

VALUTAZIONE FUNZIONALE DEI MUSCOLI RESPIRATORI

- ✓ **ESAME CLINICO DEL PAZIENTE**
- ✓ **PROVE DI FUNZIONALITA' RESPIRATORIA**
- ✓ **PROVE FUNZIONALI SPECIFICHE**



ASSOCIAZIONE RIABILITATORI
DELL'INSUFFICIENZA RESPIRATORIA

PEF

PICCO DI FLUSSO ESPIRATORIO

PCEF

PICCO DI FLUSSO ESPIRATORIO
DURANTE LA TOSSE

l/sec.

**SFORZO
DIPENDENTE**

PEF

FEV_{30%} (V_{max30%})

0

TLC

FVC

RV

-5

PIF

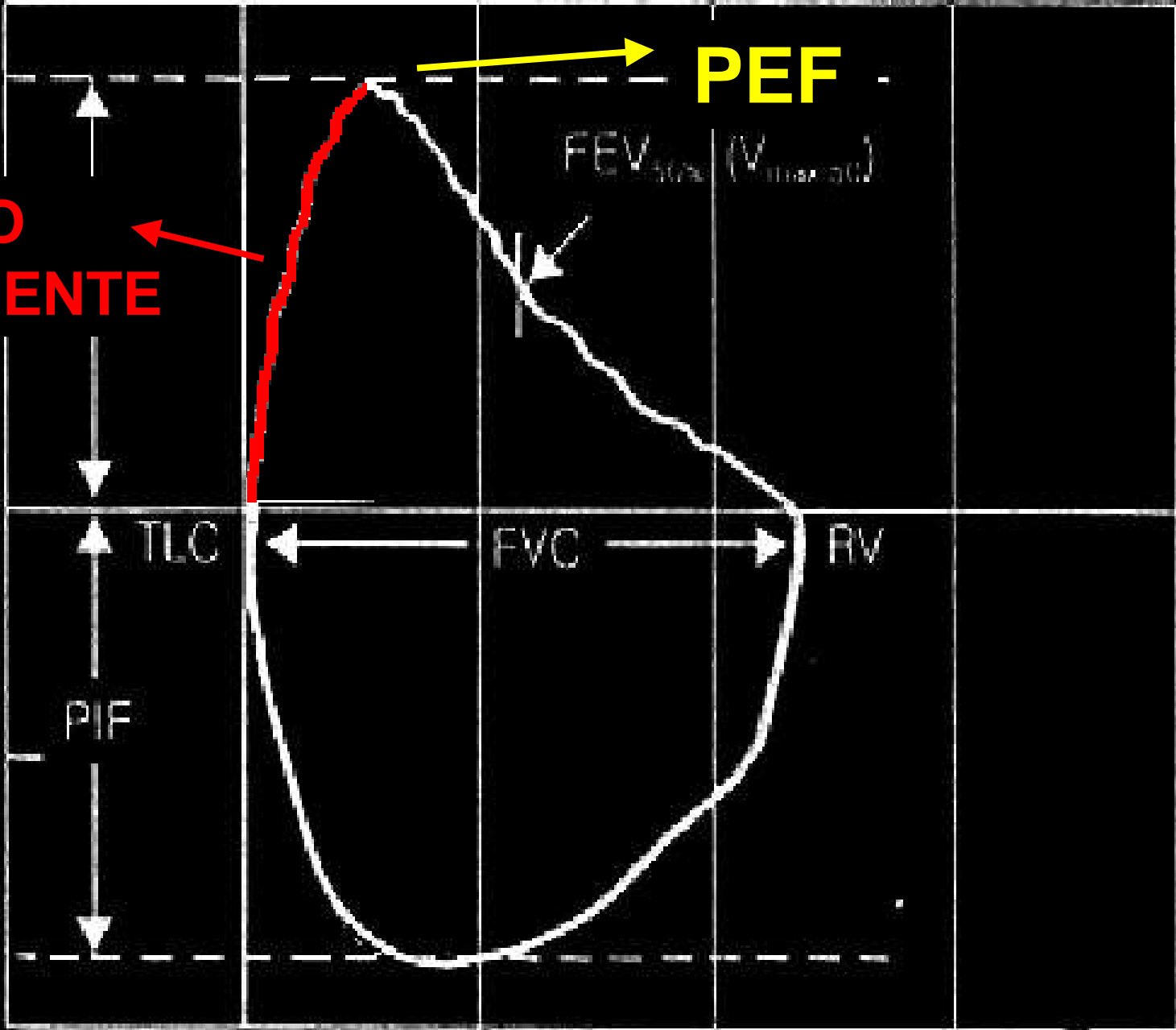
0

2

4

6

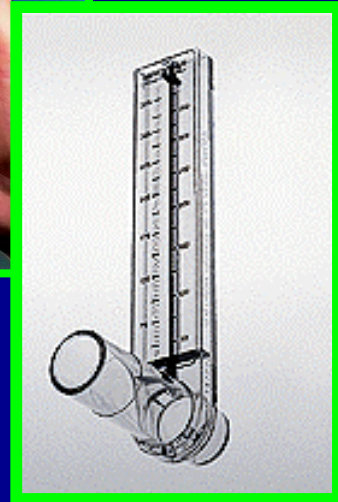
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VALUTAZIONE PEF E PCEF



VALUTAZIONE PEF E PCEF



VALUTAZIONE PEF E PCEF



INDICI DI TOSSE INEFFICACE

1. FASE DI INSPIRAZIONE

$CV < 1500 \text{ ml}$ (20 – 30 % predetto)

Bach JR et al. Respir Care 1997

2. FASE DI COMPRESSIONE

$PCEF = PEF$

Suarez AA et al. Am J Phys Med Rehabil 2002

3. FASE DI ESPULSIONE

$MEP < 40 \text{ cmH}_2\text{O}$

$PCEF \leq 3 \text{ L / sec}$

Szienberg A et al. Chest 1988

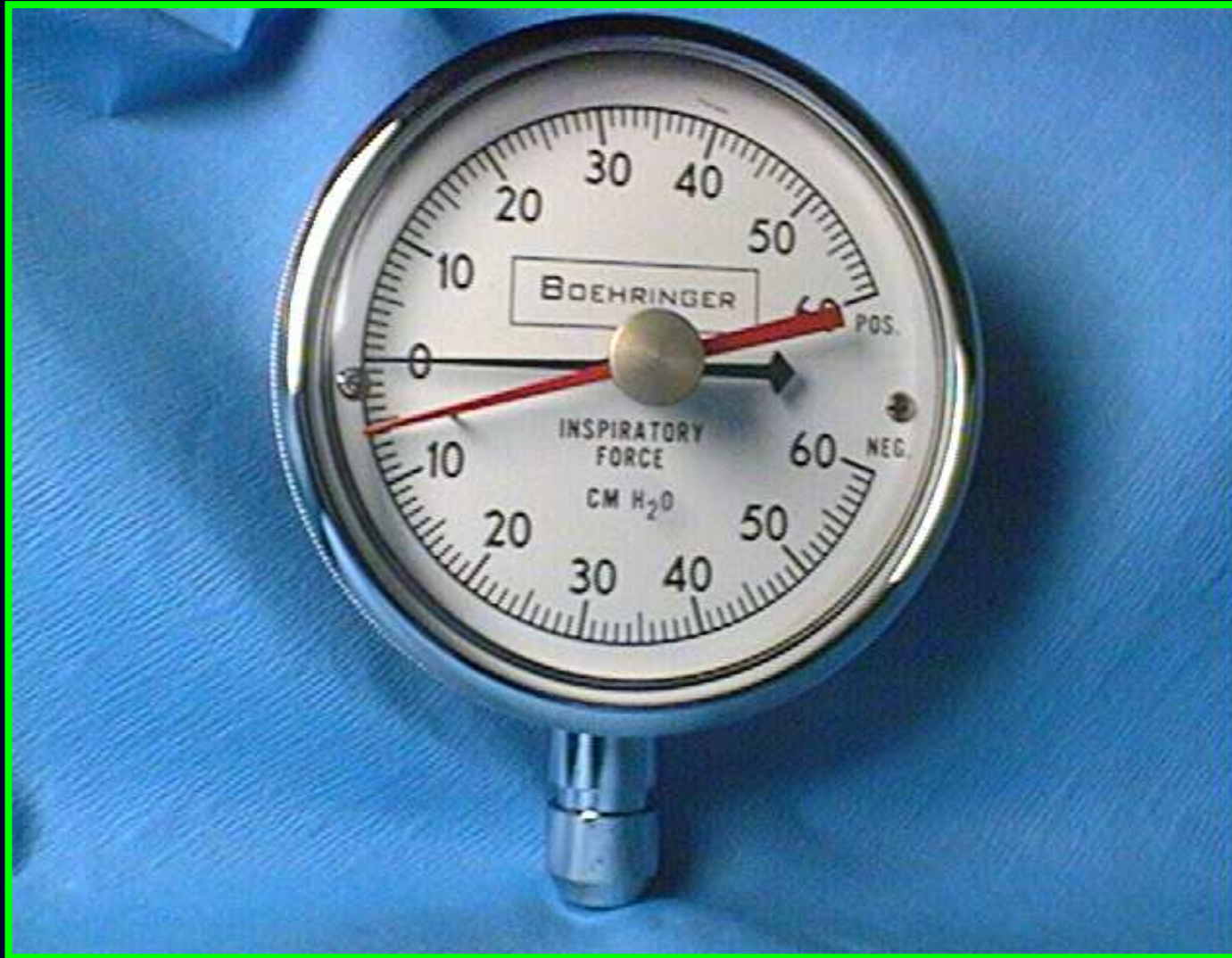
Bach JR et al. Arch. Phys Med Rehabil 1993

LE PRESSIONI RESPIRATORIE MASSIMALI

LE MASSIME PRESSIONI
INSPIRATOIRE ED ESPIRATORIE
(**MIP E MEP**) RIFLETTONO IL
MASSIMO SFORZO COMBINATO DI
TUTTI I MUSCOLI RISPETTIVAMENTE
INSPIRATORI ED ESPIRATORI

MISURAZIONE:

- ✓ **MANOMETRO**
- ✓ **TRASDUTTORE DIFFERENZIALE DI PRESSIONE**
- ✓ **(VALVOLA AD ACQUA)**



MANOMETRO

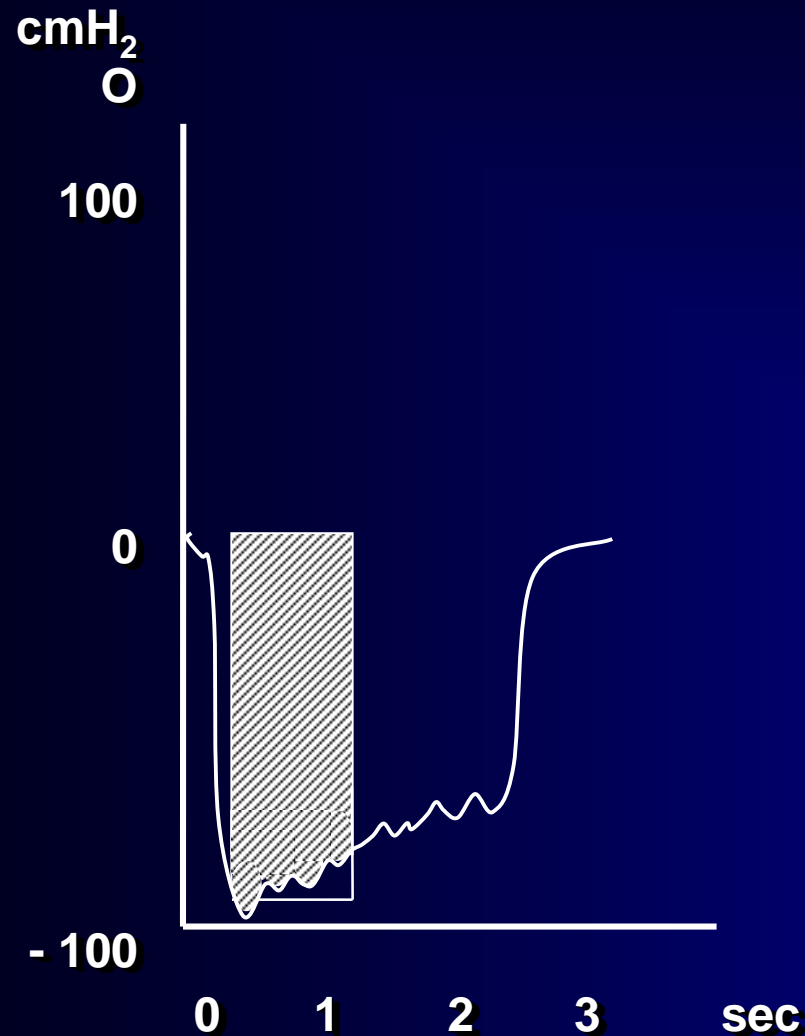


TRASDUTTORE DIFFERENZIALE DI PRESSIONE

MAXIMAL INSPIRATORY PRESSURE (MIP)

LA **MIP** È LA MASSIMA PRESSIONE NEGATIVA CHE PUÒ ESSERE MISURATA ALL'APERTURA DELLE VIE AEREE QUANDO UN SOGGETTO INSPIRA A VIE AEREE OCCLUSE DA VOLUME RESIDUO (RV) O DA CAPACITÀ FUNZIONALE RESIDUA (FRC)

MIP



LO SFORZO
INSPIRATORIO DEVE
ESSERE SOSTENUTO
PER ALMENO 3 SEC.
VIENE CALCOLATO IL
VALORE MEDIO DI
PRESSIONE MANTENUTA
PER ALMENO 1 SEC.

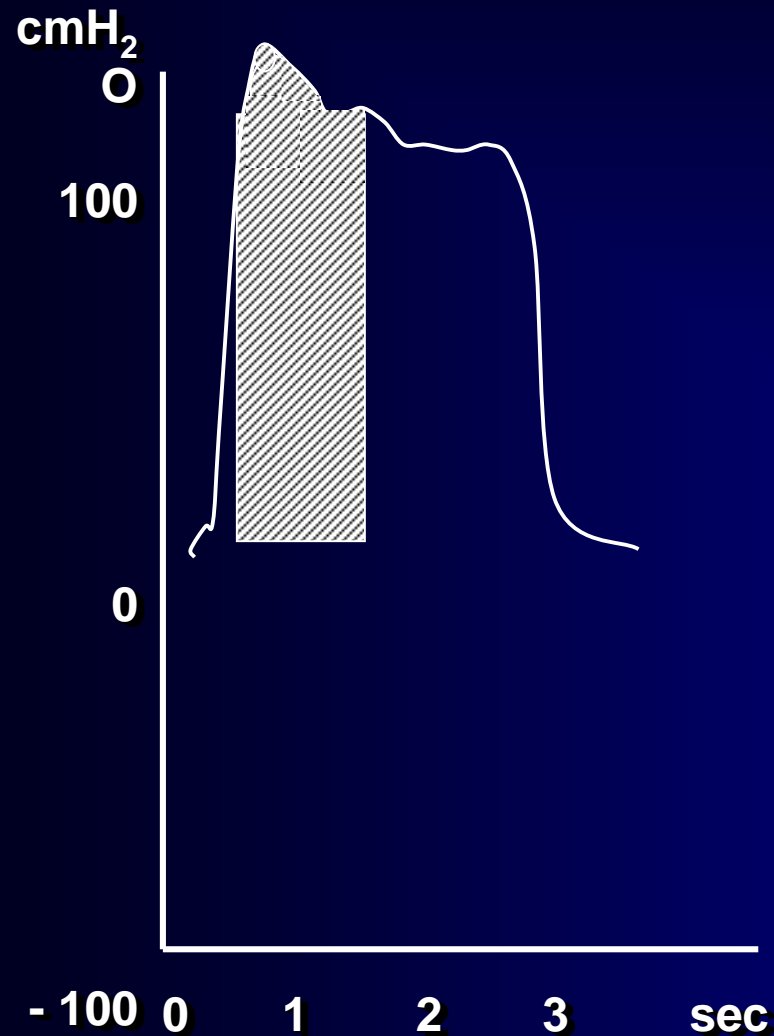
MIP: ESECUZIONE DELLA PROVA

- ✓ **ESEGUITA IN POSIZIONE SEDUTA**
- ✓ **IL NASO DEVE ESSERE CHIUSO MEDIANTE UN TAPPANASO**
- ✓ **NEL BOCCAGLIO DEVE ESSERE PREVISTO UN PICCOLO FORO (2MM)**
- ✓ **DEVE ESSERE PRECEDUTA DA UN BREVE SEDUTA DI APPRENDIMENTO DELLA MANOVRA**
- ✓ **DEVE ESSERE RIPETUTA ALMENO 5 VOLTE E VIENE SCELTO IL RISULTATO MIGLIORE**
- ✓ **IL SOGGETTO DEVE ESSERE VIGOROSAMENTE INCITATO**
- ✓ **E' UTILE L'IMPIEGO DI UN FEED-BACK VISIVO**
- ✓ **DEVE ESSERE POSTA MOLTA CURA NELL'INDIVIDUAZIONE DI EVENTUALI FUGHE D'ARIA DALLA BOCCA**
- ✓ **VENGONO CONSIDERATE VALIDE SOLO LE PRESSIONI MANTENUTE PER ALMENO 1 SEC**

MAXIMAL EXPIRATORY PRESSURE (MEP)

LA **MEP** È LA MASSIMA PRESSIONE POSITIVA CHE PUÒ ESSERE MISURATA ALL' APERTURA DELLE VIE AEREE QUANDO UN SOGGETTO ESPIRA A VIA AEREE OCCLUSE DA CAPACITÀ POLMONARE TOTALE (TLC) O DA CAPACITÀ FUNZIONALE RESIDUA (FRC)

MEP

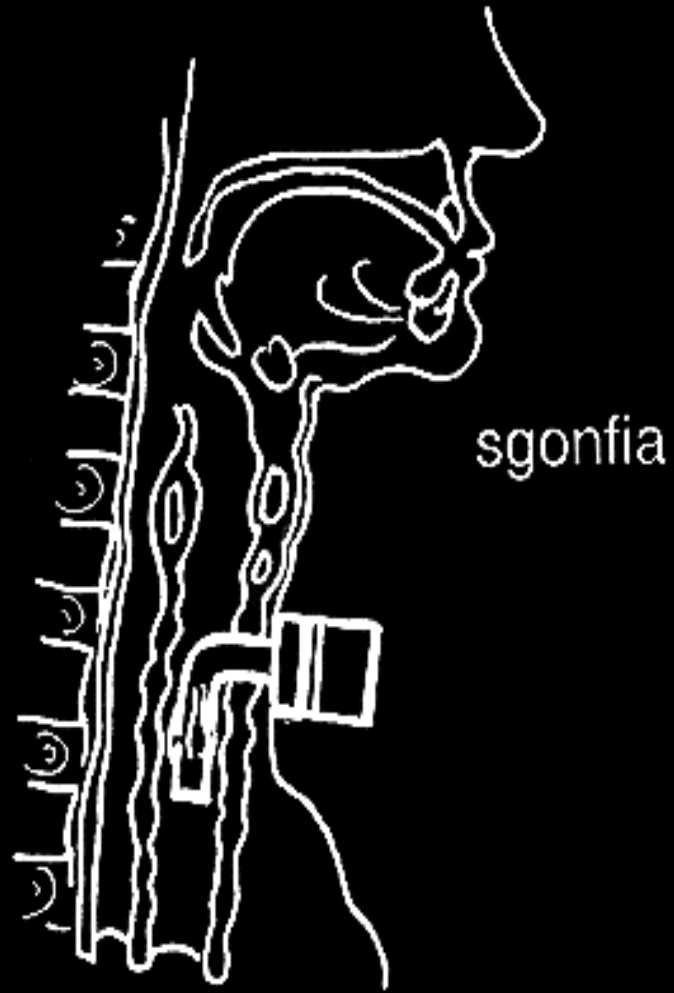


LO SFORZO
ESPIRATORIO DEVE
ESSERE SOSTENUTO
PER ALMENO 3 SEC.

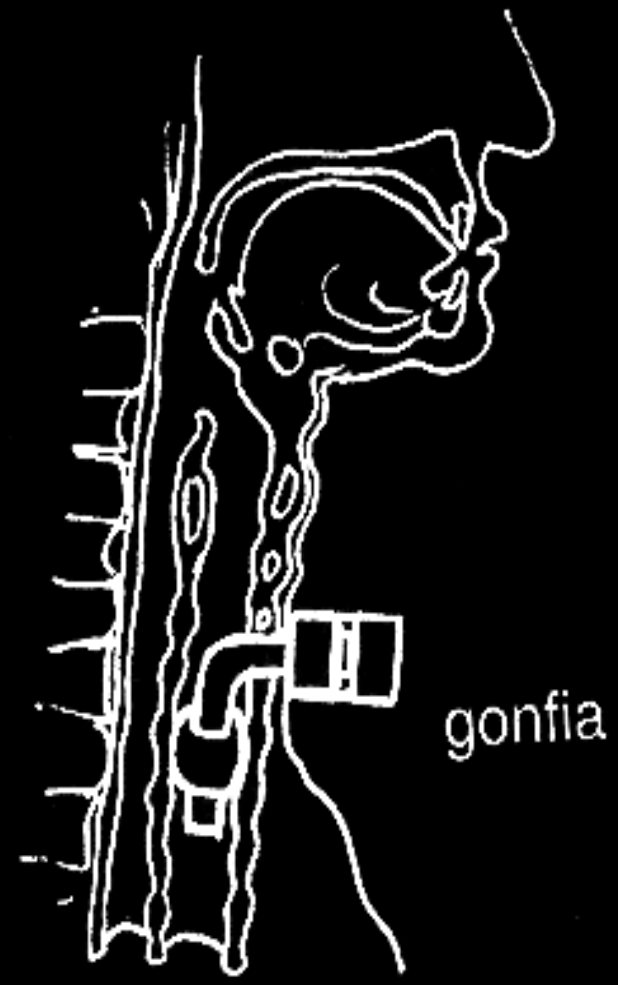
VIENE CALCOLATO IL
VALORE MEDIO DI
PRESSIONE
MANTENUTA PER
ALMENO 1 SEC.

MEP: ESECUZIONE DELLA PROVA

- ✓ **ESEGUITA IN POSIZIONE SEDUTA**
- ✓ **IL NASO DEVE ESSERE CHIUSO MEDIANTE UN TAPPANASO**
- ✓ **COMPRIMERE LE GUANCE DURANTE LO SFORZO ESPIRATORIO**
- ✓ **DEVE ESSERE PRECEDUTA DA UN BREVE SEDUTA DI APPRENDIMENTO DELLA MANOVRA**
- ✓ **DEVE ESSERE RIPETUTA ALMENO 5 VOLTE E VIENE SCELTO IL RISULTATO MIGLIORE**
- ✓ **IL SOGGETTO DEVE ESSERE VIGOROSAMENTE INCITATO**
- ✓ **E' UTILE L'IMPIEGO DI UN FEED-BACK VISIVO**
- ✓ **DEVE ESSERE POSTA MOLTA CURA NELL'INDIVIDUAZIONE DI EVENTUALI FUGHE D'ARIA DALLA BOCCA**
- ✓ **VENGONO CONSIDERATE VALIDE SOLO LE PRESSIONI MANTENUTE PER ALMENO 1 SEC**



cannula tracheale
con cuffia



✓ I VALORI PIU' ELEVATI DI **MIP**
SI OTTENGONO A PARTIRE DA
RV

✓ I VALORI PIU' ELEVATI DI **MEP**
SI OTTENGONO A PARTIRE DA
TLC

**VALORI
NORMALI
(cmH₂O)**

**VALORI
MARCATAMENTE
PATOLOGICI
(cmH₂O)**

MISURE	MASCHI	FEMMINE	
MIP	100-140	70-110	≤ 30
MEP	200-250	130-170	≤ 40

MIP

	maschi	femmine
Ringquist (1966)	129.4 (31.5)	97.8 (24.4)
Black e Hyatt (1969)	123.2 (21.3)	86.6 (15.2)
Rochester (1983)	126.3 (27.5)	90.6 (24.4)
Leech et al. (1983)	113.2 (35.6)	72.3 (26.9)
Wilson et al. (1984)	105.9 (30.5)	73.3 (21.3)
Winken et al. (1987)	104.9 (25.4)	70.3 (23.4)
Bruschi et al.(1992)	119.9 (36.5)	83.7 (30.3)

MEP

	maschi	femmin e
Ringquist (1966)	238.1 (45.6)	163.9 (29.5)
Black e Hyatt (1969)	232.1 (41.7)	151.7 (26.5)
Rochester (1983)	215.2 (44.8)	137.4 (68.2)
Leech et al. (1983)	153.8 (81.4)	93.7 (32.6)
Wilson et al. (1984)	147.6 (33.6)	92.6 (16.3)
Winken et al. (1987)	139.5 (37.7)	88.6 (23.4)
Bruschi et al.(1992)	139.8 (30.16)	95.3 (20.1)

UOMO

$126 - 1.028 \times \text{age} + 0.343 \times \text{weight (Kg)} \pm (22.4)$

DONNA

$171 - 0.694 \times \text{age} + 0.861 \times \text{weight (Kg)} - 0.743 \times \text{height (cm)} \pm (18.5)$

Raida I e coll. Am J Respir Crit Care Med 158:1459-1468,1998

CONCLUSIONI

- ✓ **MIP E MEP SONO UTILI INDICATORI DELLA FORZA DEI MUSCOLI RESPIRATORI IN TOTO**
- ✓ **SONO VALORE IN PARTE CORRELATO ALL'ETÀ, AL SESSO E ALLE CARATTERISTICHE ANTROPOMETRICHE DEL SOGGETTO**
- ✓ **E' NECESSARIO CONSIDERARE I VOLUMI POLMONARI A CUI LE PRESSIONI VENGONO ESEGUITE**
- ✓ **LA MISURAZIONE INFRASOGGETTO RISULTA ESSERE QUELLO IN GRADO DI FORNIRE LE INFORMAZIONI MAGGIORMENTE AFFIDABILI E UTILI**

The Unidirectional Valve Is the Best Method To Determine Maximal Inspiratory Pressure During Weaning*

Caruso, Pedro MD; Friedrich, Celena RT; Denari, Silvia DC RT; Ruiz, Soraia AL RT;
Deheinzelin, Daniel MD, PhD, FCCP

Objectives: Although maximal inspiratory pressure (MIP) is used as an index of inspiratory muscular strength, there is no consensus on how to measure it. We compared, during weaning from mechanical ventilation, two methods of measurement to determine which shows the greater values (MIP_{best}) and is more reproducible. One method measured MIP when negative pressure was maintained for at least 1 s after a forceful expiration, and the other method measured MIP with a unidirectional expiratory valve (MIP_{uni}).

Design: The study had a crossover design, and patients randomly performed three measurements of each method (t1). The procedure was repeated by the same observer after 20 min (t2). The maximal value in each method was considered.

Setting: ICU, Hospital A.C. Camargo, Sao Paulo, Brazil.

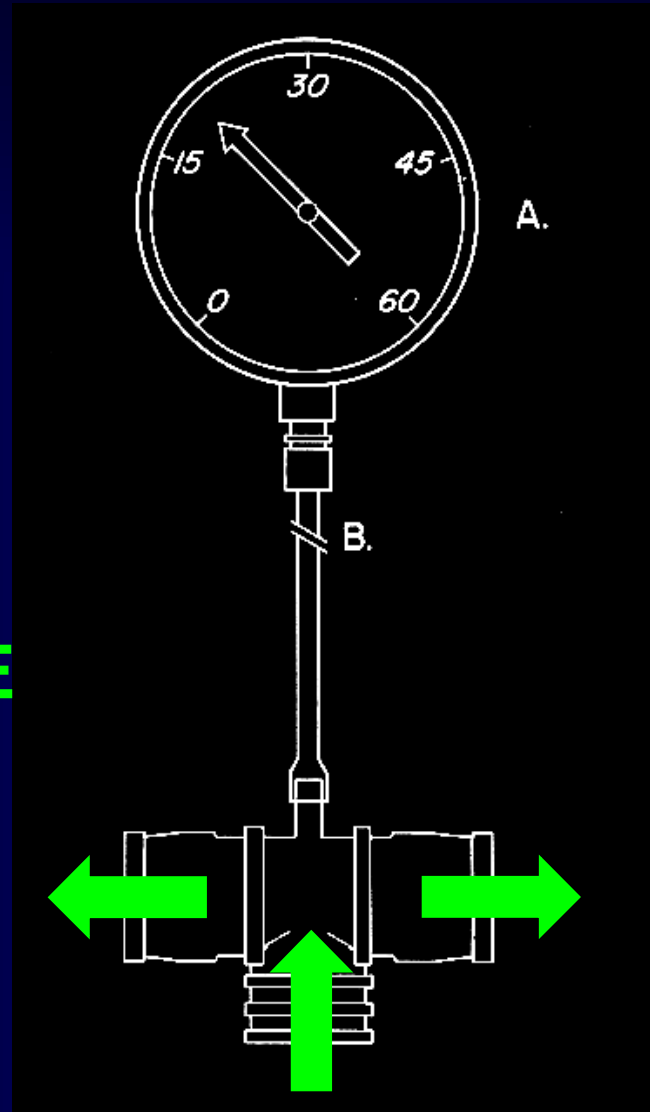
Patients: Fifty-four consecutive patients undergoing short-term mechanical ventilation who became eligible for the study when their physicians decided to restore spontaneous breathing.

Results: MIP_{best} values were arrived at using MIP_{uni} 75% of the time either in t1 or t2. MIP_{uni} yielded a higher average of MIP_{best} values in t1 and t2 ($p < 0.0001$). The effort-to-effort coefficient of variation of one method compared with the other during t1 and t2 was similar ($p > 0.2$ for t1; $p > 0.8$ for t2). Also, when comparing t1 and t2, the coefficients of variation were similar for each method ($p > 0.62$).

Conclusions: Because MIP_{uni} displayed the maximal values, it is the best method for estimating MIP in patients undergoing short-term mechanical ventilation. The reproducibility of consecutive measurements was similar between the methods, even after a short period of time.

MISURAZIONE MIP

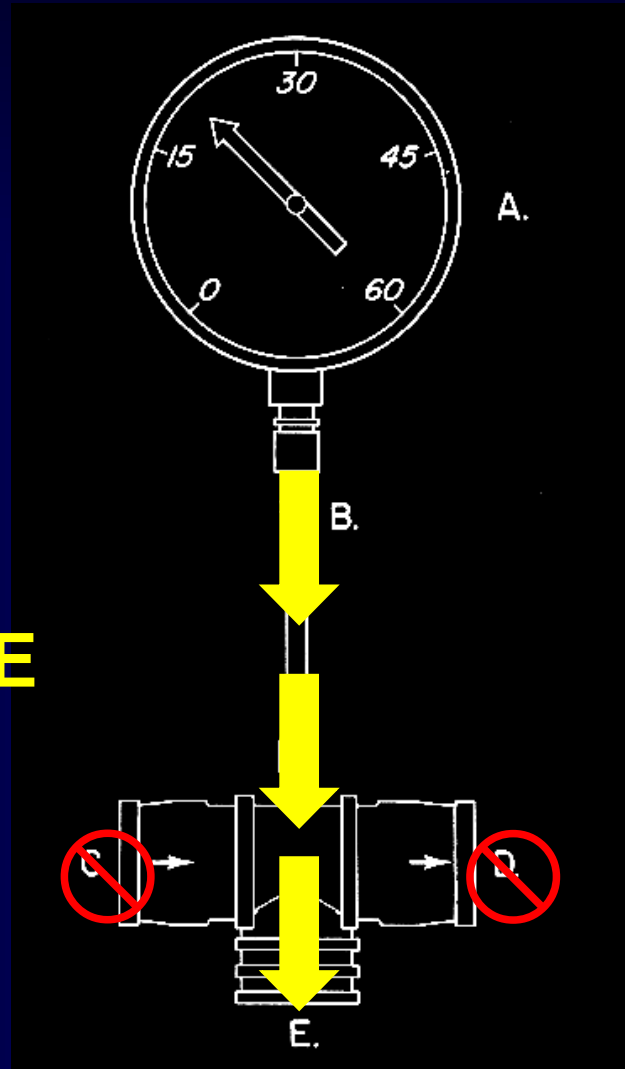
ESPIRAZIONE



PAZIENTE

MISURAZIONE MIP

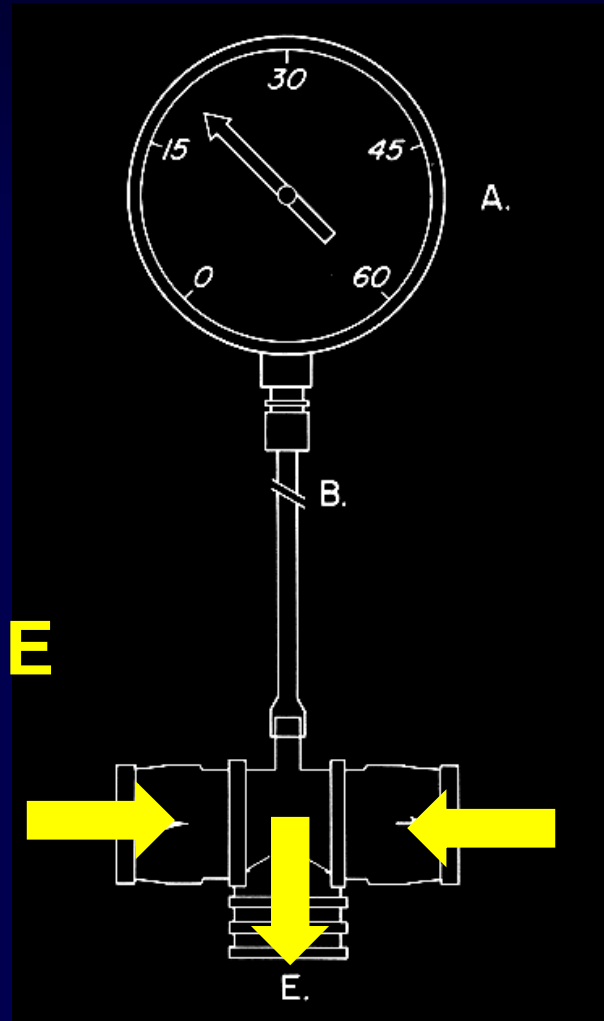
INSPIRAZIONE



PAZIENTE

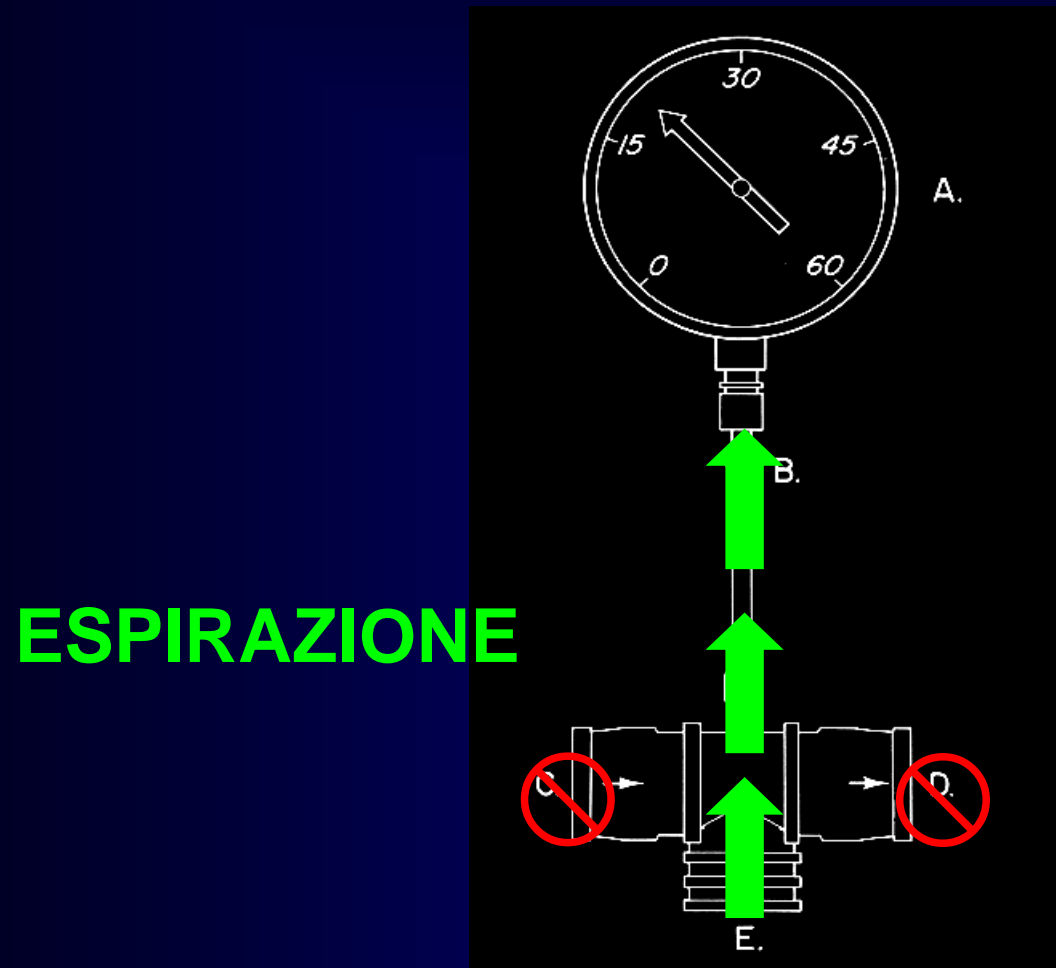
MISURAZIONE MEP

INSPIRAZIONE

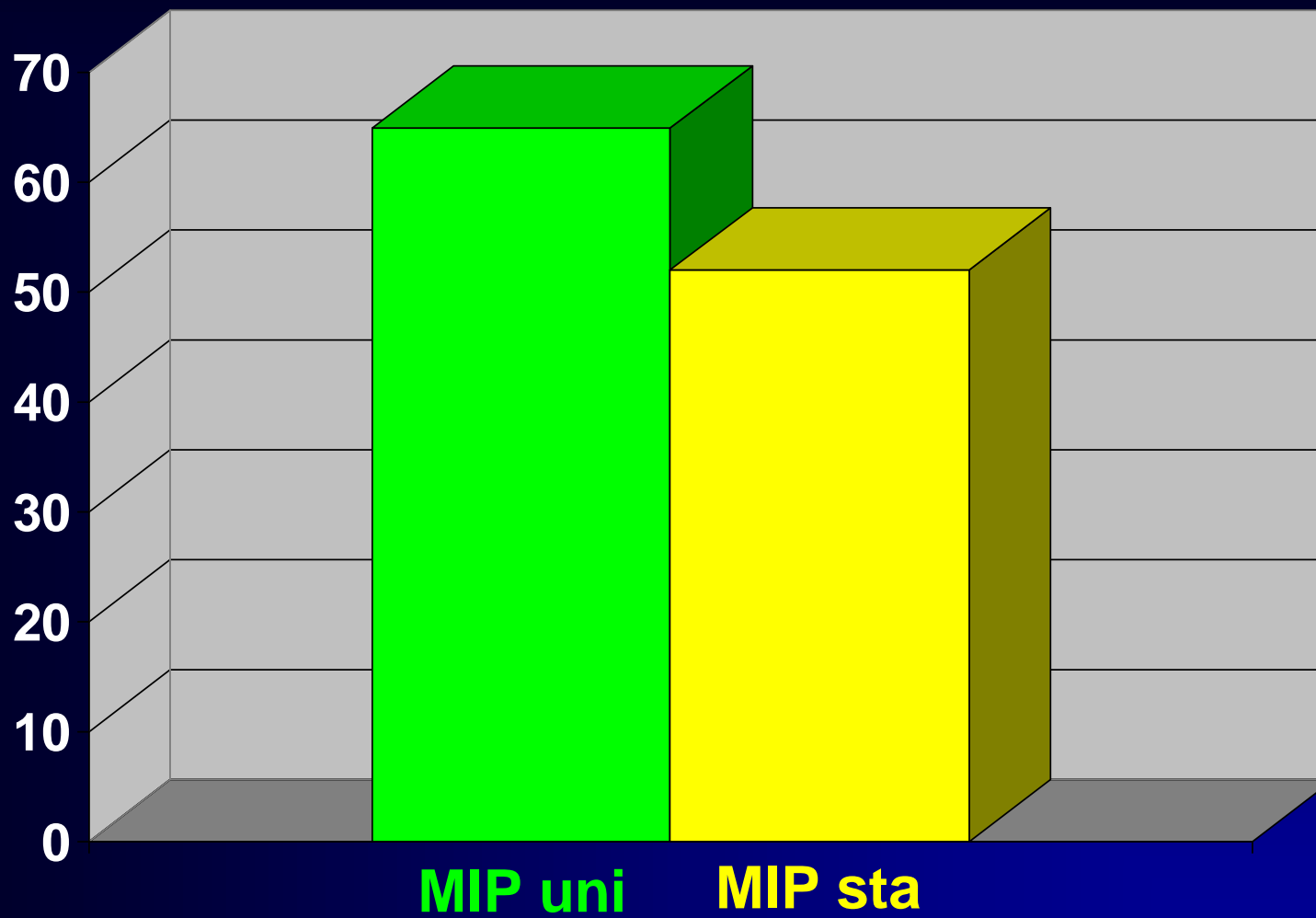


PAZIENTE

MISURAZIONE MEP



PAZIENTE



CARUSO: CHEST, VOLUME 115(4).APRIL 1999.1096-1101

Maximal Expiratory Pressures in Spinal Cord Injury Using Two Mouthpieces*

Tully, Keith BA; et al

Study objective: A technique for assessing expiratory muscle strength is the measurement of maximal expiratory pressure (PE_{max}). Previous studies have shown that a tube-style mouthpiece yields greater PE_{max} values than a flange-style mouthpiece because the latter technique is limited by the strength of the buccal muscles. In individuals with weak muscles of exhalation, this limitation may not apply because the strength of their buccal muscles may exceed that of the respiratory muscles.

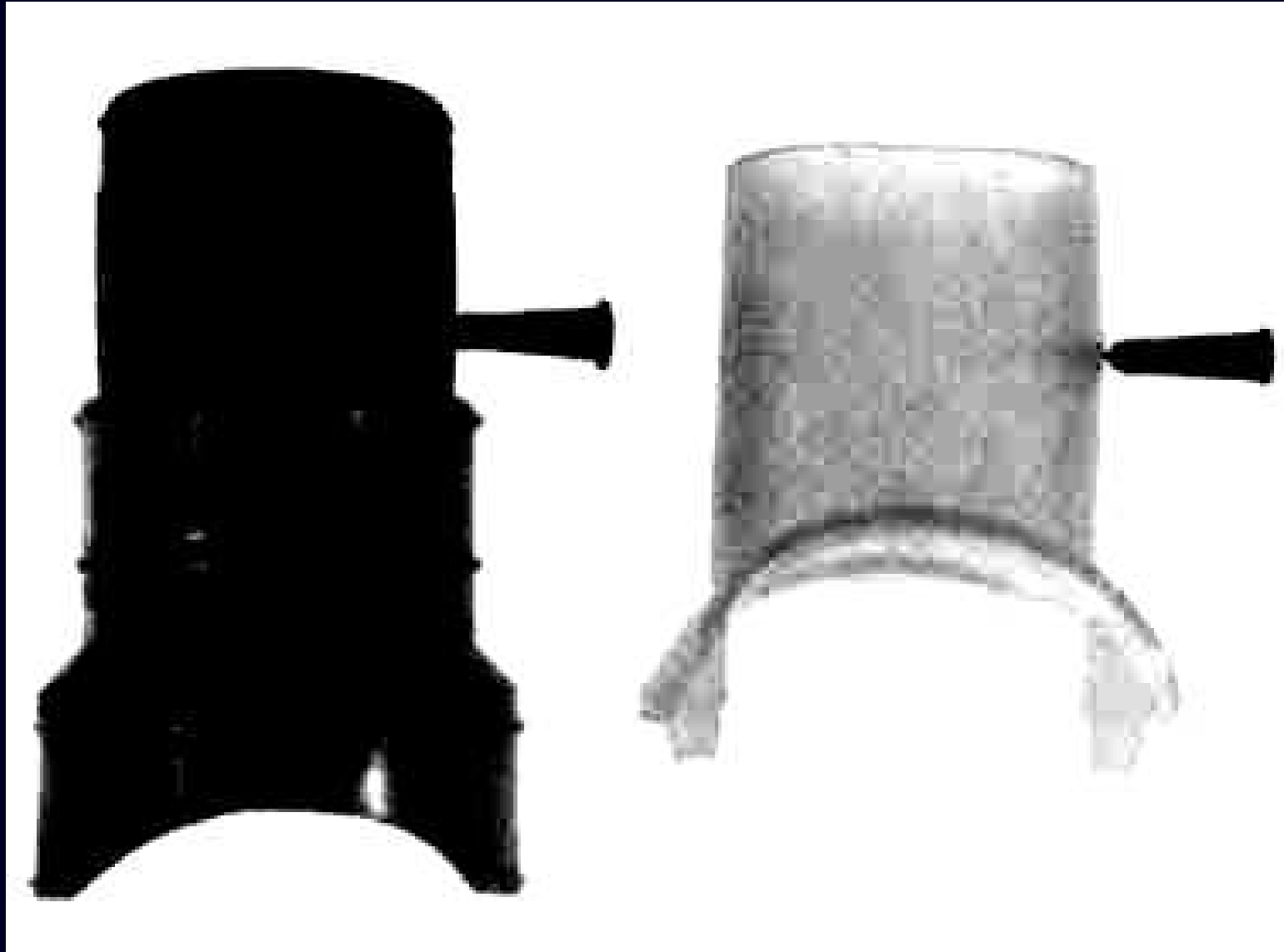
Design: A tube-style mouthpiece and flange-style mouthpiece were used to measure PE_{max}. The order of the mouthpiece used in testing was alternated between subjects and the greatest values obtained after three efforts were compared.

Setting: Department of Veterans Affairs Medical Center.

Participants: Fifty subjects with chronic spinal cord injury without acute medical illnesses recruited from veterans and the community.

Results: The mean difference between PE_{max,tube} and PE_{max,flange} was 20.7 +/- 26.4 cm H₂O (p=0.0001). Differences were negligible in those with the weakest muscles of exhalation but were substantial even in some quadriplegic subjects.

Conclusion: Even in individuals with neuromuscular disorders, errors in assessment of expiratory strength occur when a flange-style mouthpiece is used, and we recommend that this technique be abandoned in the measurement of PE_{max}. (CHEST 1997; 112:113-16)



Tully: Chest, Volume 112(1).July 1997.113-116

How Many Maneuvers Are Required to Measure Maximal Inspiratory Pressure Accurately*

Wen, Andrew S. MD et coll

Objective: To determine whether performing more maximal inspiratory pressure (MIP) maneuvers per test provides a more accurate assessment of the true maximal inspiratory strength.

Design: Review of MIP data from 367 tests. Each subject was encouraged to perform 20 MIP maneuvers per test, unless the patient reached the highest measurable pressure three times, or because of poor cooperation, fatigue, or respiratory distress. From the same raw data, MIP was calculated in two ways: (1) the "short MIP" was defined as the average of the first three highest values with $\leq 5\%$ variability; the results from further maneuvers were ignored; and (2) the "long MIP" is defined as the average of the three highest values with $\leq 5\%$ variability from all recorded maneuvers.

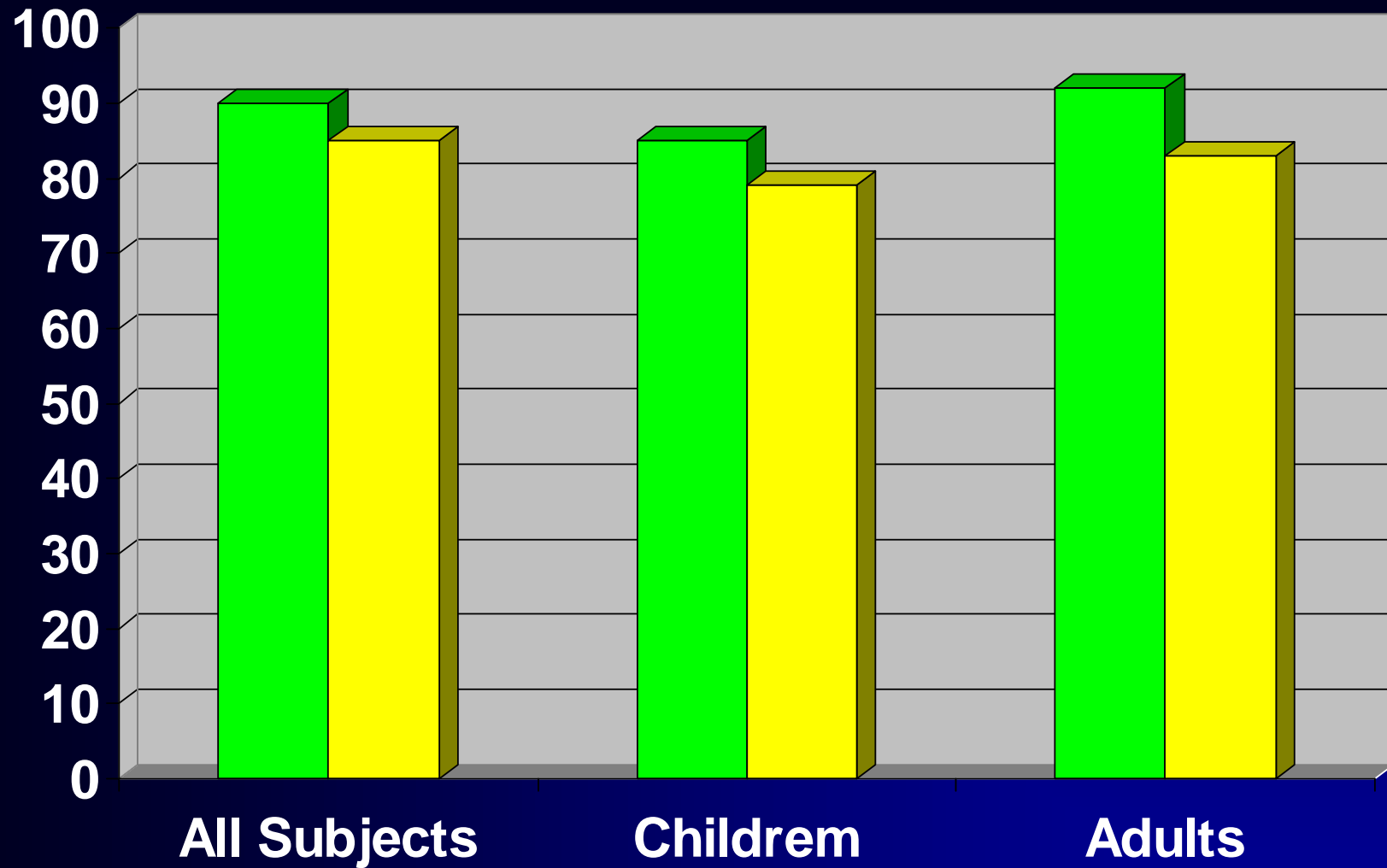
Setting: Pulmonary Physiology Laboratory, Childrens Hospital Los Angeles.

Participants: One hundred seventy-eight pediatric and adult subjects (age, 14 \pm 3 [SD] years; 53% male) with suspected inspiratory muscle weakness.

Measurements and results: The long MIP (91 \pm 39 cm H₂ O) was significantly greater than the short MIP (82 \pm 39 cm H₂ O) ($p < 0.000005$). In 177 of 367 tests, the short MIP underestimated the peak performance.

Conclusions: From the same raw data, the long MIP was significantly greater than the short MIP. In 48% of the tests, the short MIP method underestimated the peak performance determined by the long MIP method.

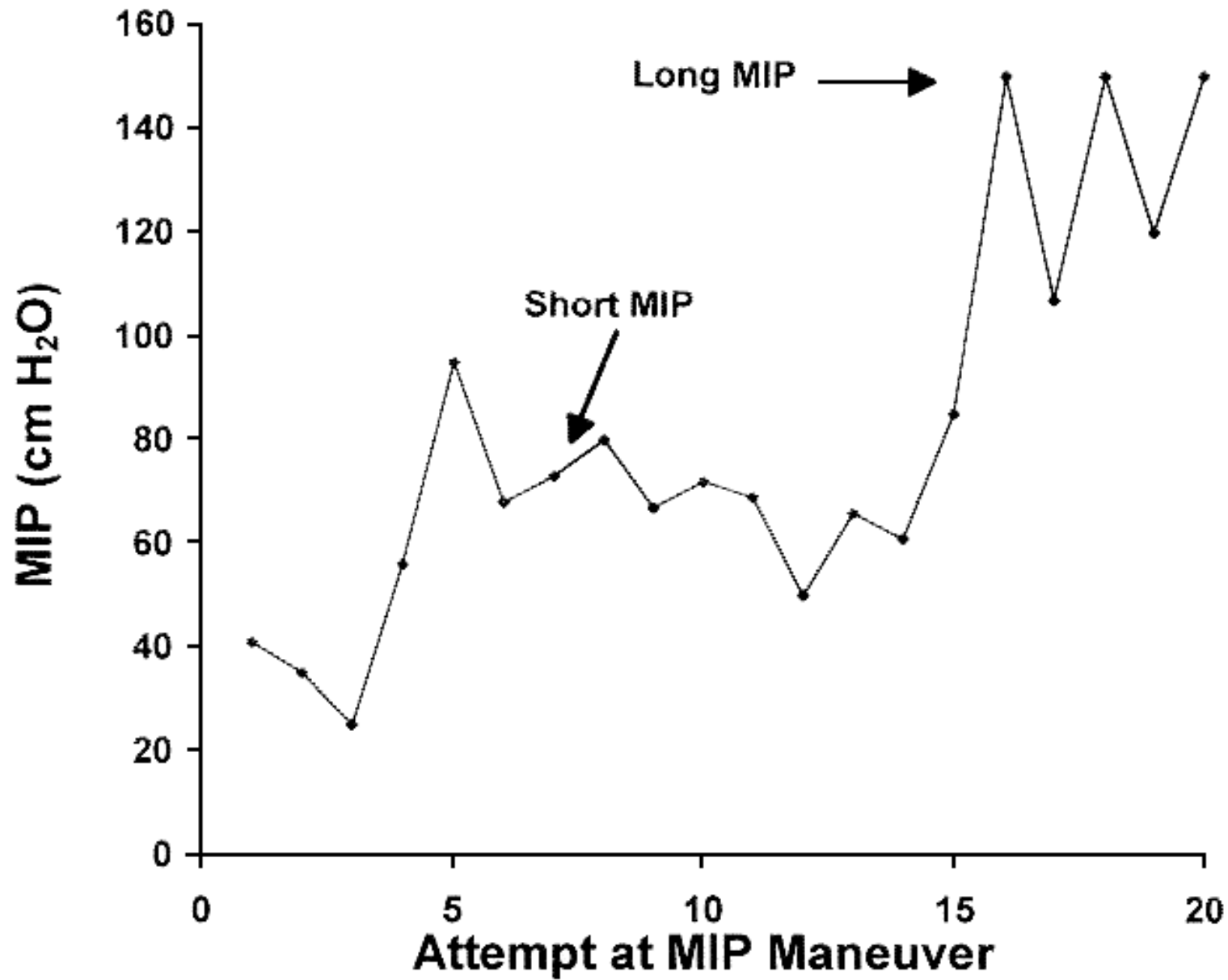
We speculate that the difference between the long MIP and the short MIP can be attributed to a learning effect. (CHEST 1997; 111:802-07)



 Long MIP

 Short MIP

Wen: Chest, Volume 111(3).March 1997.802-807



Wen: Chest, Volume 111(3).March 1997.802-807