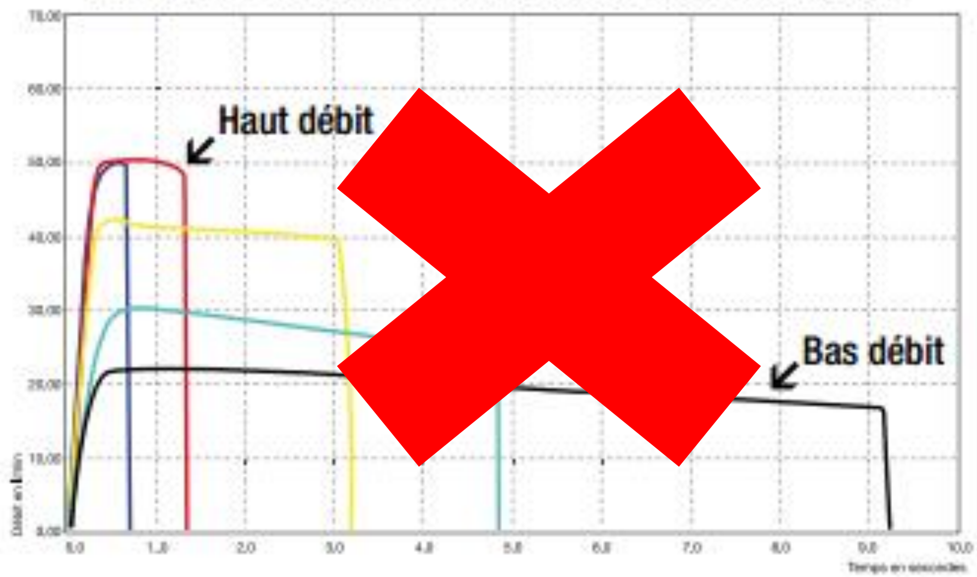
Bourdin, Respir Care, 2012

Intérêt du relaxateur de pression dans les soins respiratoires

Le réglage du débit est particulièrement important.

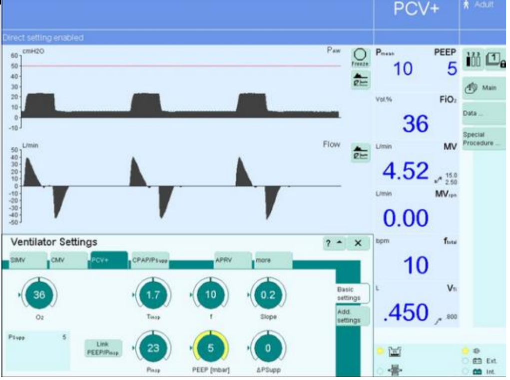
Lorsque le débit est bas, il laisse aux poumons le temps de se remplir permettant ainsi à un plus grand volume d'air d'entrer dans les poumons avant d'atteindre la pression de coupure.

Alpha 200 C, courbe de débit en fonction des réglages



La diminution du débit permet de faire rentrer de plus grands volumes d'air.

Oups!



IPV + Ventilateur?

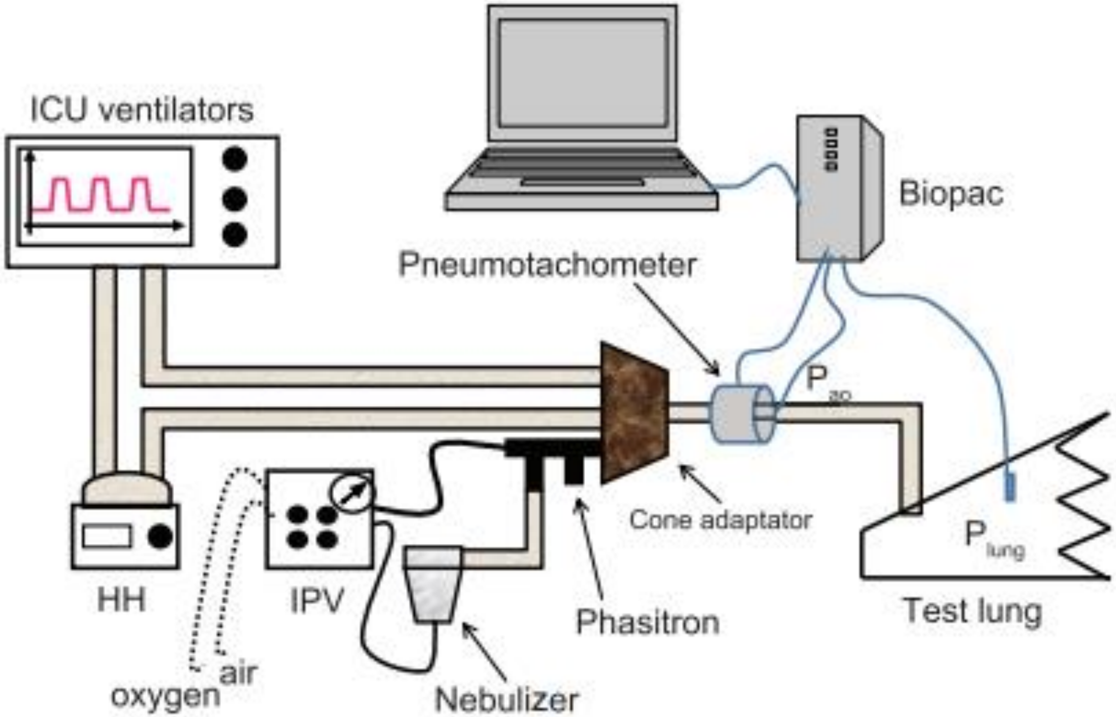


Fig. 1. Experimental set-up used in the present study. IPV = intrapulmonary percussive ventilation. HH = heated humidifier. P_{lung} = lung pressure. P_{ao} = pressure at the airway opening.

Riffard, Respir Care, 2014

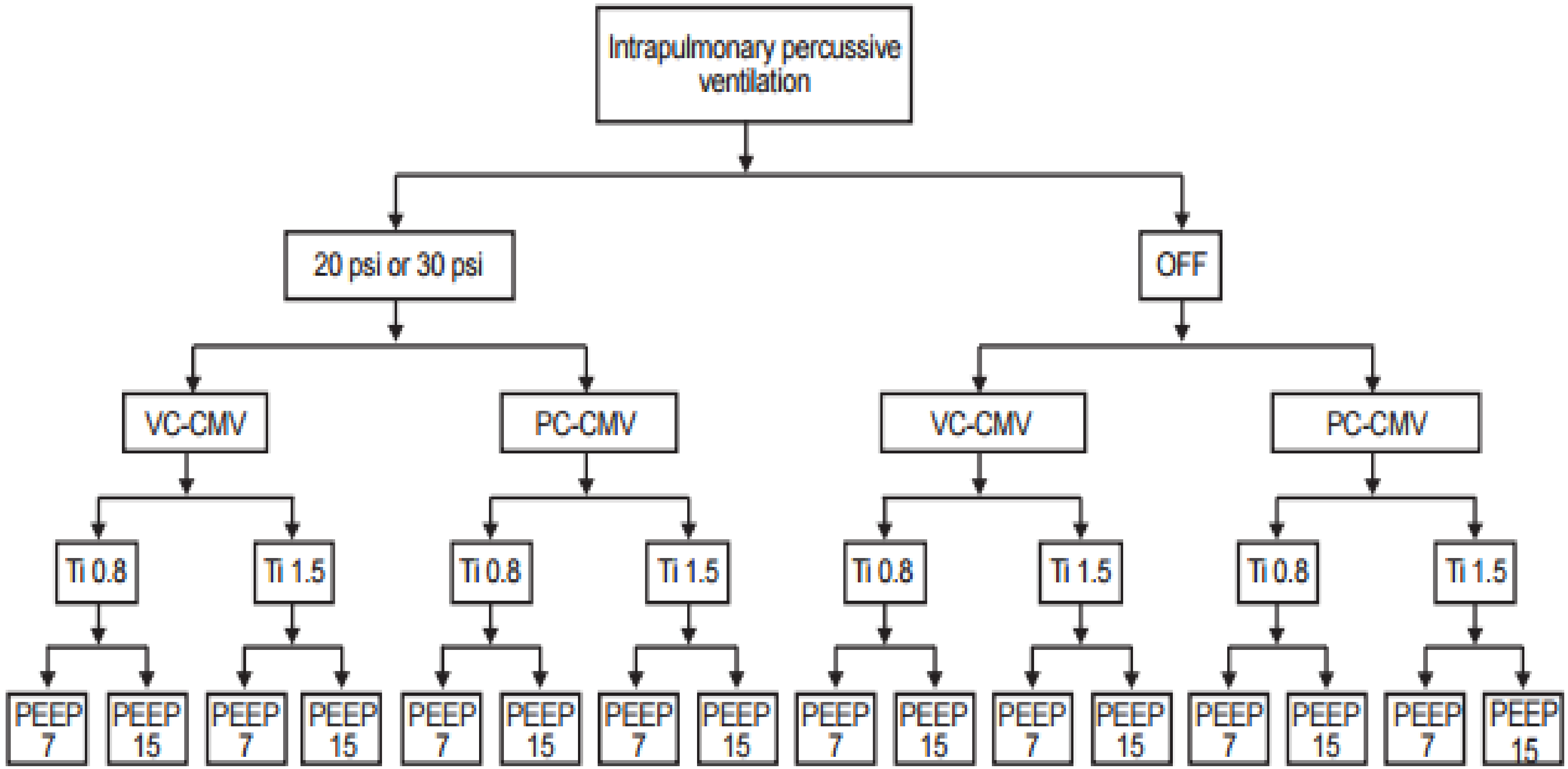
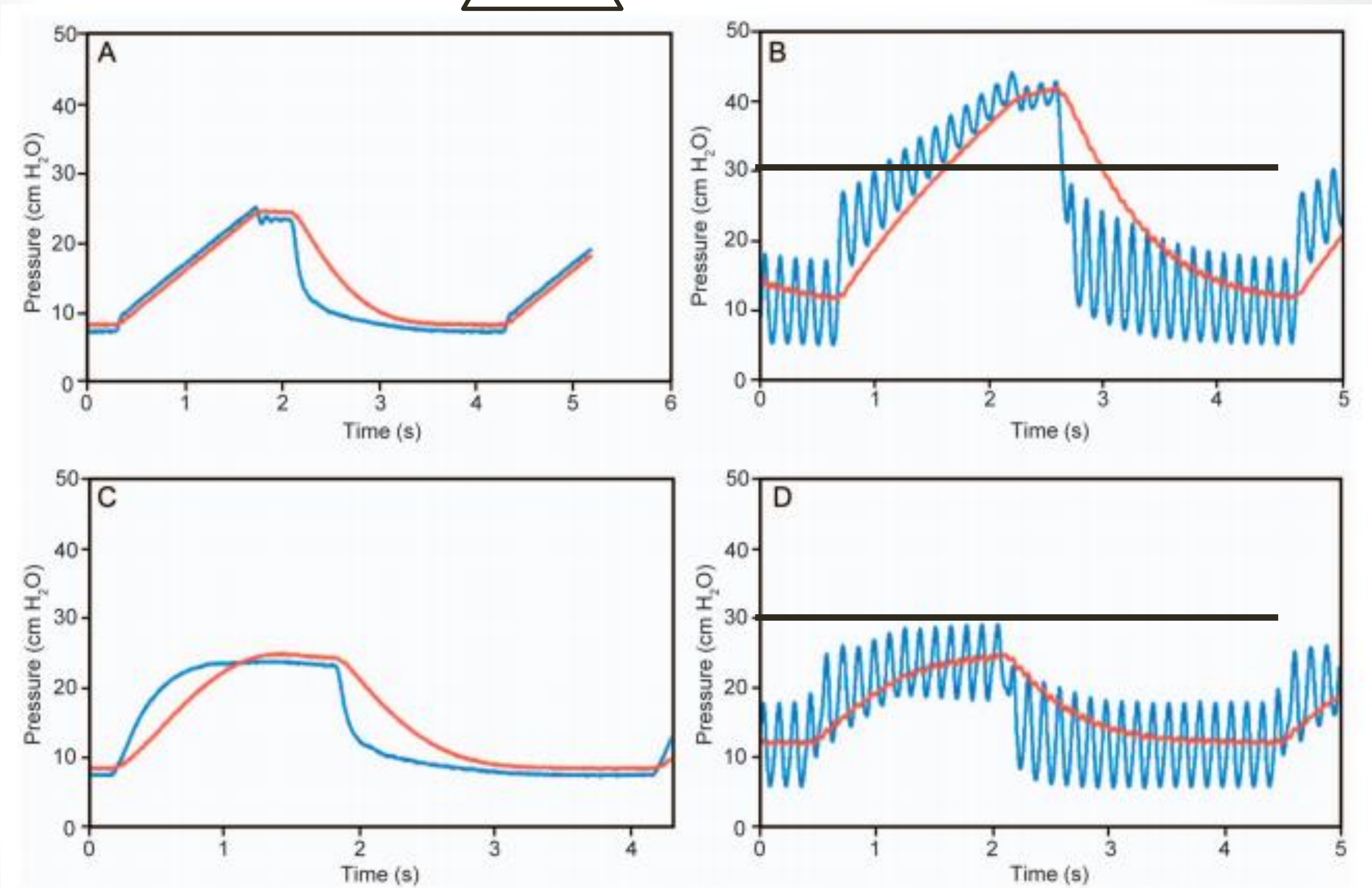


Fig. 2. Study design. IPV = intrapulmonary percussive ventilation. PC-CMV = pressure controlled continuous mandatory ventilation mode.VC-CMV = volume controlled continuous mandatory ventilation mode. T_I = inspiratory time.

Riffard, Respir Care, 2014

Pression alvéolaire > 30 cmH_2O



Riffard, Respir Care, 2014

Ventilation non invasive?

?

?

Intentional Leaks in Industrial Masks Have a Significant Impact on Efficacy of Bilevel Noninvasive Ventilation*

A Bench Test Study

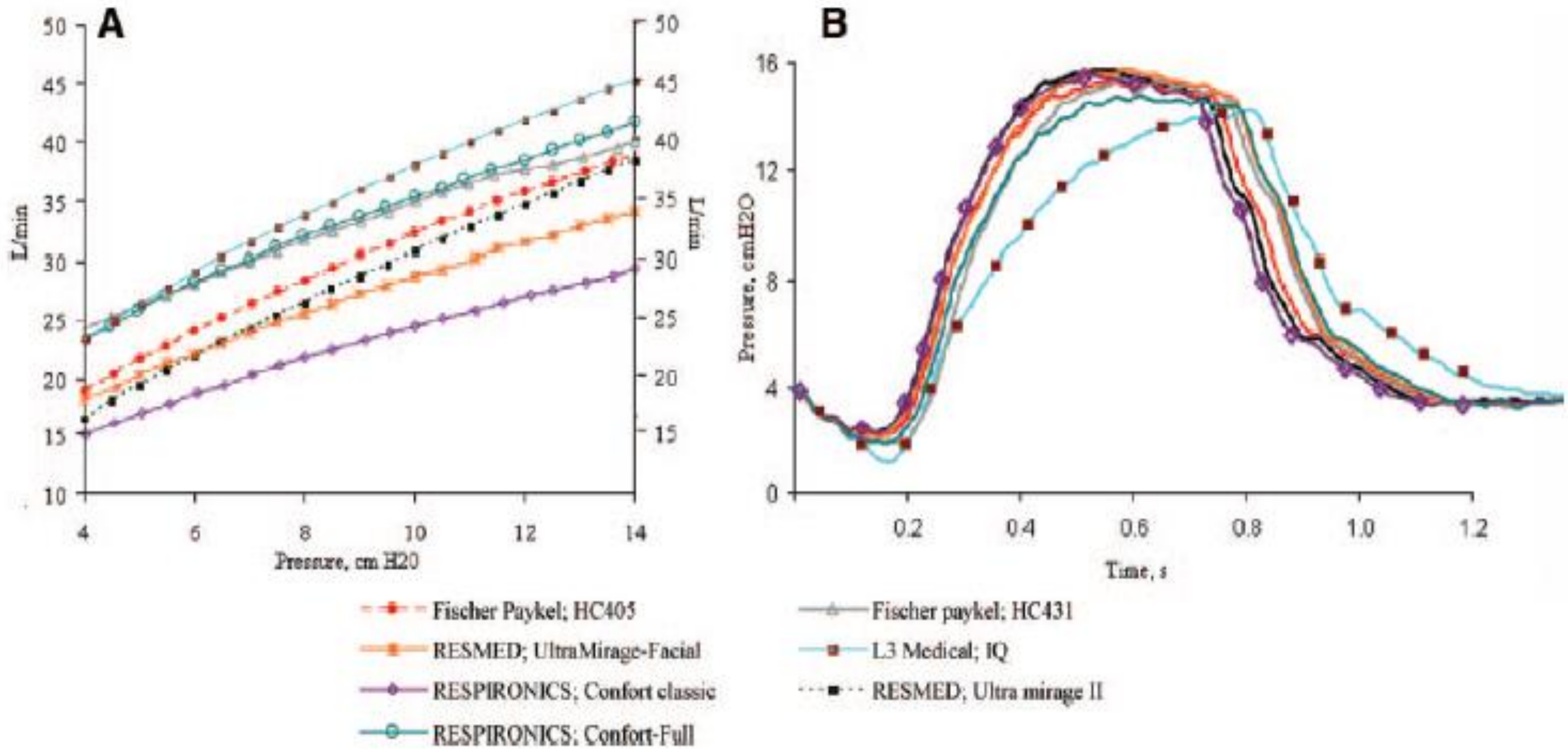


FIGURE 1. *Left*, *A*: Intentional leaks expressed as function of the pressure in seven different masks. *Right*, *B*: Pressure-time plot of VPAP III ST with the seven masks for the normal lung condition.

Borel, Chest, 2009

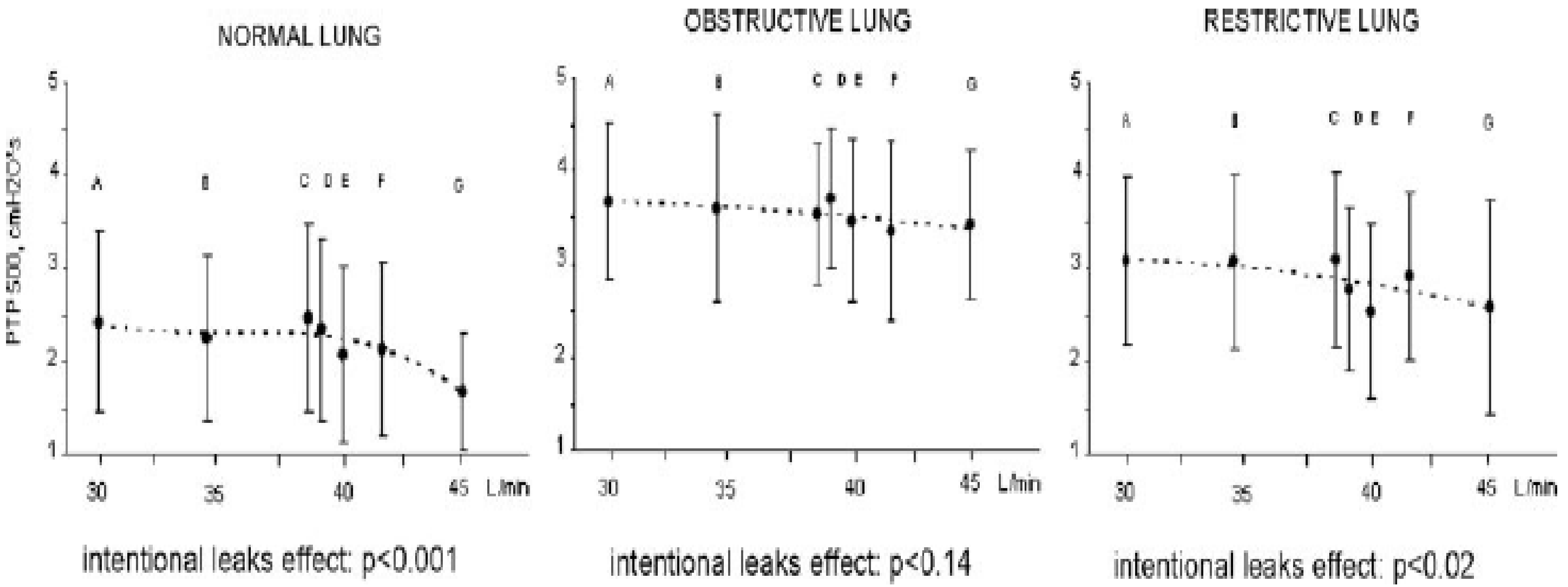


FIGURE 3. Capacity to achieve and maintain preset pressure (PTP_{500}) according to intentional leaks of the seven masks and the four BPPVs (single-factor repeated-measures analysis). *A*: ComfortClassic (29.4 L/min); *B*: facial Ultra Mirage (34.1 L/min); *C*: nasal Ultra Mirage (38.5 L/min); *D*: FlexiFit 405 (39.1 L/min); *E*: FlexiFit 431 (40 L/min); *F*: ComfortFull (41.7 L/min); and *G*: IQ SleepNet (45.2 L/min) at 14 cm H_2O of inspiratory pressure. Each point of VT represents mean ± SD of the four apparatus' tested for each mask.

Borel, Chest, 2009

CHEST
Original Research
RESPIRATORY CARE

Monitoring of Noninvasive Ventilation by Built-in Software of Home Bilevel Ventilators

A Bench Study

Table 1—*Home Ventilators Tested, Compatible Software, and Modality of Estimation of Leaks*

Monitoring Ventilator	Software	Leaks
Monnal T30	Bora Soft V.6	Average leak[a]
Synchrony	Encore Pro 2	Average leak[a]
Trilogy	Direct View	Average leak[a]
Ventimotion	Ventisupport	Average leak[a]
Vivo 40	Vivo PS Software 3	Average leak at expiratory positive airway pressure[b]
VPAP III ST	ReScan 3.10	Average leak without intentional leaks[c]
VPAP IV ST-A	ReScan 3.10	Average leak without intentional leaks[c]

Contal, Chest, 2012

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

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
Unintentional leak, 0 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

Sous estimation des volumes réels de 10 à 37%

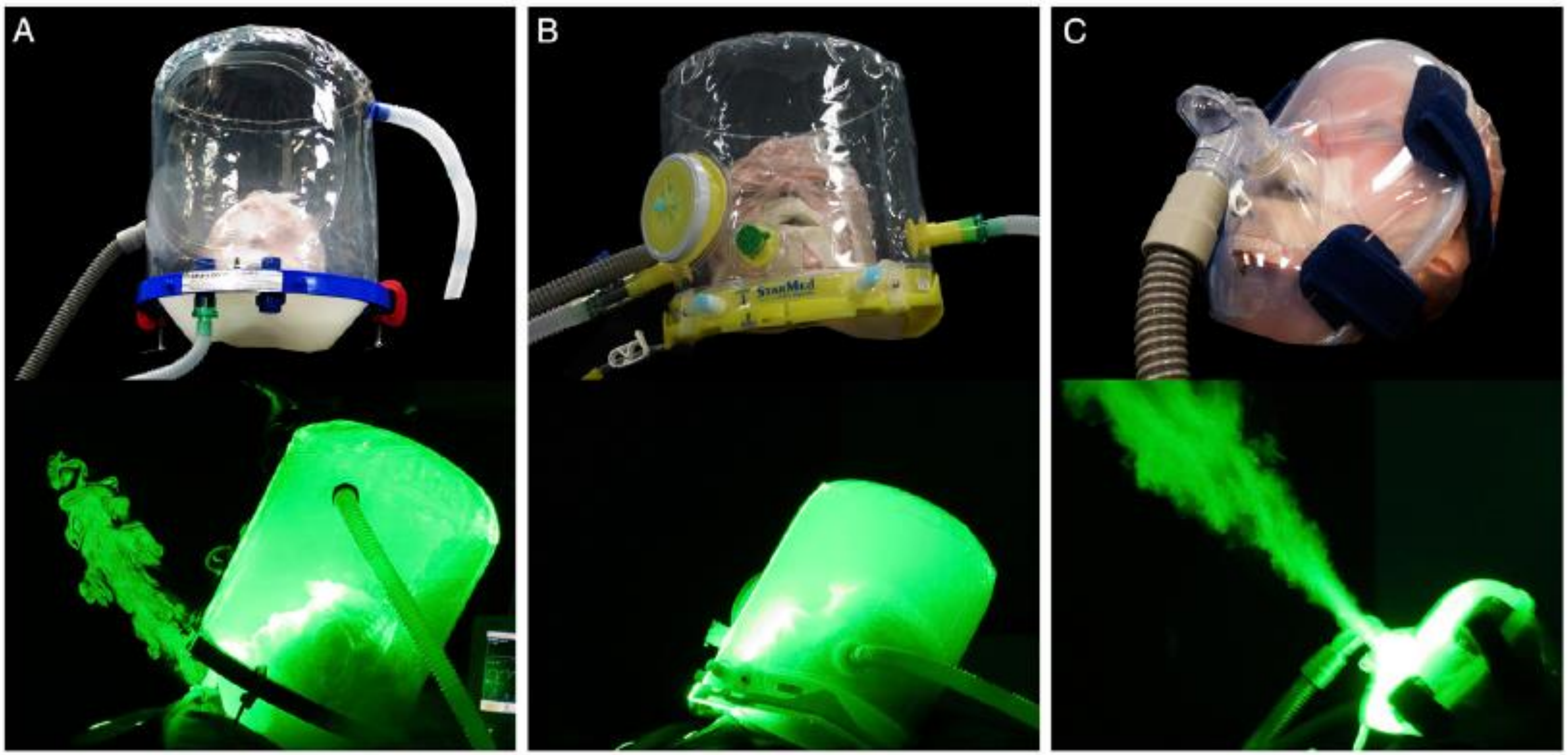
Contal, Chest, 2012

[Original Research Critical Care]

CHEST

Exhaled Air Dispersion During Noninvasive Ventilation via Helmets and a Total Facemask

David S. Hui, MD, FCCP; Benny K. Chow, PhD; Thomas Lo, MSc; Susanna S. Ng, MBChB; Fanny W. Ko, MD, FCCP; Tony Gin, MD; and Matthew T. V. Chan, MD



Intensive Care Med (2012) 38:160–167
DOI 10.1007/s00134-011-2416-9

PHYSIOLOGICAL AND TECHNICAL NOTES

Carlo Olivieri
Roberta Costa
Giorgio Conti
Paolo Navalesi

Bench studies evaluating devices for non-invasive ventilation: critical analysis and future perspectives

Table 1 Major problems encountered during bench studies evaluating devices for non-invasive ventilation and of the possible solutions

Critical issue	Problem	Proposed solution
Different lung models	Impact unknown	Need for evaluation
Simulated effort	Influence of inspiratory effort on ventilator performance	Standardized inspiratory effort: weak effort 2 cmH_2O, normal effort 8 cmH_2O, high effort 15 cmH_2O, strenuous effort 25 cmH_2O
Mechanical properties of the "virtual" respiratory system	Different values of resistance and compliance	Healthy: $C = 100$ mL/cmH_2O; $R = 5$ cmH_2O/L/s Obstructive: $C = 100$ mL/cmH_2O; $R = 20$ cmH_2O/L/s Restrictive: $C = 25$ mL/cmH_2O; $R = 5$ cmH_2O/L/s Mixed: $C = 50$ mL/cmH_2O; $R = 10$ cmH_2O/L/s

Enseignement?

TECHNIQUES AND PROCEDURES

Design of a Lung Simulator for Teaching Lung Mechanics in Mechanical Ventilation

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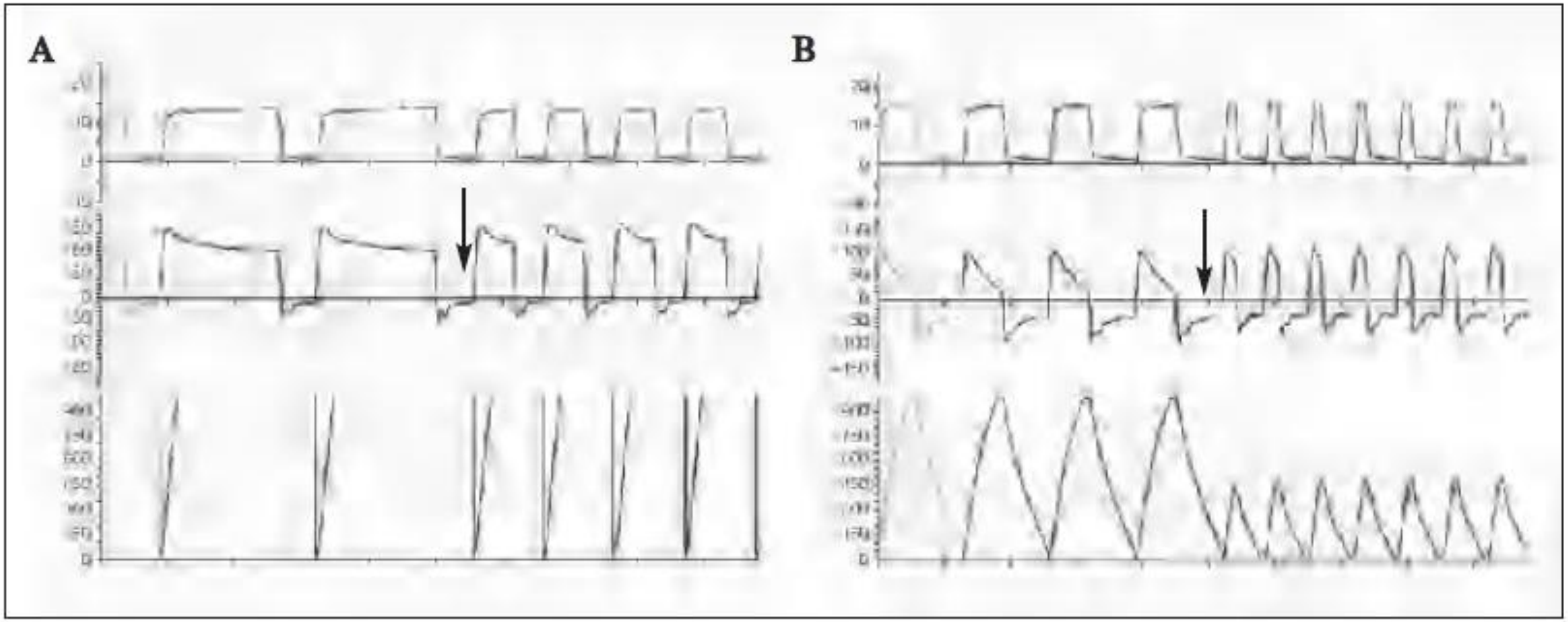
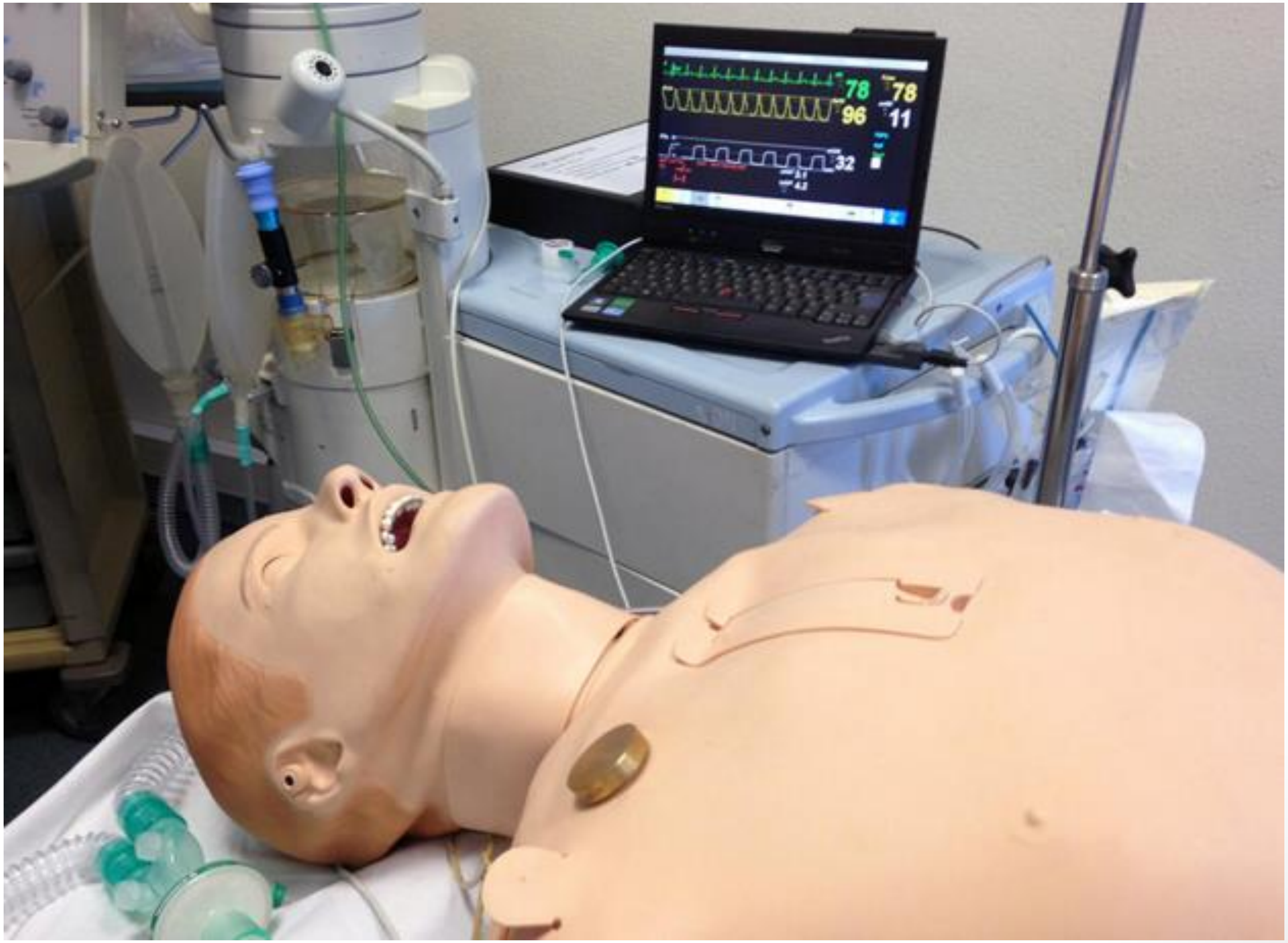
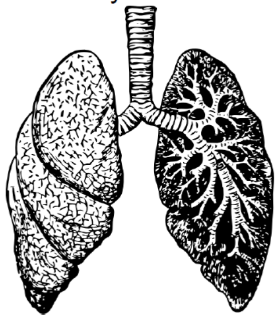


Simulation haute fidélité





Conclusion

- Il existe une multitudes d’étude sur banc d’essais susceptibles de fournir des données sur la performance des dispositifs.
- Permettent l’évaluation de dispositifs impliquant directement les soins de kinésithérapie respiratoire.
- Des données qui pourraient peut être influencer la pratique des thérapeutes.
- Aucune étude à ce jour sur l’évaluation des données fournies par les bancs d’essais sur la pratique clinique.
- (Il y a à disposition des Jaujaquois un nouveau banc à essayer.)

Merci de votre attention