# Quel désencombrement en complément à la réhabilitation pulmonaire ?

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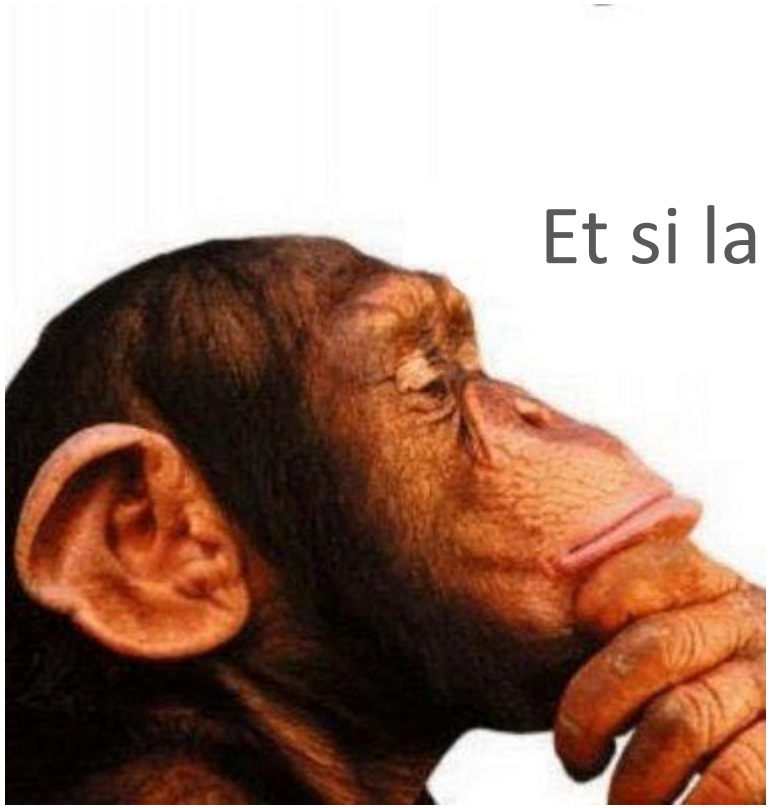
11es JOURNÉES FRANCOPHONES ALVÉOLE
CITÉ DES CONGRÈS DE LYON
10 & 11 MARS 2016

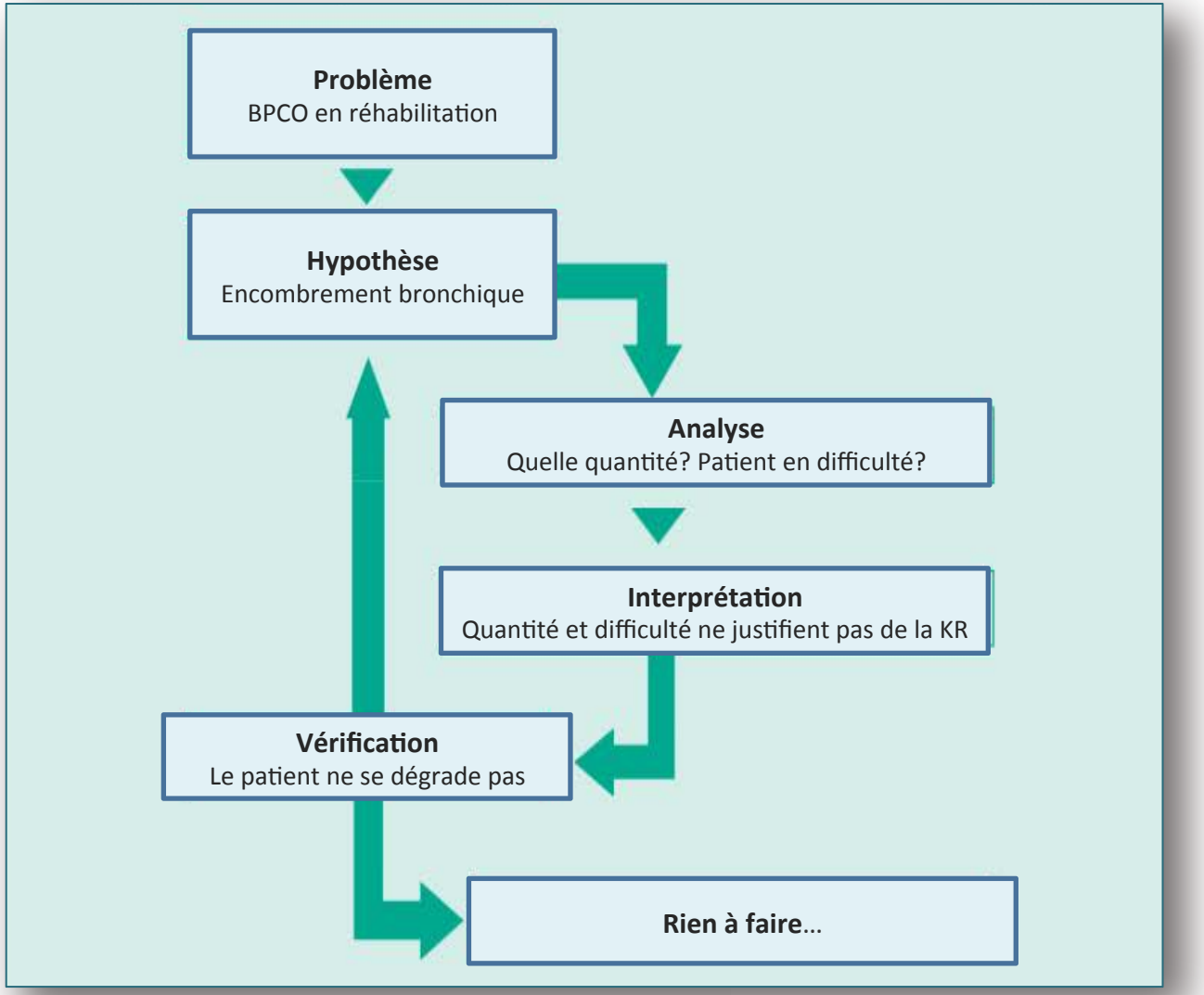
# PAS DE CONFLIT D’INTERET


JETEZ UN PAVÉ...
...DANS LA MARE AUX REQUINS!
?
M.

Et si la réponse était… **(Rien)**



# Sous forme de raisonnement clinique…




**LE PLUS FREQUENT!**

# Guidelines for the physiotherapy management of the adult, medical, spontaneously breathing patient

*Julia Bott, Sharron Blumenthal, Maria Buxton, Sheric Ellum, Caroline Falconer, Rachel Garrod, Alex Harvey, Tracey Hughes, Melanie Lincoln, Christine Mikelsons, Catherine Potter, Jennifer Pryor, Lesley Rimington, Frances Sinfield, Catherine Thompson, Pamela Vaughn, John White*

*On behalf of the British Thoracic Society Physiotherapy Guideline Development Group, a subgroup of the British Thoracic Society Standards of Care Committee, and the Association of Chartered Physiotherapists in Respiratory Care, a clinical interest subgroup of the Chartered Society of Physiotherapy*

Thorax 2009;64(Suppl I):i1–i51

American Association *for* Respiratory Care

**Recommendations Supported by Low-Level Evidence**

1. CPT is not recommended for the routine treatment of uncomplicated pneumonia.
2. ACT is not recommended for routine use in patients with COPD.
3. ACT may be considered in patients with COPD with symptomatic secretion retention, guided by patient preference, toleration, and effectiveness of therapy.
4. ACT is not recommended if the patient is able to mobilize secretions with cough, but instruction in effective cough technique (eg, FET) may be useful.

Respir Care 2013;58(12):2187–2193

# Sous forme de raisonnement clinique…

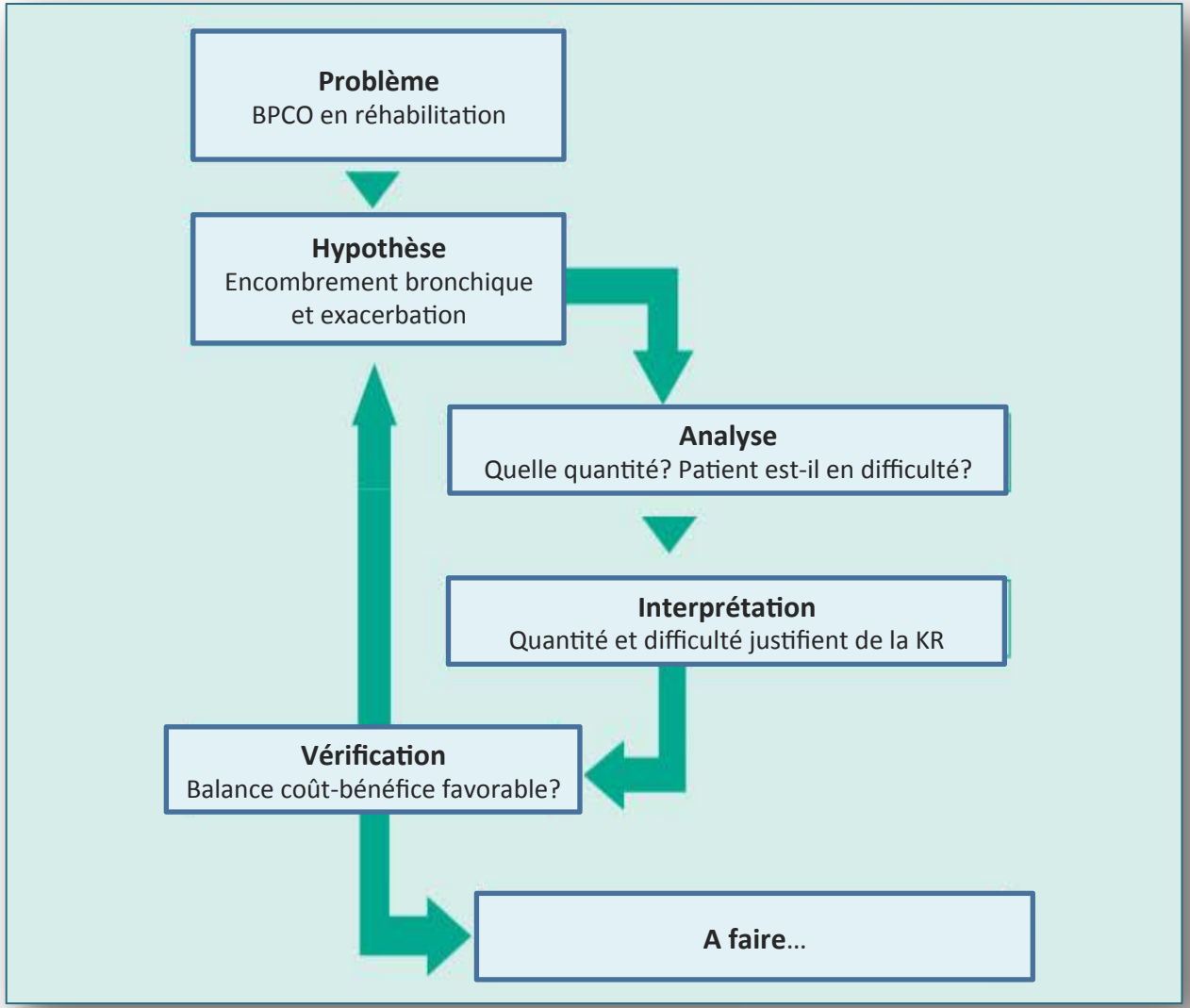


**Table 2** Comparing subjects with and without productive cough in COPD and non-COPD, respectively; age (mean), sex, smoking habits, heart disease, exacerbations and mortality, number of subjects (percent).

| | COPD | | $P^a$ | Non-COPD | | $P^a$ |
|---|---|---|---|---|---|---|
| | Productive cough | No productive cough | | Productive cough | No productive cough | |
| | $n = 394$ | $n = 599$ | | $n = 209$ | $n = 784$ | |
| Sex | | | | | | |
| Women | 165(38.8) | 286(50.4) | | 94(40.3) | 357(47.0) | |
| Men | 260(61.2) | 282(49.6) | **<0.001** | 139(59.7) | 403(53.0) | 0.075 |
| Age, mean (SD) | 65.8 | 64.3 | **0.034** | 67.4 | 63.7 | **<0.001** |
| Smoking habits | | | | | | |
| Non smoker | 71(16.8) | 161(28.6) | | 97(42.5) | 369(49.1) | |
| Ex smoker | 162(38.4) | 259(46.1) | | 90(39.5) | 298(39.6) | |
| Smoker | 189(44.8) | 142(25.3) | **<0.001** | 41(18.0) | 85(11.3) | **0.022** |
| Exacerbations | | | | | | |
| Any | 126(29.6) | 80(14.1) | **<0.001** | 45(19.3) | 44(5.8) | **<0.001** |
| Frequent[b] | 60(14.1) | 25(4.4) | **<0.001** | 18(7.7) | 12(1.6) | **<0.001** |
| Heart disease | 85(20.0) | 100(17.6) | 0.338 | 47 (20.2) | 113(14.9) | 0.054 |
| GOLD grade | | | | | | |
| 1 | 190(44.7) | 309(54.4) | | | | |
| 2 | 186(43.8) | 229(40.3) | | | | |
| 3–4 | 49(11.5) | 30(5.3) | **<0.001** | | | |
| Mortality | 124(29.2) | 107(18.8) | **<0.001** | 54 (23.2) | 121(15.9) | **0.011** |

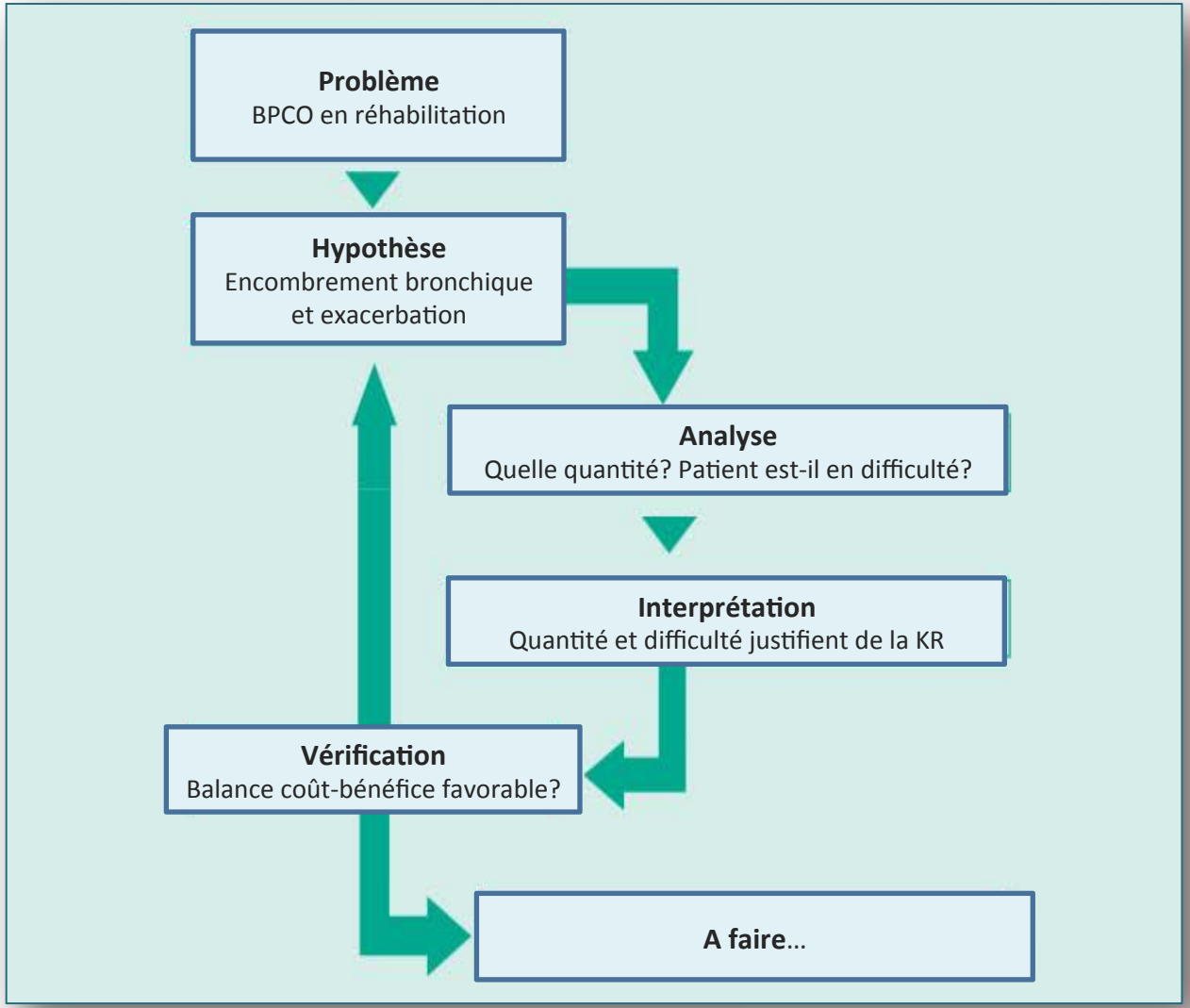
A *P*-value of <0.05 was regarded as statistically significant.

[a] Comparing subject with and without productive cough.

[b] Two or more during the last twelve months.

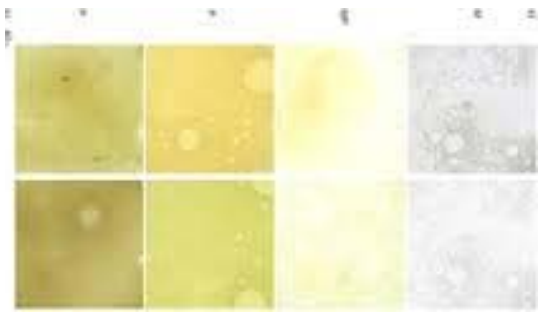
Lindberg A, Respir Med. 2015 Jan;109(1):88-95

# Sous forme de raisonnement clinique…



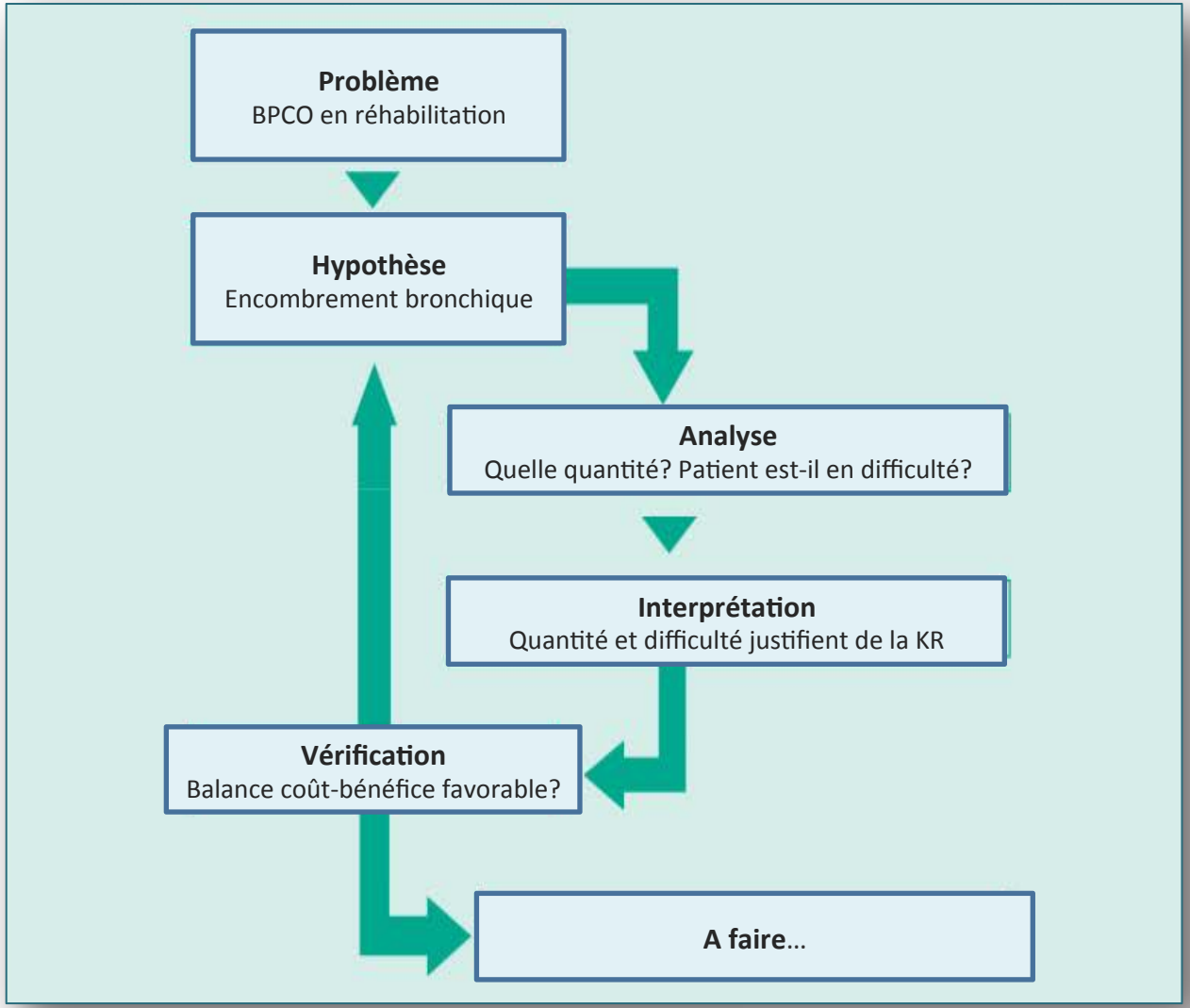
## Définition SPLF 2015 de l'exacerbation de BPCO

L'exacerbation aigue de BPCO est définie comme un événement aigu caractérisé par une aggravation des symptômes respiratoires au-delà des variations quotidiennes et conduisant à une modification thérapeutique : soit, simple augmentation des bronchodilatateurs ; dans ce cas, une durée supérieure à 24 heures est requise pour parler d'exacerbation ; soit, ajout d'un traitement supplémentaire (antibiothérapie et/ou corticothérapie orale).

Toux inefficace = risque accru de mortalité (odd ration = 2.5) (Steer Thorax 2012)

# Sous forme de raisonnement clinique…



CHEST

VOLUME 114 / NUMBER 2 / AUGUST, 1998 Supplement

# Managing Cough as a Defense Mechanism and as a Symptom*

## A Consensus Panel Report of the American College of Chest Physicians

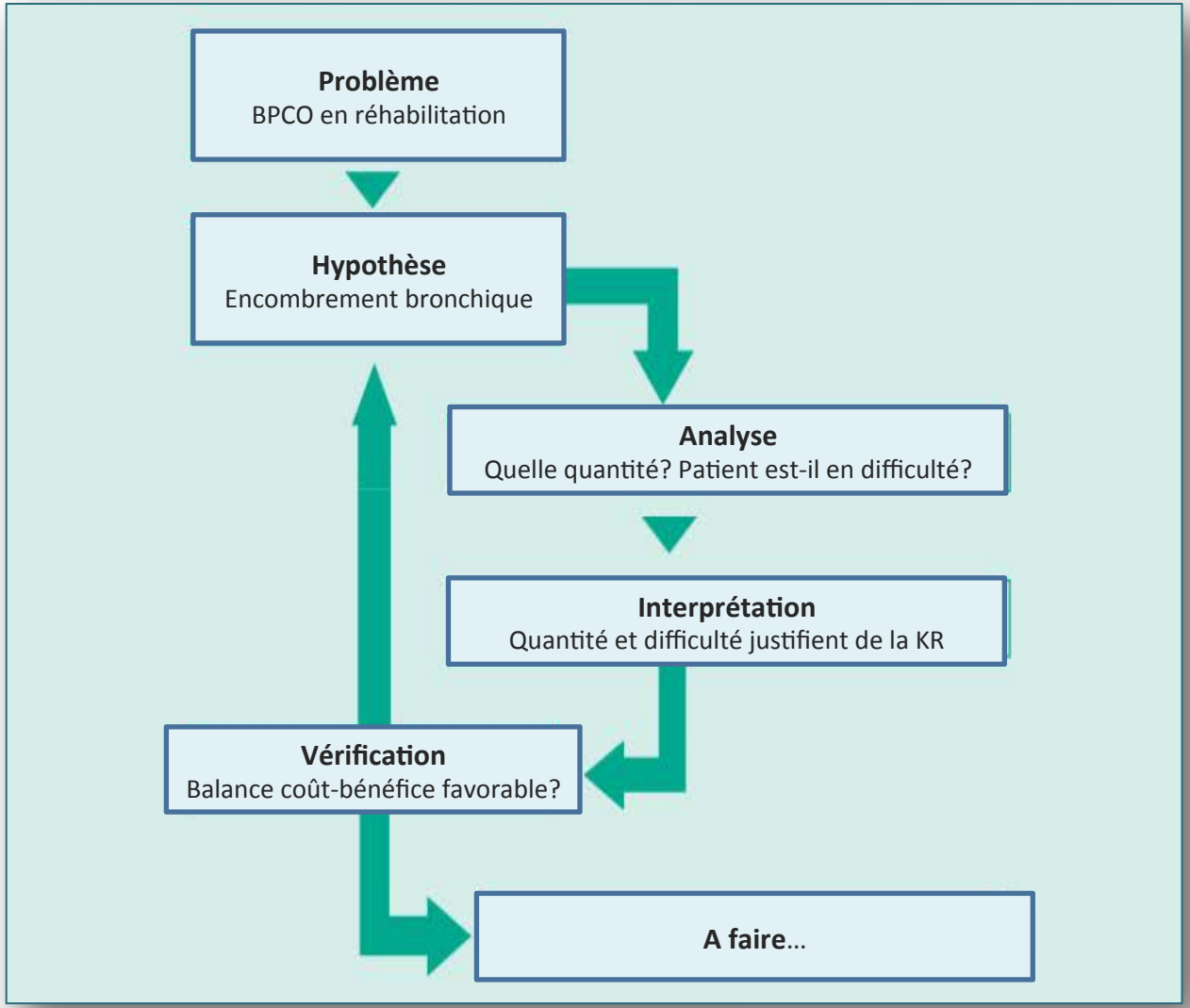
*Richard S. Irwin, MD, FCCP, Chair;*
*Louis-Philipe Boulet, MD, FCCP;*
*Michelle M. Cloutier, MD, FCCP; Richard Fuller, MD;*
*Philip M. Gold, MD, FCCP; Victor Hoffstein, MD, FCCP;*
*Alvin J. Ing, MD; F. Dennis McCool, MD, FCCP;*

may occur when respiratory muscles are weakened or when the surface adhesive properties of mucus are altered. While a variety of nonpharmacologic protussive treatment modalities may improve cough mechanics, clinical studies documenting improvement in patient morbidity and mortality are lacking.

3. It is the complications of cough that lead patients to seek medical attention. The most common complications are subjective perceptions of exhaustion and self-consciousness, and symptoms of insomnia, hoarseness, musculoskeletal pain, sweating, and urinary incontinence. The pressures produced during vigorous coughing can cause a variety of com-

Chest physiotherapy was beneficial **only** for patients who produced large volumes of sputum (more than 20 to 30mL in 24h) during an acute exacerbation or chronically, rather than for all patients with a diagnosis of bronchiectasis

# Sous forme de raisonnement clinique…

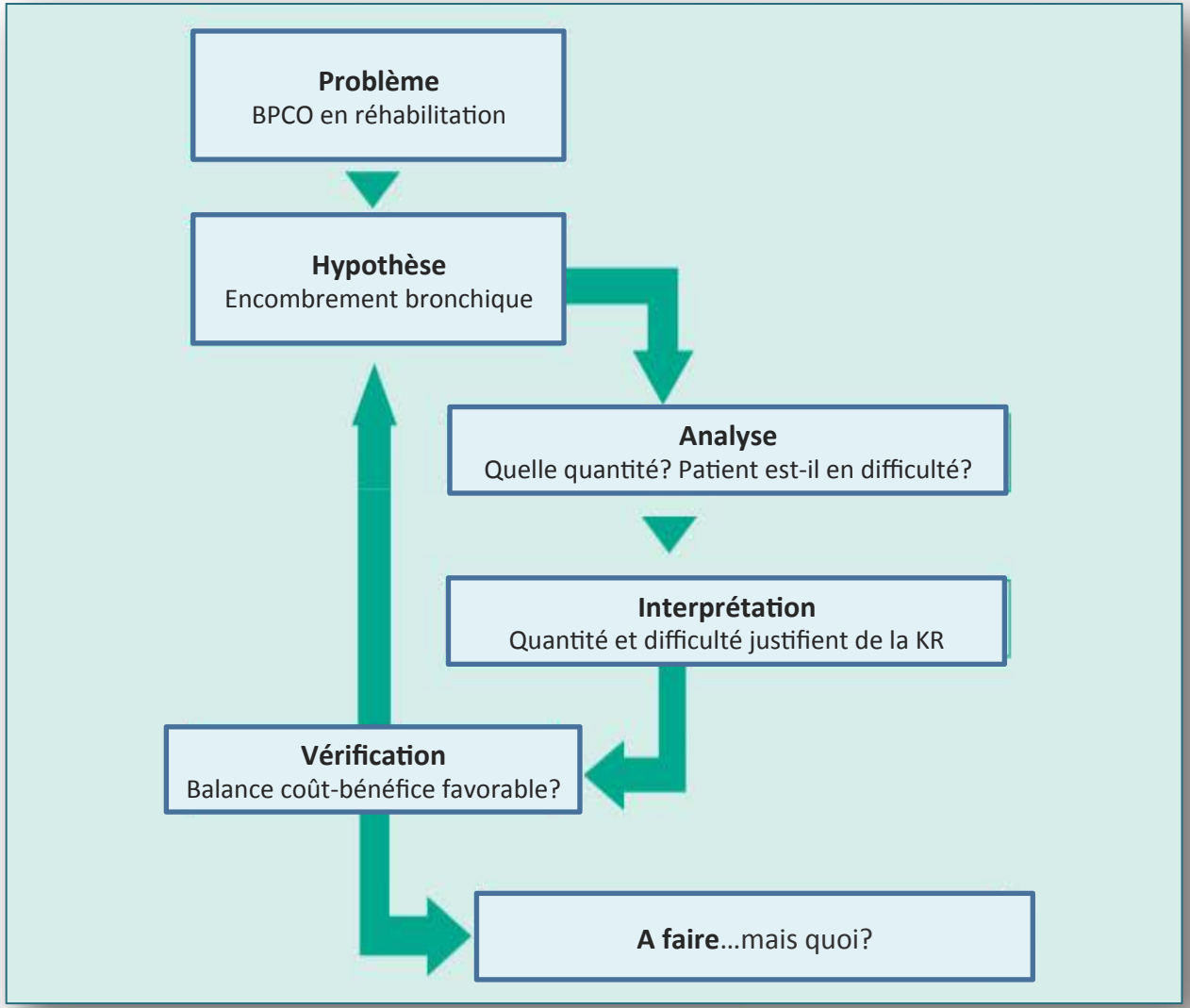


# A randomised controlled equivalence trial to determine the effectiveness and cost–utility of manual chest physiotherapy techniques in the management of exacerbations of chronic obstructive pulmonary disease (MATREX)

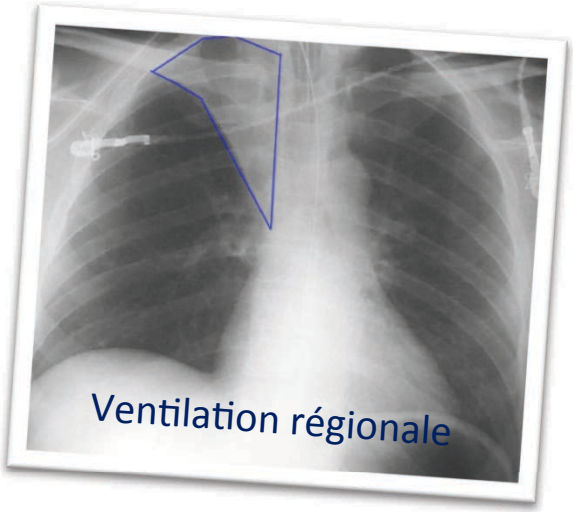
J Cross,[1*] F Elender,[1] G Barton,[2] A Clark,[2]
L Shepstone,[2] A Blyth,[1] M Bachmann[2]
and I Harvey,[2] on behalf of the
MATREX Research Group

Health Technol Assess 2010;14(23)

# Sous forme de raisonnement clinique…

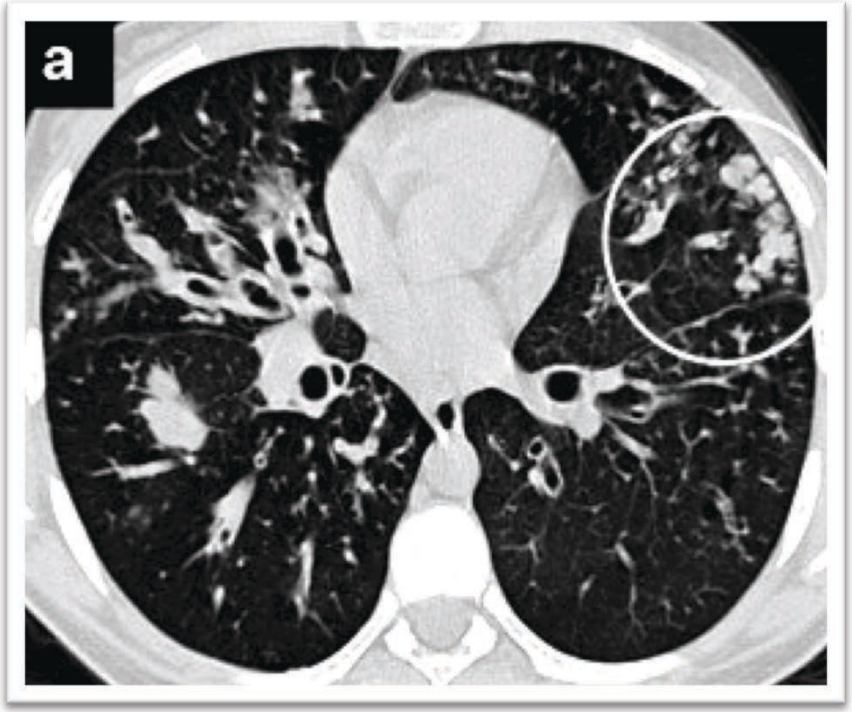


# En fonction du symptôme…



# En fonction de la physiopathologie…

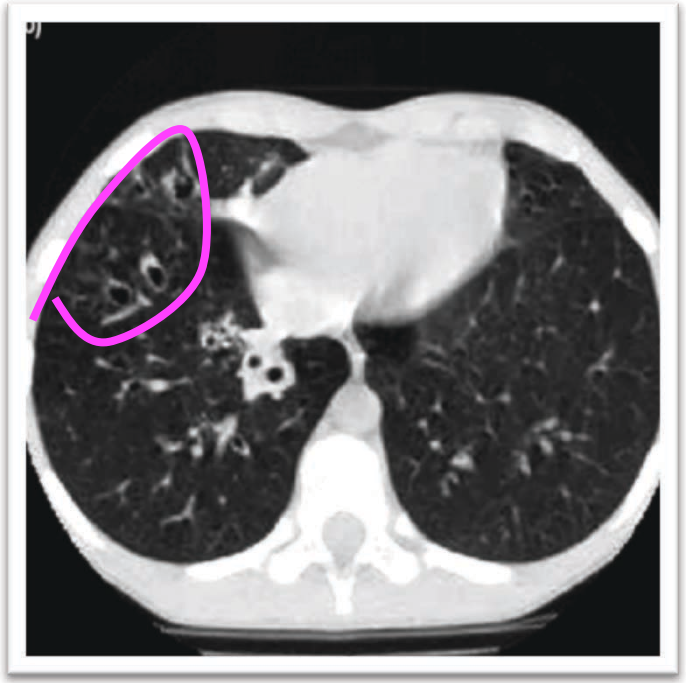


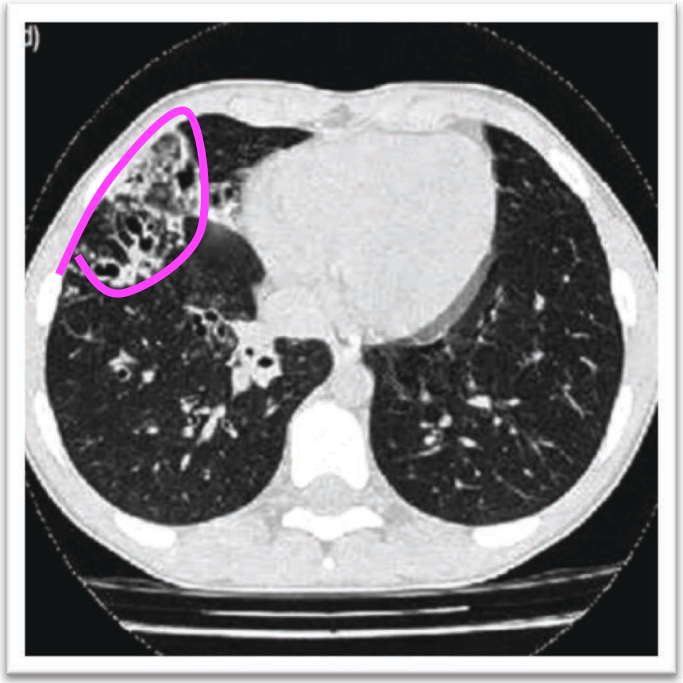

High-Resolution CT demonstrating lung abnormalities in a CF patient (16yo)


High-Resolution CT in a CF patient (15yo) (Personal data)

Robinson, Clin Chest Med. 2007;28:405-421

# En fonction du patient…





CF patient with improvement of lung function but deterioration of lung structure. The left panel shows HRCT scan at 10 yrs of age ($FEV_1$=86%, FVC=93, $FEF_{25-75\%}$=80). The right panel shows HRCT at 13 yrs of age ($FEV_1$=96%, FVC=91, $FEF_{25-75\%}$=105).

de Jong, ERJ. 2004;23(1):93-97

Joint BTS/ACPRC guideline

# Guidelines for the physiotherapy management of the adult, medical, spontaneously breathing patient

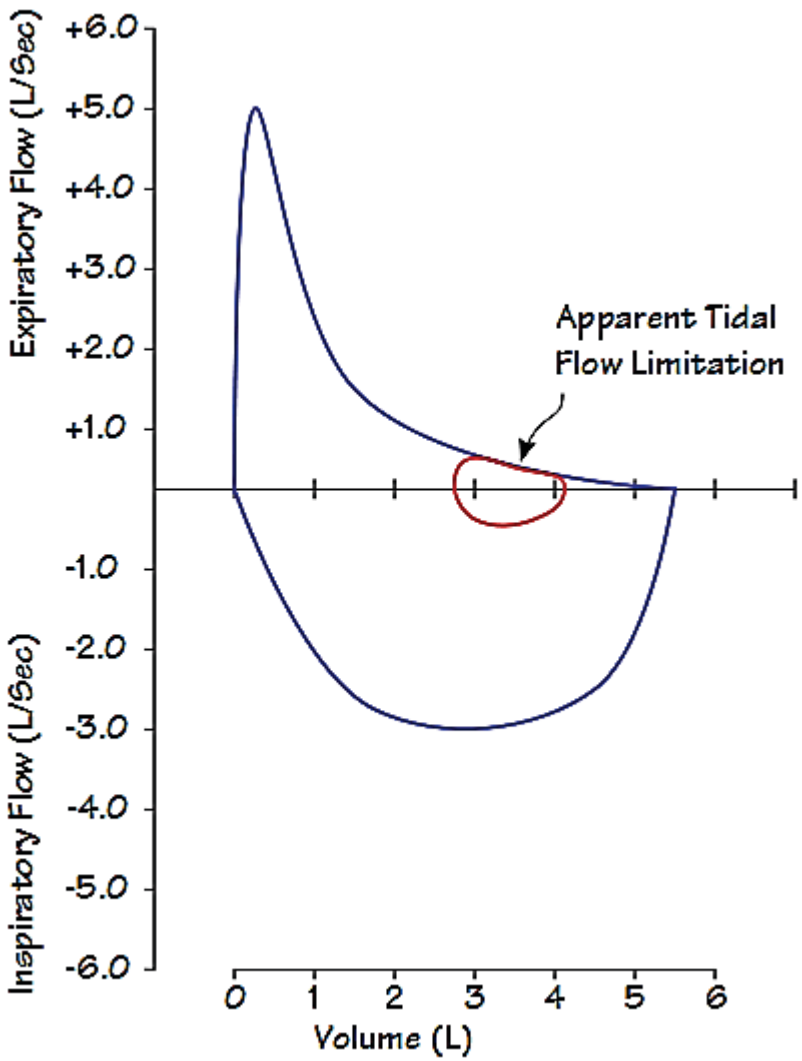
J Bott, S Blumenthal, M Buxton, S Ellum, C Falconer, R Garrod, A Harvey, T Hughes, M Lincoln, C Mikelsons, C Potter, J Pryor, L Rimington, F Sinfield, C Thompson, P Vaughn, J White, on behalf of the British Thoracic Society Physiotherapy Guideline Development Group

Information, advice and education should be integral to pulmonary rehabilitation. (**Grade A**)

Consider the active cycle of breathing techniques (which includes the forced expiration technique), autogenic drainage and plain or oscillating positive expiratory pressure for patients with stable COPD who need an airway clearance technique to assist in the removal of secretions. (**Grade C**)

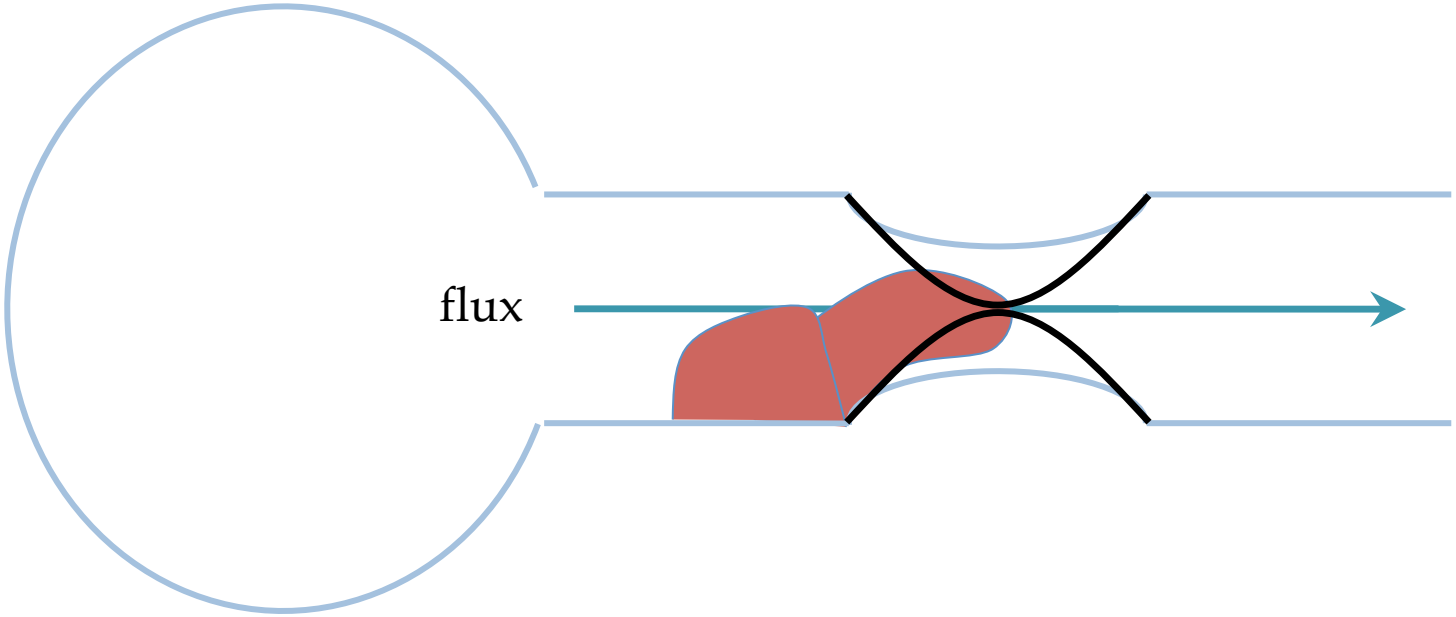
*The body of evidence for airway clearance techniques is greatest in patients with CF*

Thorax 2009; 64 (Suppl I):i1–i51



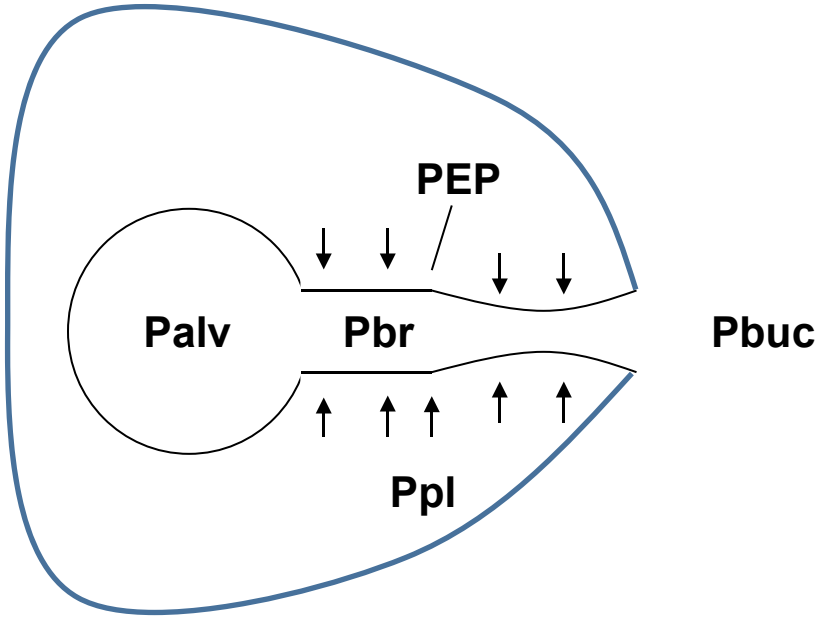

# MODULATION DU FLUX EXPIRATOIRE

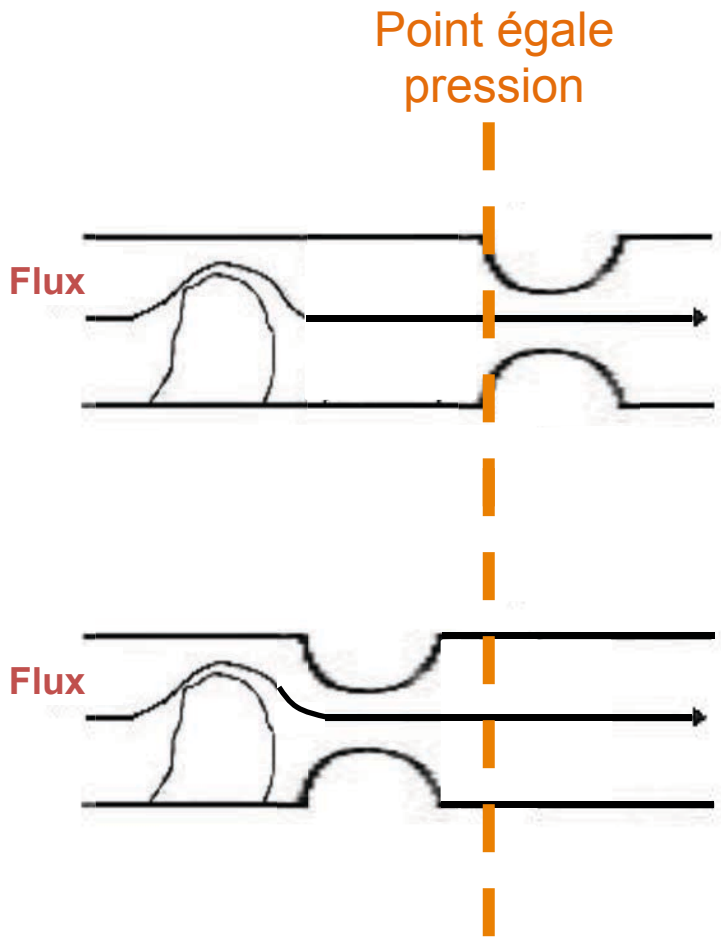
# Une histoire de flux…




Flux = Débit / Section

# Compression dynamique des voies aériennes



# Mécanisme d'action

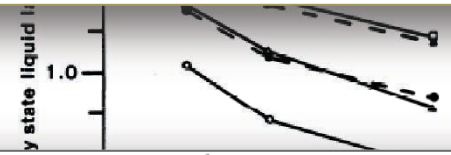
## Mucus clearance by two-phase gas-liquid flow mechanism: asymmetric periodic flow model

CHONG S. KIM, ANTONIO J. IGLESIAS, AND MARVIN A. SACKNER
*Pulmonary Division, University of Miami School of Medicine at Mount Sinai Medical Center, Miami Beach, Florida 33140*

TABLE 5. *Critical mucus layer thickness required for mucus transport in horizontal tube*

| PEIFR: | 3.0 | 2.0 | 1.5 |
|---|---|---|---|
| $\dot{V}_{E_p}$: | 60 | 40 | 30 |
| Mucus simulants | | | |
| *A1* | 0.47±0.01 (89) | 0.70±0.02 (92) | 0.87±0.02 (86) |
| *A2* | 0.66±0.02 (76) | 0.91±0.02 (76) | 1.08±0.03 (77) |
| *A3* | 0.52±0.01 (60) | 0.74±0.03 (69) | 0.94±0.02 (71) |
| *B1* | 0.71±0.01 (87) | 1.02±0.03 (94) | 1.23±0.04 (93) |
| *B2* | 0.80+0.02 (64) | 0.97±0.03 (64) | 1.14±0.02 (64) |
| *B3* | 0.58±0.01 (51) | 0.81±0.02 (61) | 0.99±0.07 (62) |
| *C1* | 1.08±0.03 (92) | 1.24±0.04 (90) | 1.38±0.04 (88) |
| *C2* | 1.05±0.04 (65) | 1.25±0.04 (69) | 1.33±0.05 (68) |
| *C3* | 0.72±0.03 (48) | 0.88±0.03 (53) | 1.07±0.04 (55) |

Values are means ± SD given in mm for 1.0-cm-ID horizontal tube. PEIFR, peak expiratory to inspiratory flow rate; $\dot{V}_{E_p}$, peak expiratory flow (l/min). Values in parentheses indicate percent of steady-state transport thickness shown in Table 4. For details of mucus simulants,




two phases. The greater the difference in airflow velocity, the faster the liquid movement. However, our results indicate that LLTS is mainly governed by the absolute value of the higher airflow, not by the difference between the expiratory and inspiratory flow rate. Our results further show that when the expiratory flow rate is kept constant above the inspiratory flow rate, LLTS remains unaffected regardless of the magnitude of the inspiratory flow rate until the inspiratory flow rate approaches within 10% difference from the expiratory flow rate.

and the square of mean airflow
e, the liquid layer is expected to
er airflow velocity and vice versa.
tric periodic airflow, the unequal
duce unequal shear forces in op-
efore, liquid layer may move ac-
e in airflow velocity between the
the difference in airflow velocity,
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mainly governed by the absolute
ow, not by the difference between
spiratory flow rate. Our results
the expiratory flow rate is kept
piratory flow rate, LLTS remains
f the magnitude of the inspiratory
nspiratory flow rate approaches
from the expiratory flow rate.
be in variance with the theoretical
becomes obvious when the flow
characteristics in the two-phase flow model are closely
analyzed.

In two-phase gas-liquid flow models, particularly in annular or stratified flow situation, the interfacial shear

DISCUSSION

*Liquid layer transport speed.* Theoretically, the shear stress on the liquid layer is directly proportional to the inertia force of airflow which is represented by the prod-

J Appl Physiol 1987;62(3):959-971

# A chaque technique son flux…

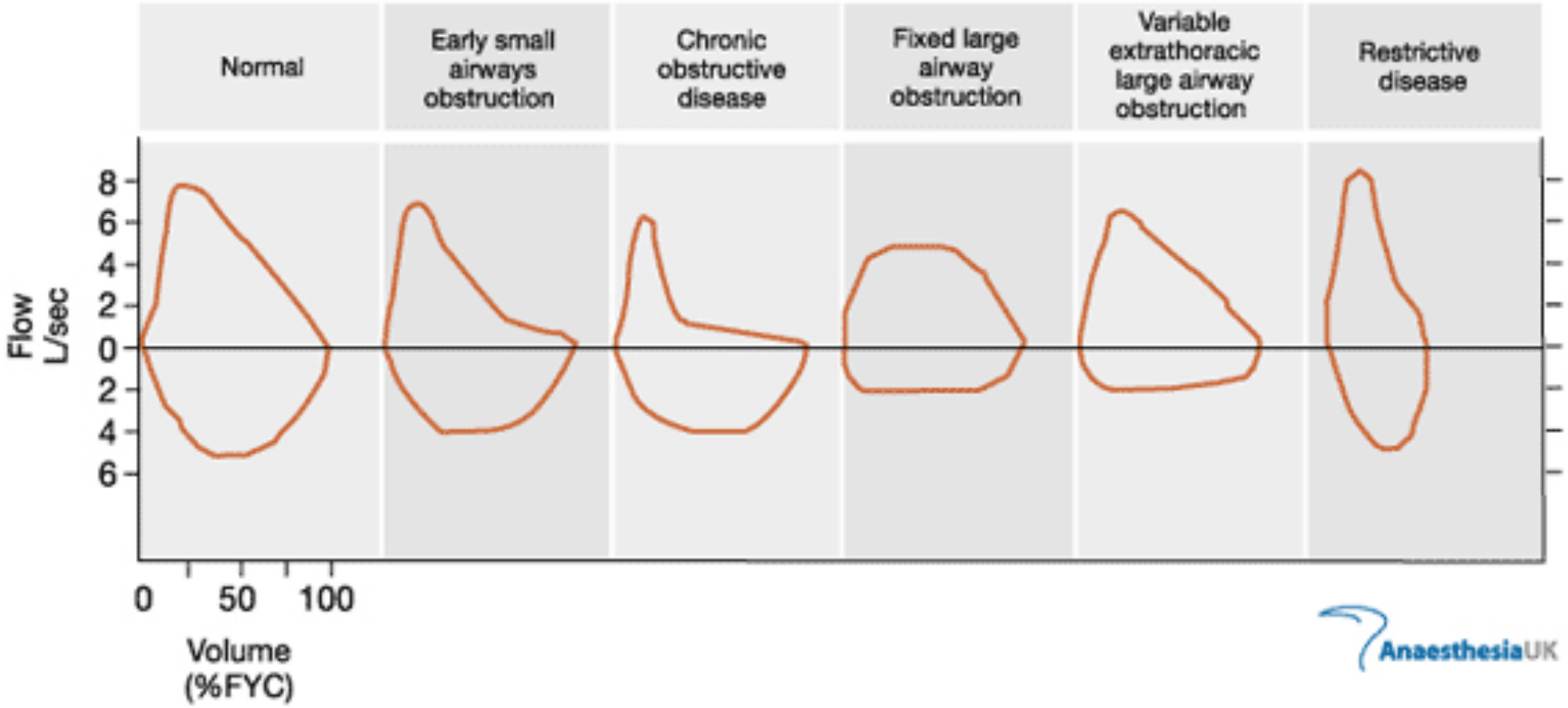
**TABLE 1** Effects of physiotherapy interventions on peak flow rate respiratory volumes and stimulation of cough

| Intervention | Subjects n | PEFR $L \cdot s^{-1}$ | PIFR $L \cdot s^{-1}$ | PEFR/PIFR | $V_I$ L | $V_E$ L | Coughs stimulated |
|---|---|---|---|---|---|---|---|
| **Vibration** | 17¶ | 1.58±0.73 | 1.06±0.27 | 1.51 | 1.78±0.87 | 2.44±1.06 | 0.7±1.0 |
| **Percussion** | 18 | 0.83±0.14*** | 0.84±0.10 | 0.99 | 0.91±0.37*** | 1.03±0.50 | 0.5±0.9 |
| **PEP** | 18 | 0.44±0.15*** | 0.96±0.20 | 0.47 | 1.64±0.40 | 1.96±0.57 | 0.5±0.6 |
| **Flutter®** | 17¶ | 1.13±0.30# | 1.05±0.27 | 1.15 | 1.62±0.52 | 1.81±0.57 | 0.4±0.7 |
| **Acapella®** | 18 | 0.59±0.08*** | 0.98±0.27 | 0.64 | 1.55±0.46 | 1.68±0.50 | 0.8±1.0 |
| **$TLC_{relax}$** | 15+ | 0.66±0.16 | 1.01±0.40 | 0.73 | 1.79±0.66 | 2.24±0.79 | 0 |

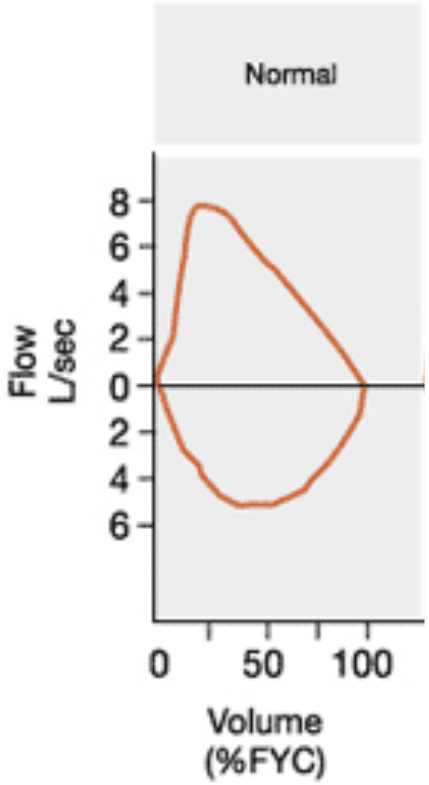
Data are presented as mean±SD of means of each subject, unless otherwise stated. PEFR: peak expiratory flow rate; PIFR: peak inspiratory flow rate; $V_I$: inspiratory volume; $V_E$: expiratory volume; PEP: peak expiratory pressure; $TLC_{relax}$: total lung capacity positive expiration. ¶: data lost due to technical difficulties (data from different interventions lost in different subjects); +: data only collected from stated number of subjects. p-values are significantly different from vibration. ***: $p<0.001$; #: $p=0.002$.

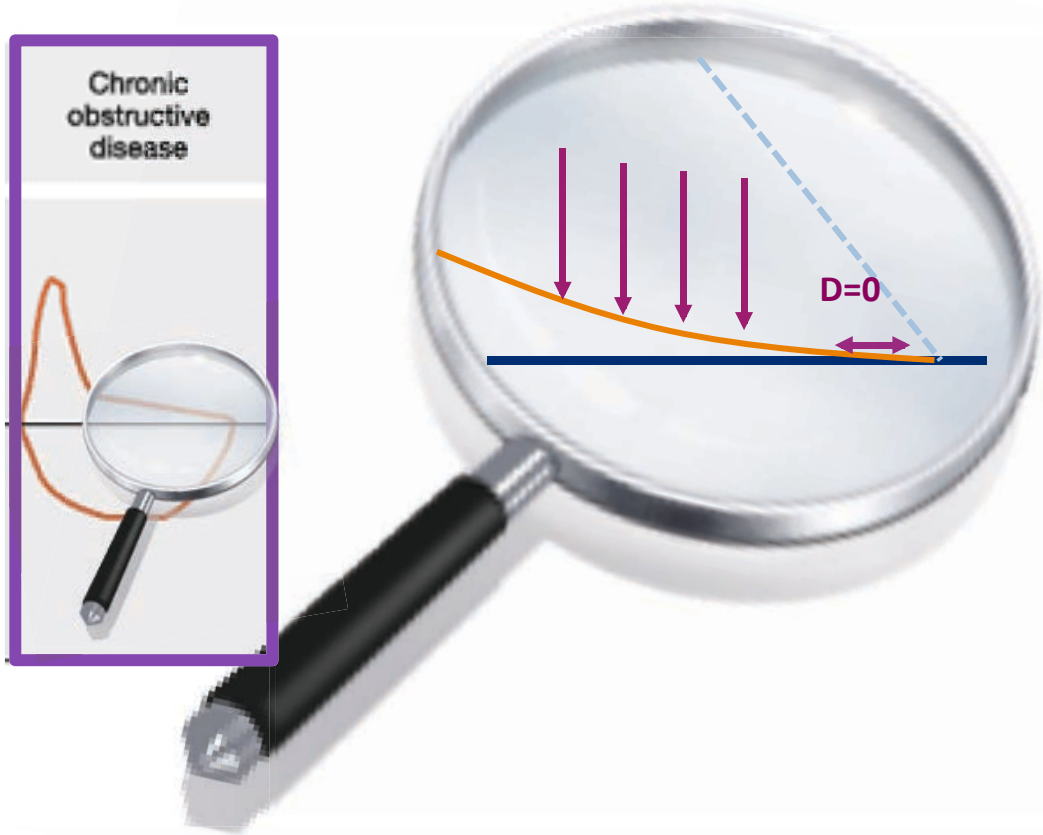
McCarren B., Eur Respir J 2006; 27: 1204–1209

# Situations ou signes cliniques

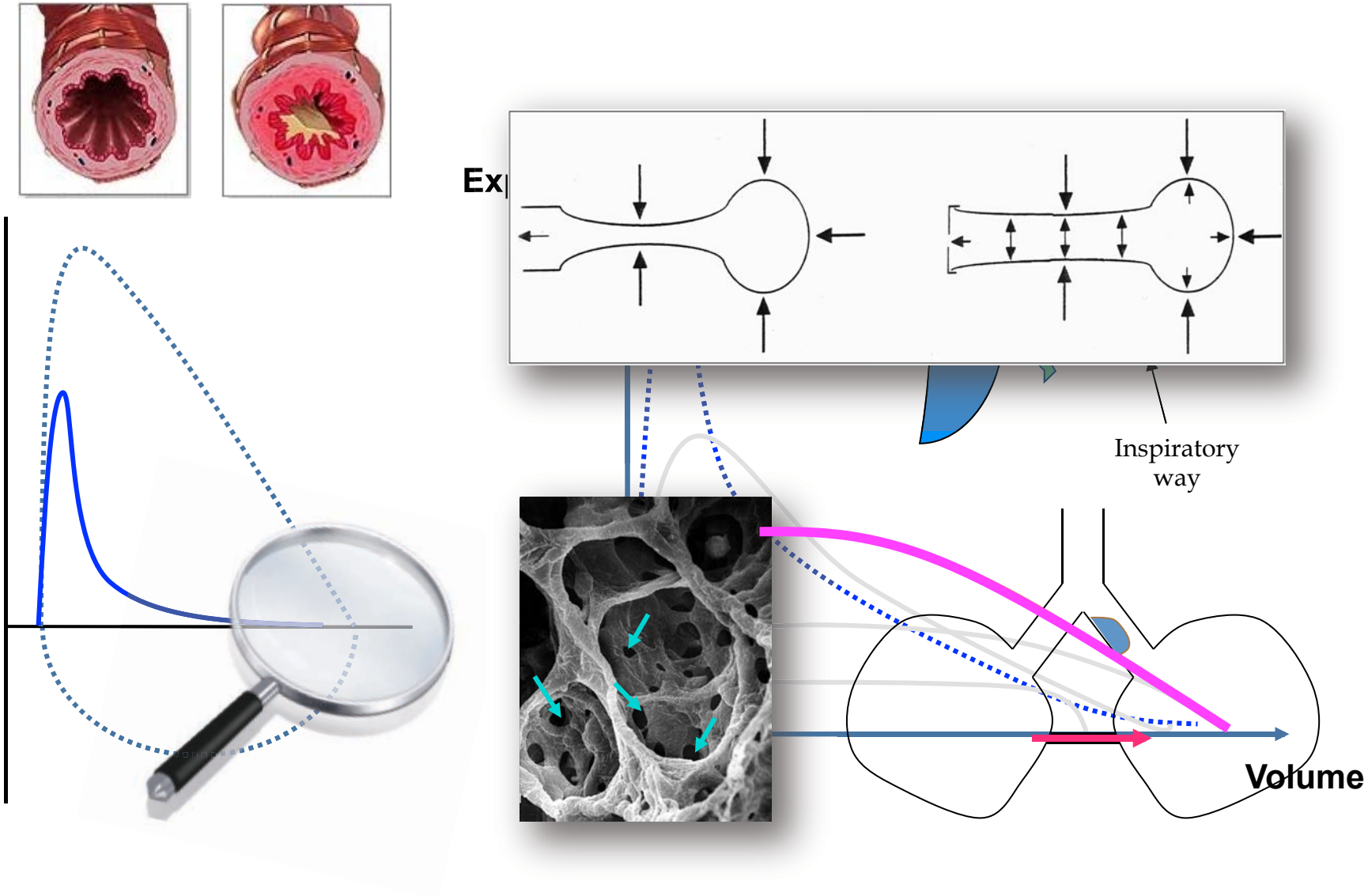


# Situations ou signes cliniques



# Pression expiratoire positive



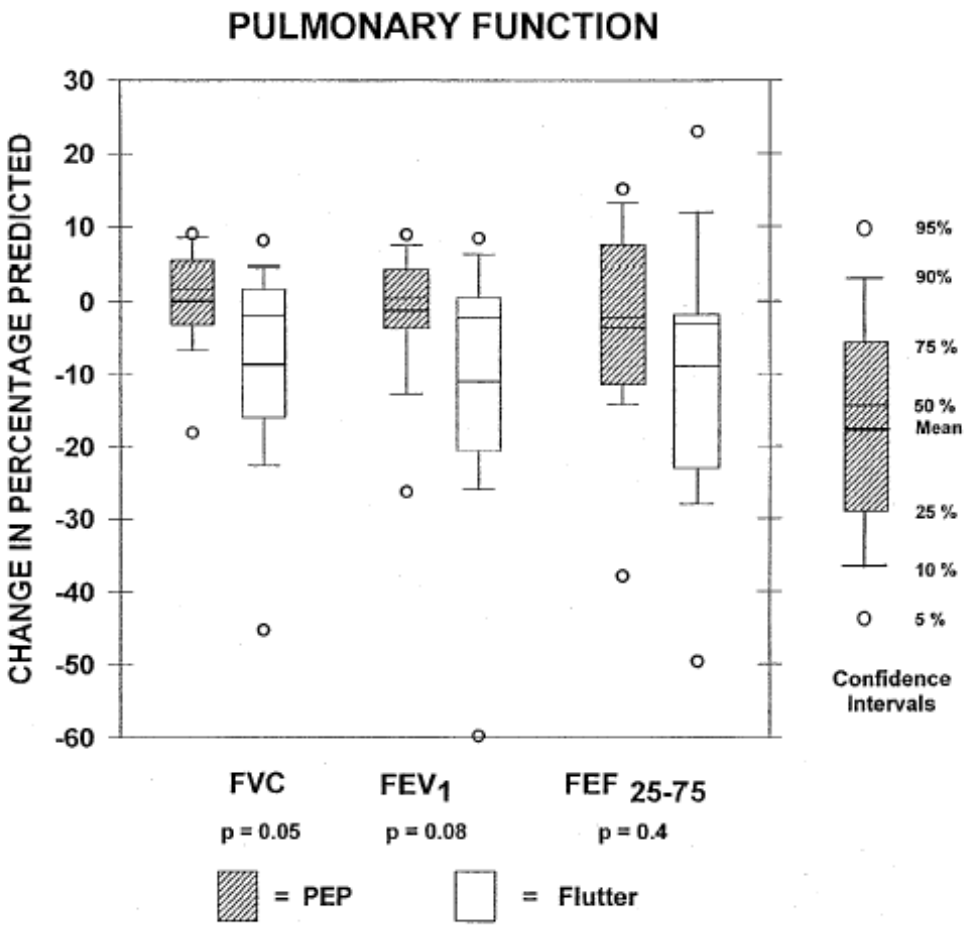
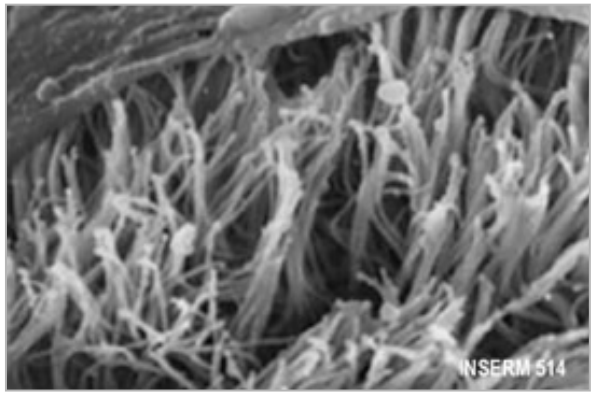



***Figure.*** Comparison of change in percentage predicted for pulmonary function parameters over 12-month period between group "A," who was performing positive expiratory pressure, and group "B," who was performing flutter.

**Conclusion:** Flutter was not as effective in maintaining pulmonary function in this group of patients with CF compared with PEP and was more costly because of the increased number of hospitalizations and antibiotic use.

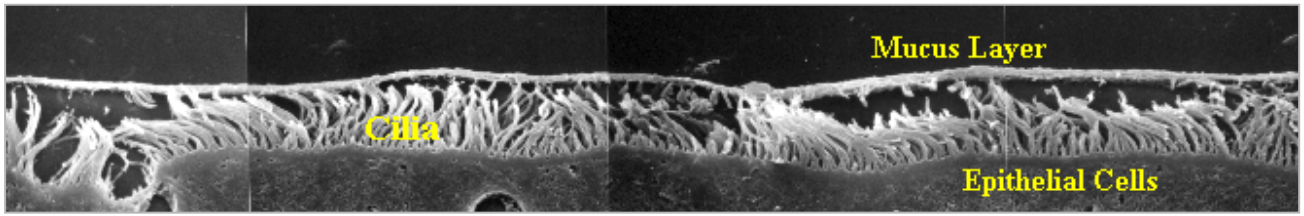
McIlwaine, J Pediatr 2001;138:845-50

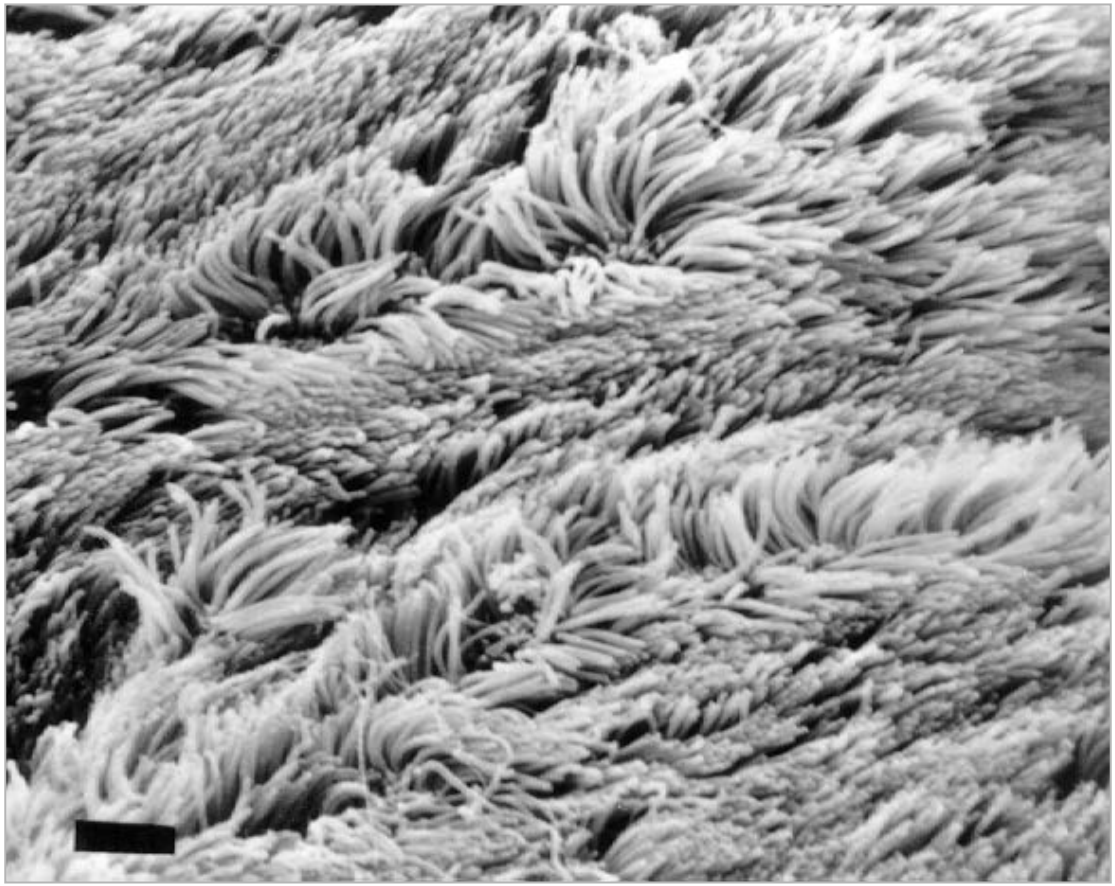
# AUGMENTER LA CLAIRANCE MUCOCILIAIRE

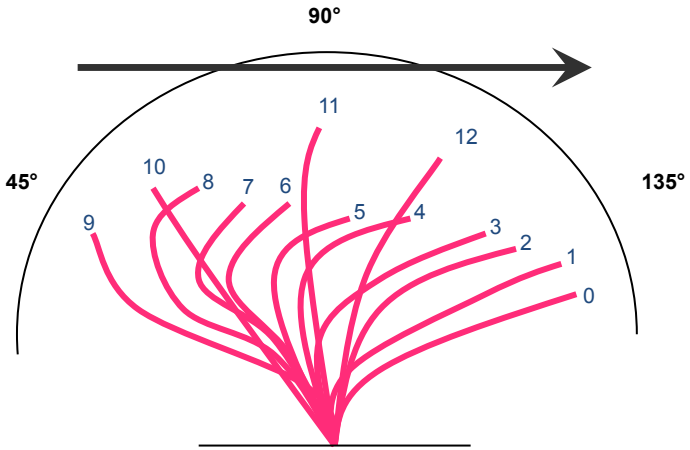



Source : Puchelle E, INSERM 514

# Battement ciliaire






≈10-15Hz

# Efficacité de la kinésithérapie basée sur la fréquence des vibrations

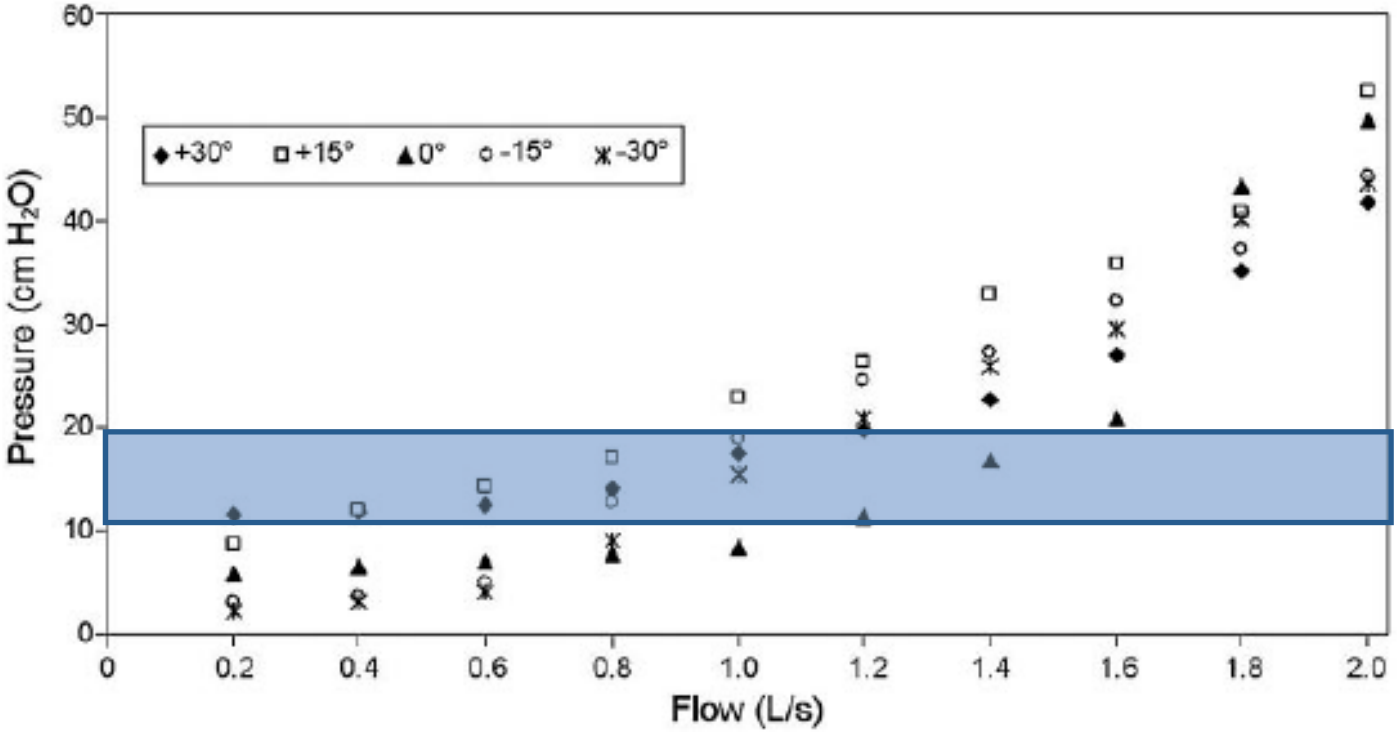
**TABLE 2** The frequency of oscillation of the physiotherapy interventions as determined by frequency spectral analysis

| Intervention | Frequency Hz |
|---|---|
| **Vibration** | 8.4±0.4 (7.3–10.0) |
| **Percussion** | 7.3±0.3 (6.5–8.0) |
| **Flutter®** | 11.3±1.5 (7.5–13.7)*** |
| **Acapella®** | 13.5±1.7 (10.0–18.3)*** |

Data are presented as mean±SD of means of each subject. p-value is significantly different from vibration. ***: $p<0.001$.

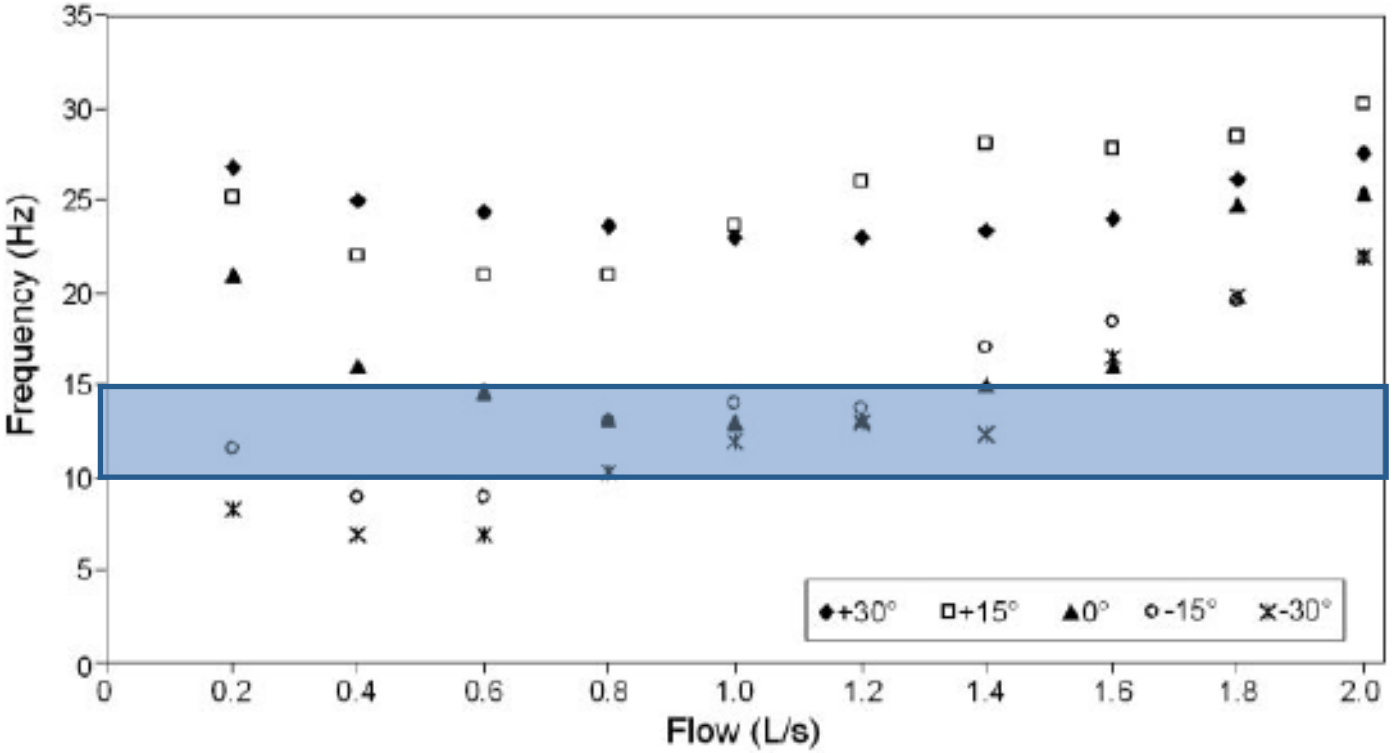
McCarren B., Eur Respir J 2006; 27: 1204–1209

# Influence du débit et de l'angulation

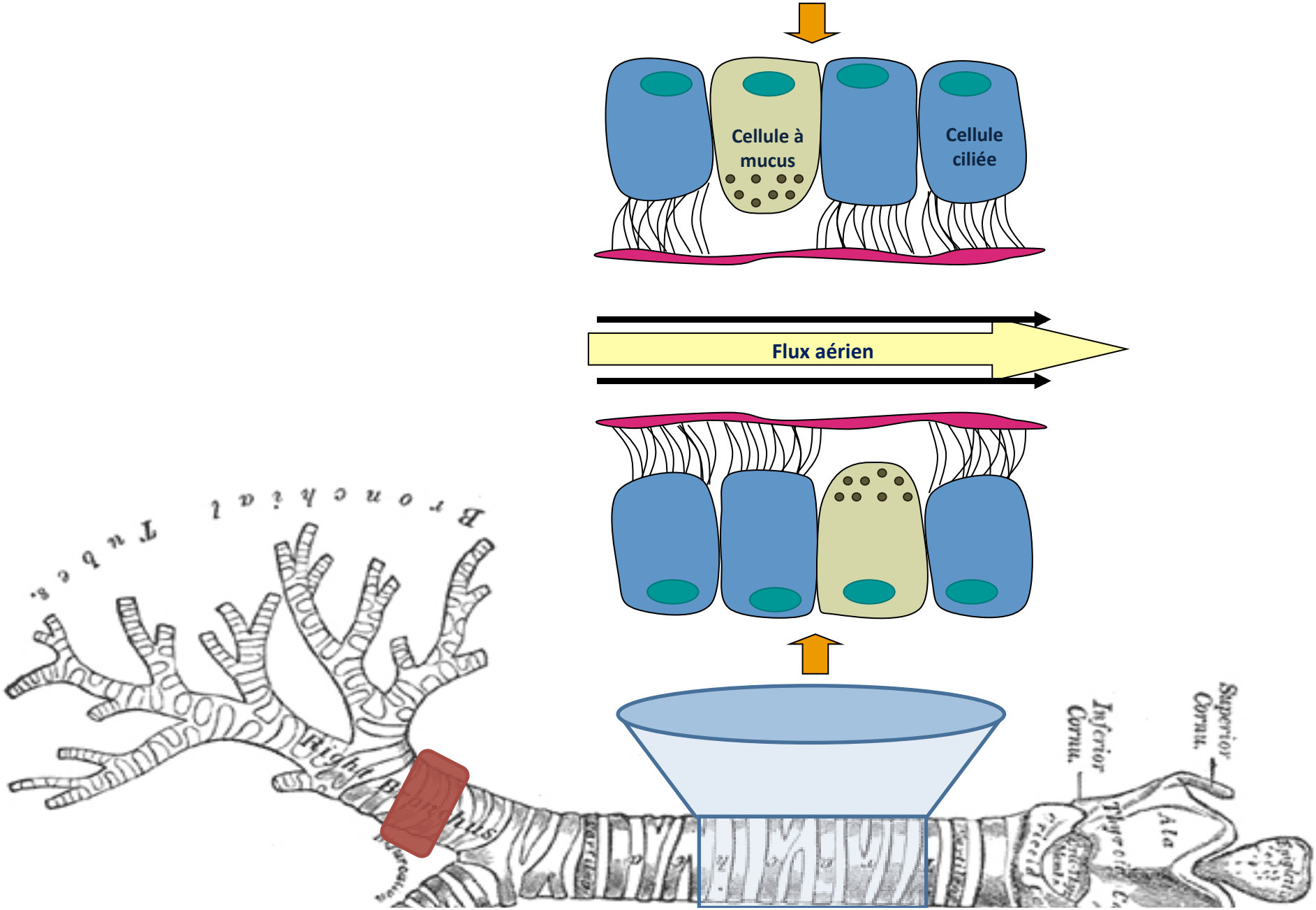


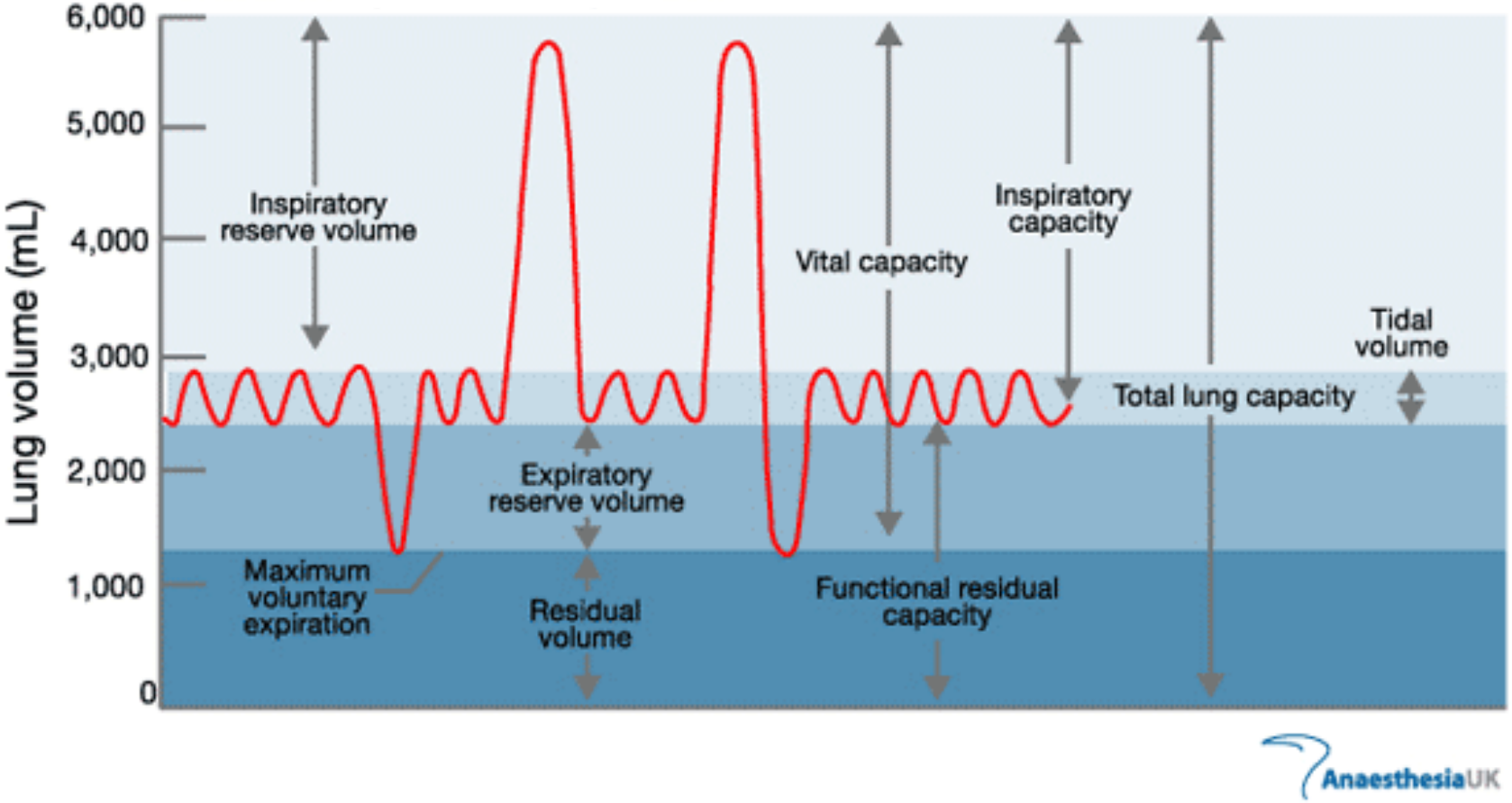

Alves, Respir Care 2008

# Utilisation optimale des appareils




Alves, Respir Care 2008


Superior Cornu.
Inferior Cornu.
Ala
Bronchial Tubes.
Cellule à mucus
Cellule ciliée
Flux aérien




# MODULATION DU VOLUME

# Breathing at low lung volumes and chest strapping: a comparison of lung mechanics

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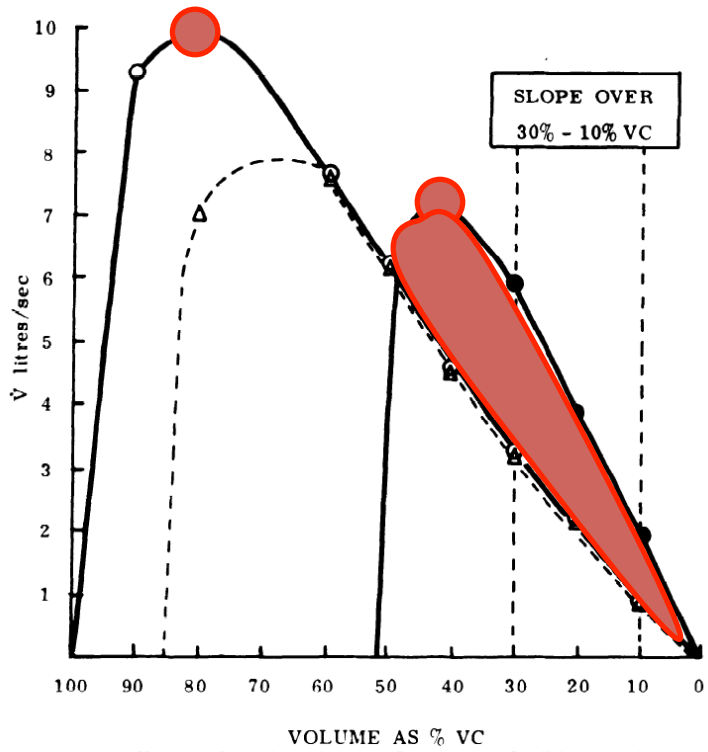
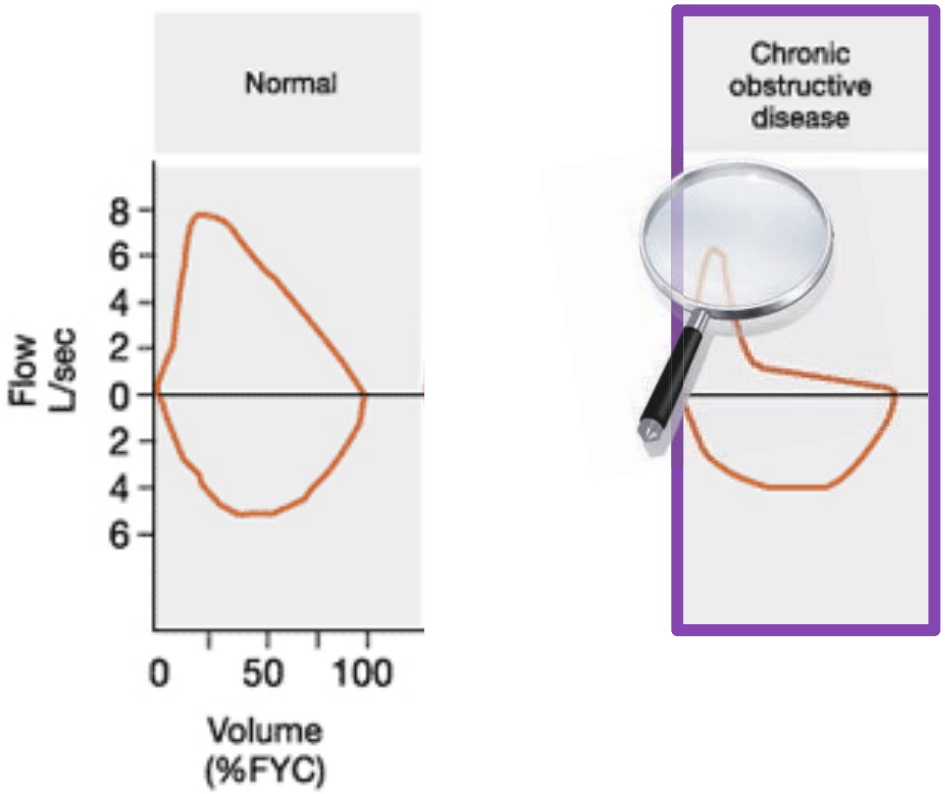


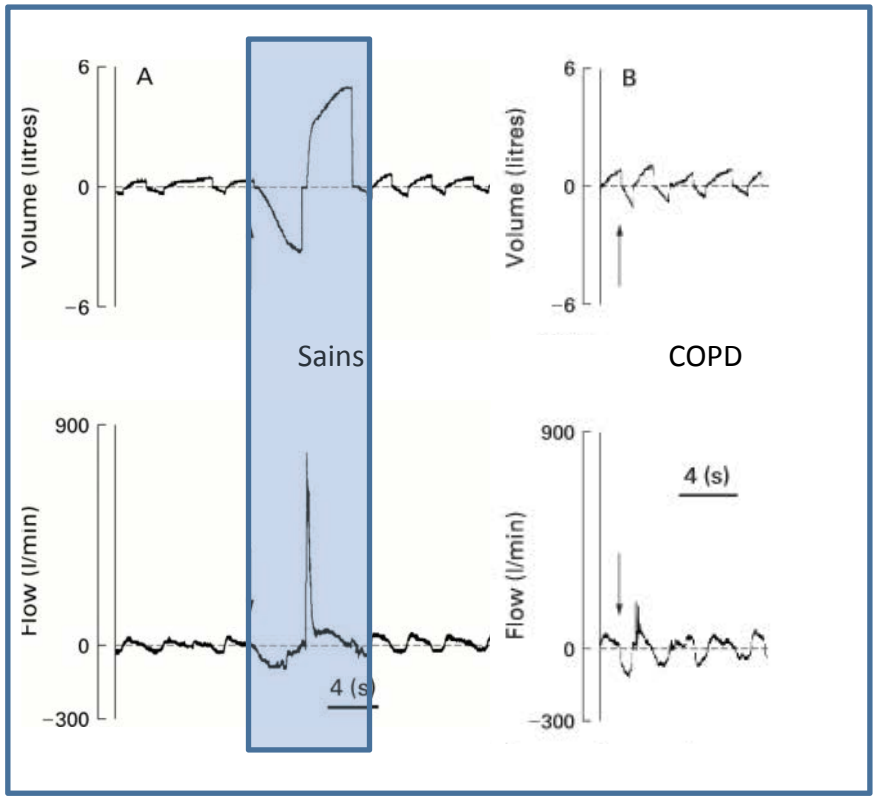

FIG. 2. Effect on forced expiratory flow rates of mild (△) and severe (●) chest strapping compared with maximal flow-volume curve (○) in *subject 2.*

- Diminution du débit de pointe
- Lors d'obstruction des petites voies aériennes, la déflation améliore les débits distaux

J Appl Physiol 1981;50(3):650-657

# Toux difficile…

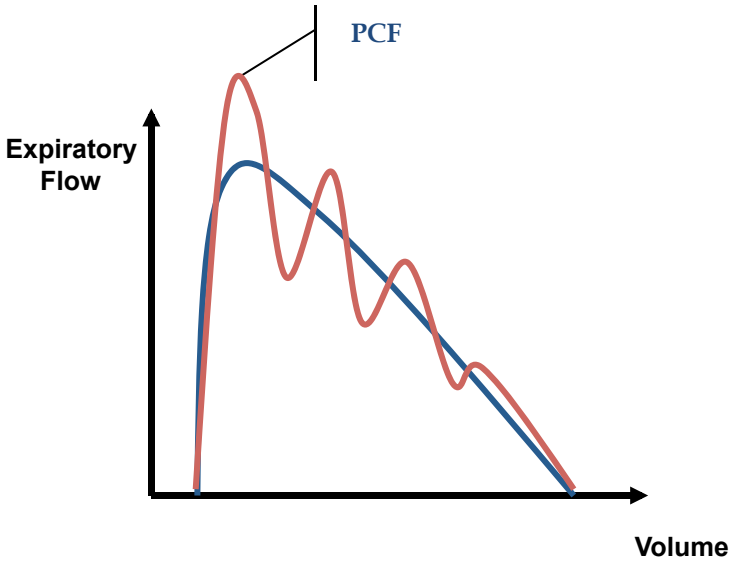



Sivasothy et al. Thorax 2001

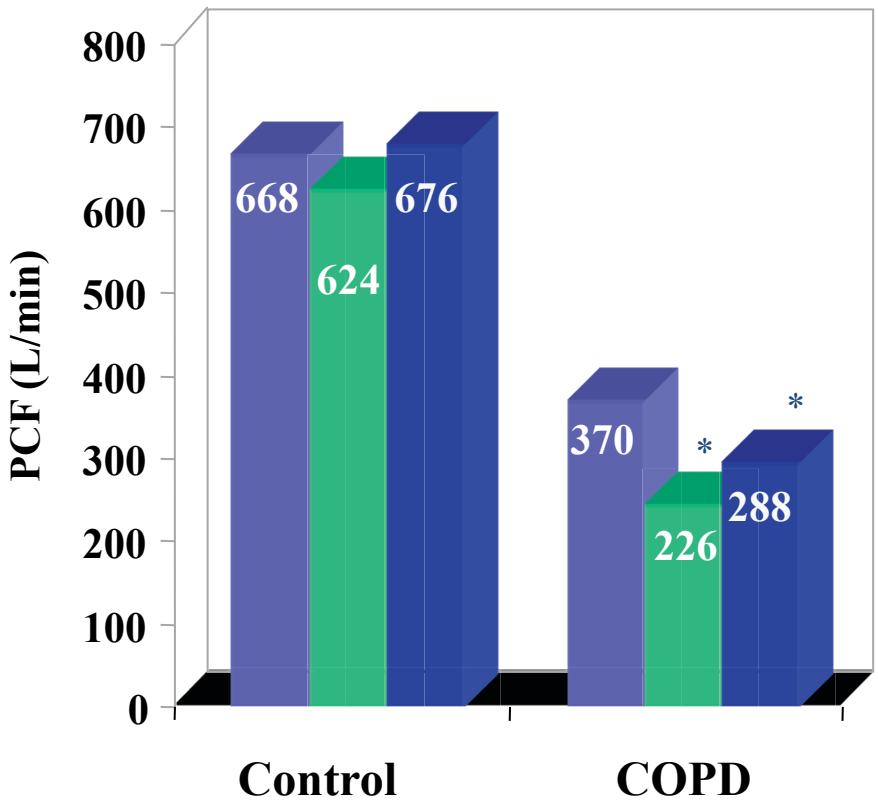
## Effect of manually assisted cough and mechanical insufflation on cough flow of normal subjects, patients with chronic obstructive pulmonary disease (COPD), and patients with respiratory muscle weakness

- 8 COPD vs 9 healthy control




Cough manually assisted

Cough mechanically assisted




Adapted from Michel Toussaint

Sivasothy et al. Thorax 2001


**Currently, the choice of an airway clearance technique is to some extent led by geographical therapeutic trends and therapists' personal experiences rather than robust long term scientific data.**

*Ammani Prasad, 2000*

# Take home message

- Peu de place pour le désencombrement en réhabilitation!!!
- Attention particulière aux patients encombrés
- Maîtriser la physiopathologie
- Choix de la technique en fonction de la situation clinique et contrôler leur efficacité


Merci