COUGH AUGMENTATION TECHNIQUES IN NMD

Limits of effective cough-augmentation techniques

PROFUSE TRACHEO-BROCHIAL SECRETION

PRODUCTION

ELIMINATION

DIFFICULT MOBILIZATION

AIRWAYS CLEARENCE METHODS

DIFFICULT EXPULSION

INCREASE COUGH

EFFECTIVE COUGH DEFINITION

LIMITS OF ASSESSMENT OF COUGH EFFICACY

LINEAR VELOCITY = \frac{\text{Expiratory flow}}{\text{Cross-sectional area of airways}}

Dynamic compression
EFFECTIVE COUGH

PCEF > 270L/min

ATS consensus statement 2004

Measuring PCEF is an easy way to assess expiratory flow but it doesn’t determine linear air velocity during expiration.

Clinical practice:

PCEF (as MIP MEP) variability depends on:
- collaboration
- interface (mask or mouthpiece)
- activation of mouth and tongue muscles
- Measuring devices

There is not always correspondence between best expiratory flow and effective expectoration.

PCEF IS THE MOST FREQUENTLY USED PARAMETER TO ASSESS COUGH EFFICACY

BUT

NEEDS VERIFICATION FROM CLINICAL ASSESSMENT
LIMITS DURING INSPIRATION

PHYSIOLOGIC INSPIRATION DURING COUGH

ABOUT 90% OF VC
- Improve elastic recoil of thoracic and pulmonary system
- Best ratio tension-length of expiratory muscles

CONtributes TO 44% OF PCEF.


ASSESSMENT OF COUGH: INSPIRATION

INEFFECTIVE COUGH:
- FVC < 1,500 L – 2 L (30-50% predicted)


A. Szittler et al. Chest 1990;

Expiratory Flow Rate L/sec

Percentage of Predicted Vital Capacity

0 100 200 300 400 500 600 700 800 900 1000

0 2 4 6 8 10
ASSESSMENT OF COUGH: INSPIRATION

DEFICIT MUSCOLI INSPIRATORI

FVC < 1,500 L – 2 L (30-50% of pred)

- INSUFFLAZIONI
- AIR STACKING
- GPB
- VENTILATOR
- IN-EXSUFLATOR

IT IS NOT NECESSARY TO ASSIST INSPIRATION WHEN:

FVC > 1,500 L – 2 L (30-50% of pred)

Personal opinion: probably FVC (and MlC) are more effective than PCEF, MIP and MEP for assessment of effective cough in neuromuscular disease
INSUFFLATION:

- **MIC**: Maximum Insufflation Capacity
  - Manual insuff Ambu/NIV volumetric
  - Mean MIC: 1712 ml.

- **LIC**: Lung Insufflation Capacity
  - IN-EXSUFLATOR
  - Mean LIC: 2069 ml.
  - IN-EXSUFLATOR is ineffective with bulbar impairment.
  - Dubious effectiveness with non-cooperative patients.


LIMITS FOR MECHANICAL COUGH ASSISTANCE

Which patients really need mechanical assistance?

  - p<0.01

- JR. Bach et al Chest, 1993;104:1022-32

LIMITS FOR MECHANICAL COUGH ASSISTANCE

Which patients really need mechanical assistance?

Other limits of mechanical assistance

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* *miglioramento significativo del PCEF rispetto al valore di base ("unassisted.")*

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** *miglioramento significativo del PCEF rispetto a MAC e insufflation*
Comparison between 5 different models of devices for cough assistance

**Work in progress**

Maximum expiratory flow recorded with a lung model pressures +40 -40

FlowEsp (l/min) -215.9 -258.0 -257.4 -174.2 -119.5

It seems unnecessary to use MI-E if PCF with other methods of cough assistance already exceeds the maximum flow that your device for cough assistance can produce.

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**RESULTS:**

**PCEF**

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*** miglioremo significativo del PCEF rispetto a Insuffl+MAC***

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**LIMITS FOR MECHANICAL COUGH ASSISTANCE**

Which patients really need mechanical assistance?

Other limits of mechanical assistance

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**COSTS**

$ €
LIMITS FOR MECHANICAL COUGH ASSISTANCE

Which patients really need mechanical assistance?

Other limits of mechanical assistance
Which pressure is effective?


In a lung model best results *At set pressures of 40 to -40 cm H2O, insufflation time of 3 sec, and exsufflation time of 2 sec, the exsufflation flow was 4.09 l/sec. A plateau insufflation volume of 3.8 l was reached after 4.9 sec of insufflation.*
Children from 6 month to 6 year old

ARS = Alveolar Recruitment Strategy
pressure of 40 cm H2O

Mi-E Ineffective

"WHEN USED VIA THE UPPER AIRWAY IT ONLY TENDS TO BE EFFECTIVE WHEN BULBAR MUSCLE FUNCTION IS ADEQUATE TO PERMIT FULL VOCAL CORD OPENING AND TO PREVENT UPPER AIRWAY COLLAPSE DURING THE FORCED EXSUFFLATION."

Mi-E Ineffective

Mi-E with uncooperative patients and non-invasive interface is usually ineffective particularly during the expiratory phase with negative pressure

Only MI-E or MI-E with abdominal thrust?
“Eleven patients had one notch indicating transient airway narrowing or collapse lasting from 0.05 to 0.15 s until the flow ceased…”

“The PCEF increased and the notches were reduced when exsufflation was coordinated with a manually delivered abdominal thrust…”

“These complementary techniques tend to decrease the transtracheal pressure gradient which tends to collapse the airway during exsufflation…”

“Except when contraindicated, we now routinely use MI-E coordinated with abdominal thrust…”
CONTRAINDICATIONS MI-E

- BULLOUS EMPHYSEMA
- PULMONARY INJURIES
- SEVERELY HYPOXIC PATIENTS DUE TO ACUTE PARENCHYMAL INJURY
- HEMODINAMICALLY UNSTABLE PATIENTS NOT MONITORED CORRECTLY
- PATIENTS WHO HAVE SUFFERED RECENT CARDIOGENIC PULMONARY EDEMA OR WITH DEPRESSED VENTRICULAR FUNCTION
- TRACHEOMALACIA
- ???????????