Mechanical aids for secretion clearance

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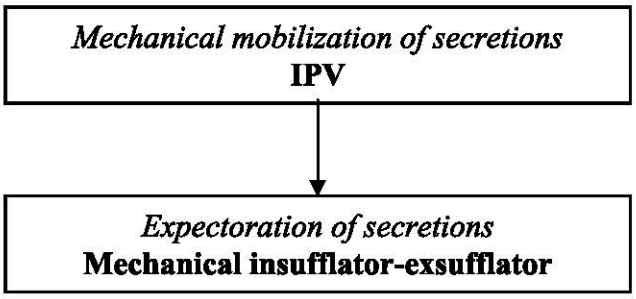
Introduction

The choice of the best mechanical aid for secretion clearance is depending on the topographic situation of the secretions. When secretions are in the proximal airways, high expiratory flows during coughing are required to expectorate. Mechanical aid to improve coughing is described elsewhere (see "Part 2: Mechanical insufflator-exsufflator" by Michelle Chatwin). When secretions are peripheral, secretions first need to be mobilized through the large proximal airways. This can be mechanically achieved by Intrapulmonary Percussive Ventilation (IPV).

Aim

The present lecture aims to explain how to set variables of IPV to mobilize secretions in NM patients.

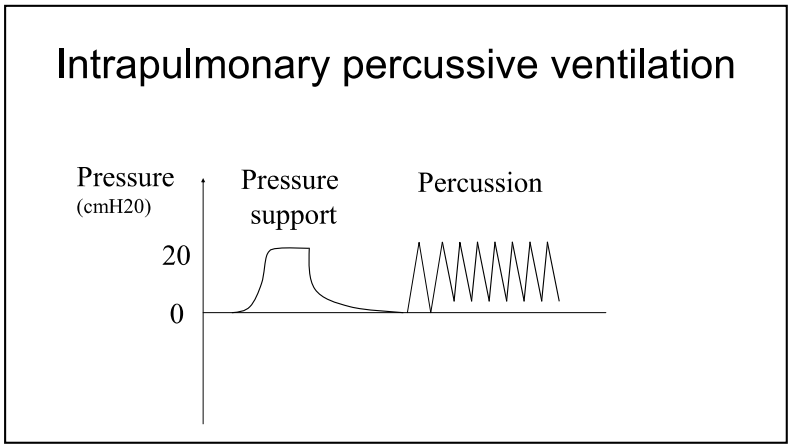


Mobilization of secretions

Mechanical mobilization of secretions may be supported by various techniques of chest physiotherapy such as *chest percussions* and *vibrations*, improved *regional ventilation*, *CPAP effect* and *nebulization*. IPV is a technique that combines these techniques in one device. NM patients wit respiratory muscle strength<50% predicted should benefit from mechanical mobilization of secretions *via* IPV without patient's effort.

What is IPV?

IPV is a technique of intermittent positive pressure breathing (IPPB) with some particularities. First, the respiratory rate is always at higher rate (60-400 cycles/min) than conventional IPPB. Second, the transient and sharp peaks of pressure contrast with "plateau" pressures from conventional IPPB techniques. These "percussive" peaks of pressure aim to mobilize secretions. IPV can be administered non-invasively *via* a face mask (ideal in NM patients) or invasively via tracheotomy or intubation.



IPV devices

Confusion is possible between devices for assisted ventilation in ICU (Percussionaire® VDR-3® and VDR-4®) and devices for chest physiotherapy (CP). Among specific devices for CP, 3 manufacturers propose IPV devices:

- Percussionaire-*USA* (Impulsator®, IPV1 and IPV2)
- Breas-*Sweden* (IMP2®)
- Dima-*Italy* (Pegaso®)

IPV in the literature

Benefits of IPV to mobilize secretions are not strongly evidence based. However adverse effects were not reported. Interestingly, recent publications have provided clinical interest of IPV in various conditions. Improved ventilation and oxygenation at lower peak pressure than conventional ventilation have been established in numerous papers. Improvement of atelectasis (1,2,3,4,5), reduction of chest infections (6,7), shortening of length of hospitalization (8), unloading respiratory work of breathing (9) and mucus mobilization (10) have been documented.

Variable of IPV – 3 buttons

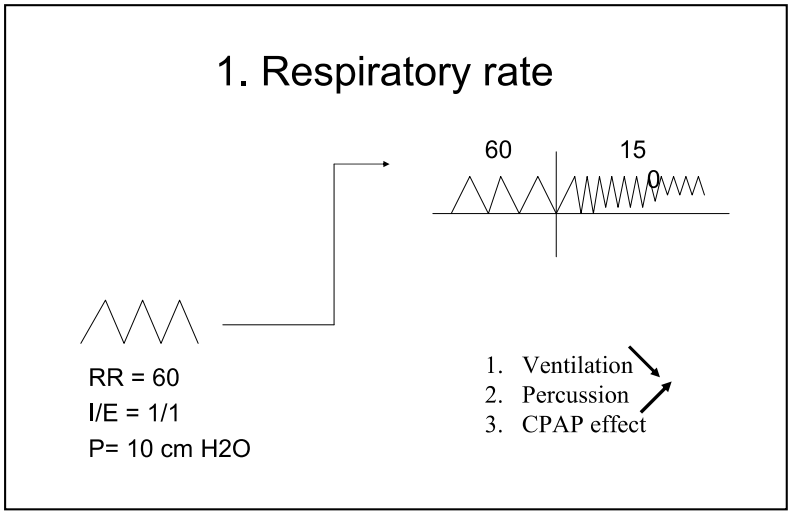
Three following 3 variables (= 3 buttons) are available on all IPV devices:

- **The respiratory rate (RR)**
- **The ratio of inspiratory on expiratory time (I/E)**
- **The pressure (P)**

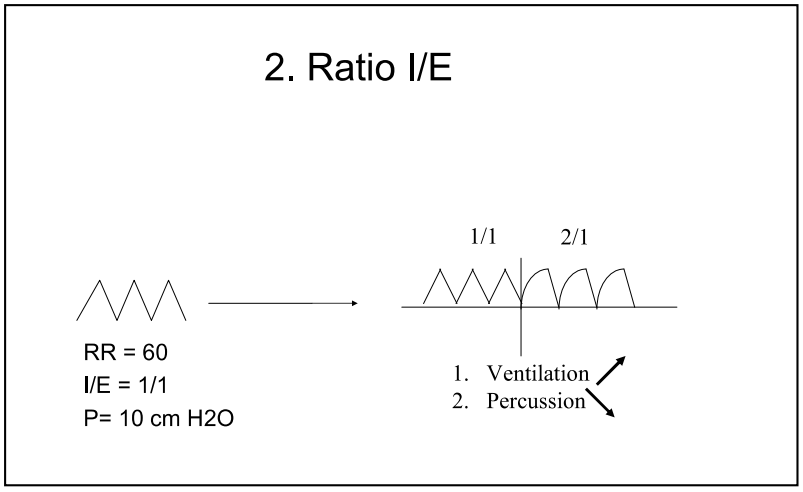
Effects of IPV

The effects of IPV and the work of breathing of patients during treatment with IPV are depending on the setting of the three variables (9,10).

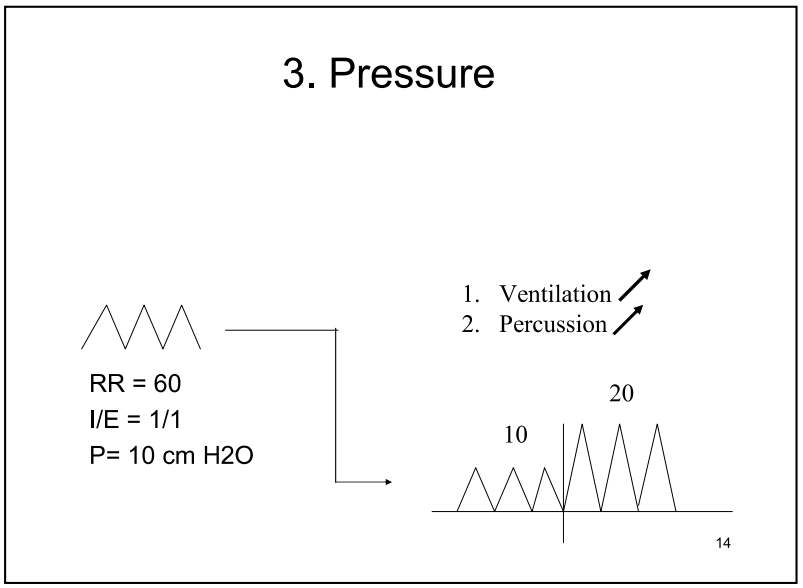
1. Increasing **RR** (ex: from 60 to 150 cycles/min) decreases the ventilation, increases the percussive effect and provides a slight CPAP effect.



2. Increasing the **ratio I/E** (ex: from 1/1 to 2/1) increases ventilation and decreases the percussive effect.

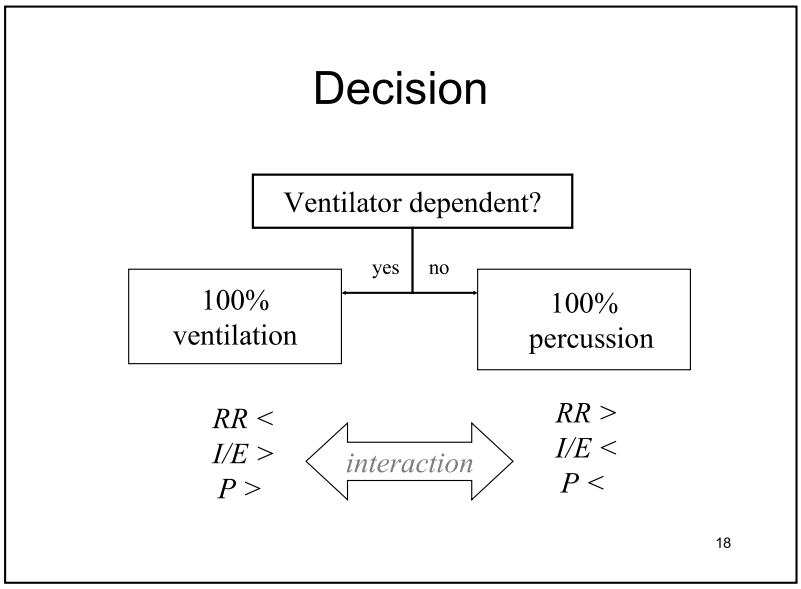


3. Increasing the peak of **pressure** (ex: from 10 to 20 cm H2O) increases both ventilation and percussion.



Decision of settings in practice

Before to set the variables on the IPV, the first question to ask is whether the patient is ventilator dependent or not.
If the answer is **YES**, the parameters may be initially adapted to provide full percussion (high RR, little I/E and P).
If the answer is **NO**, the parameters will initially be adapted to provide full ventilation (low RR, high I/E and P).



Examples of setting of variables on IPV

1. In a NM patient (1) receiving permanent mechanical ventilation and (2) affected by bronchitis, you may decide to start IPV as follows:

a) *The patient has no respiratory autonomy*: start with setting IPV on "ventilation" (low RR at 60-80/min, high I/E at 2/1, and P at 20 cm H2O). Look at the quality of ventilation (stable SpO2-PCO2 if available) and at the comfort of the patient to undergo IPV.
b) *The patient has secretions in the peripheral airways*: try to progressive turn the buttons into more percussion: increase RR *together with* decreasing I/E. If SpO2 decreases, you may increase the pressure to increase the ventilation of the IPV device.

2. In a NM patient without mechanical ventilation and mucus retention:
The patient has full respiratory autonomy: start with setting IPV on "percussion" (high RR at 150-180/min, low I/E at 1/1, and P at 5-10 cm H2O). Look at the comfort of the patient.

References

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4. Birnkrant DJ, Pope JF, Lewarski J et al. Persistent pulmonary consolidation treated with intrapulmonary percussive ventilation: a preliminary report. *Pediatr Pulmonol* 1996;21:246-9

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PG 19: Ventilatory management and cough enhancement in patients with NM disease

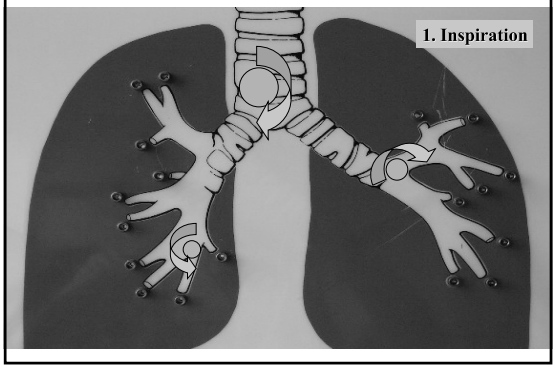
Mechanical aids for secretion clearance

Mobilization - M. Toussaint

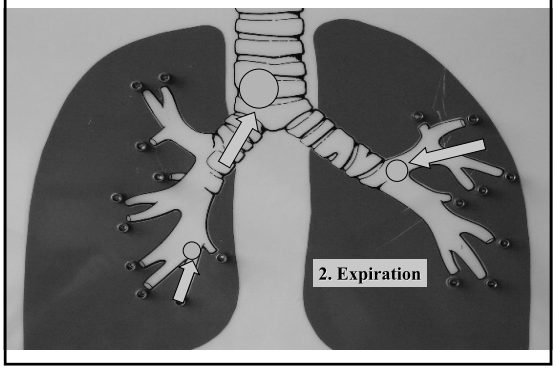
Expectoration – M. Chatwin

1

Mobilization

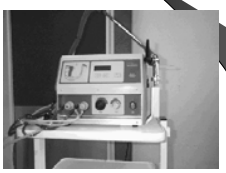


Mobilization



Intrapulmonary percussive ventilation

IPV



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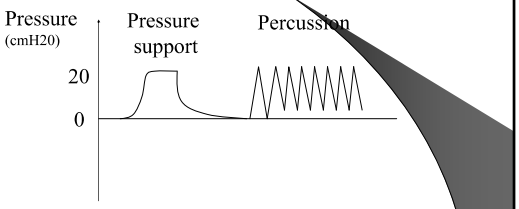
Intrapulmonary percussive ventilation



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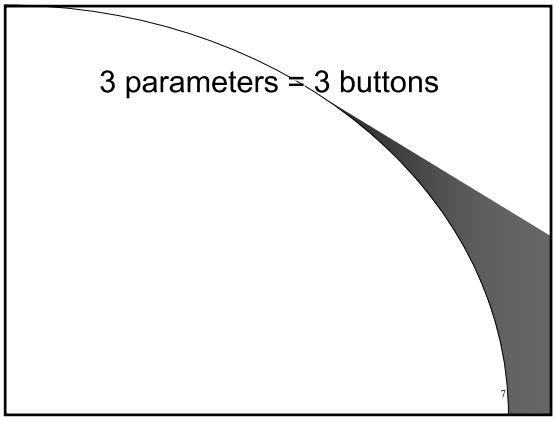
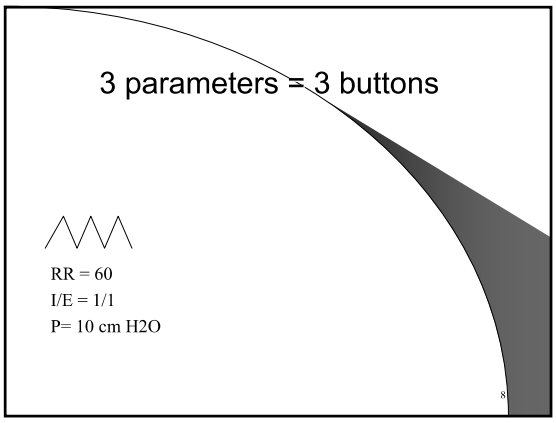
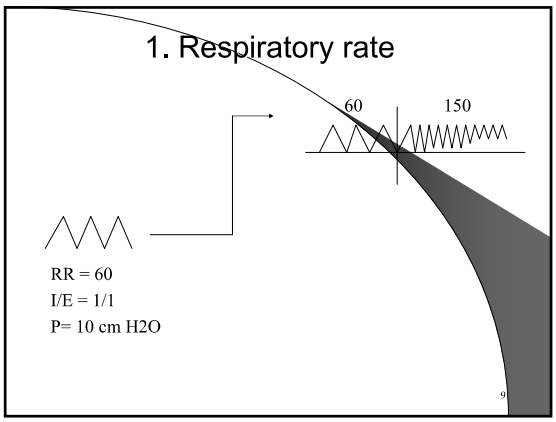
Expected effects of IPV:

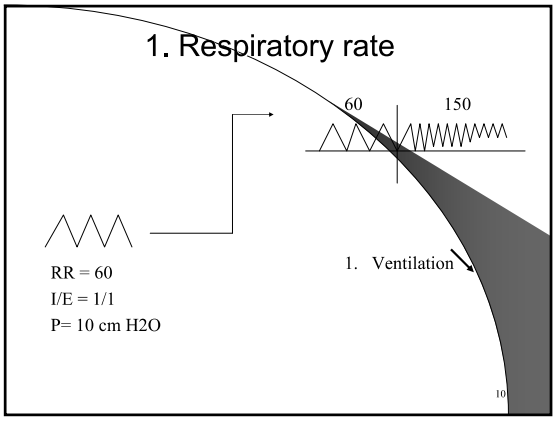
- Internal vibrations ranging 60-400/min
- Internal percussions = intrapulmonary clapping
- CPAP effect
- Nebulisation
- « Pressure Support » without the patient's effort
- Improved SpO2 and PaCO2

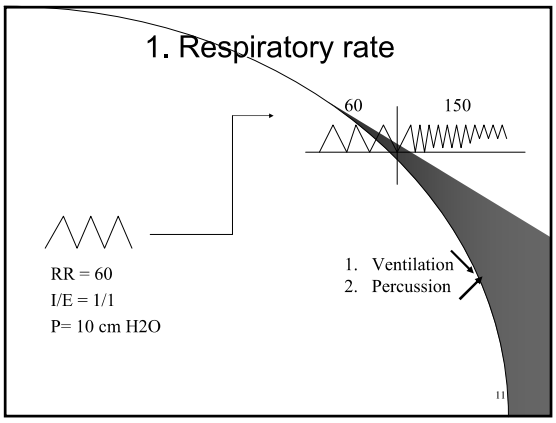
6

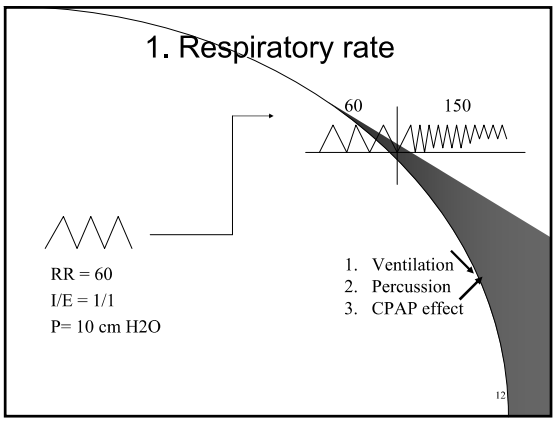

3 parameters = 3 buttons
7

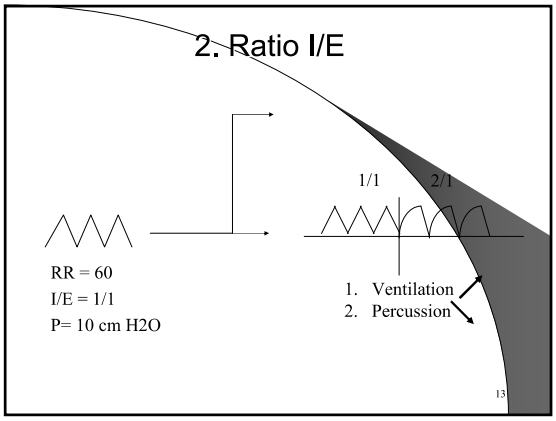

3 parameters = 3 buttons
RR = 60
I/E = 1/1
P= 10 cm H2O
8

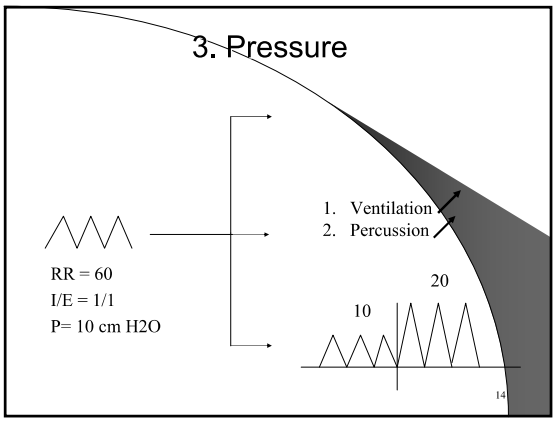

1. Respiratory rate
60
150
RR = 60
I/E = 1/1
P= 10 cm H2O
9

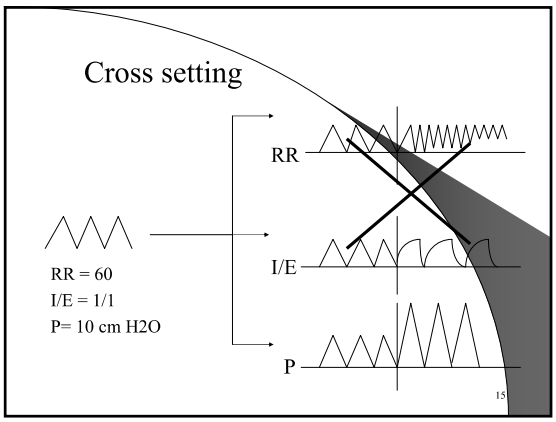

1. Respiratory rate
60
150
RR = 60
I/E = 1/1
P= 10 cm H2O
1. Ventilation
10

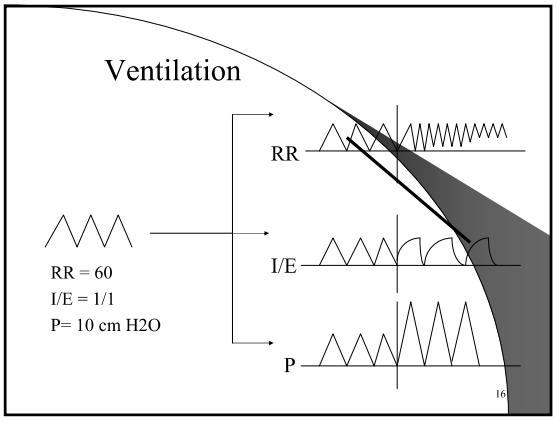

1. Respiratory rate
60
150
RR = 60
I/E = 1/1
P= 10 cm H2O
1. Ventilation
2. Percussion
11

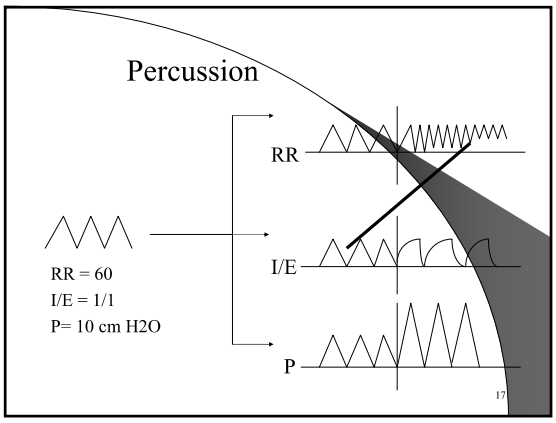

1. Respiratory rate
60
150
RR = 60
I/E = 1/1
P= 10 cm H2O
1. Ventilation
2. Percussion
3. CPAP effect
12

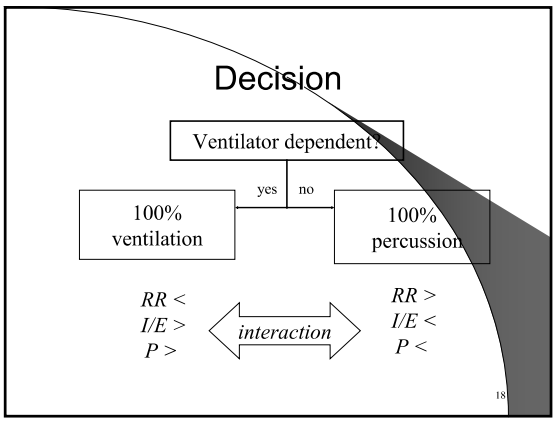

2. Ratio I/E
1/1
2/1
RR = 60
I/E = 1/1
P= 10 cm H2O
1. Ventilation
2. Percussion
13


3. Pressure
1. Ventilation
2. Percussion
RR = 60
I/E = 1/1
P= 10 cm H2O
20
10
14


Cross setting
RR
I/E
P
RR = 60
I/E = 1/1
P= 10 cm H2O
15


Ventilation
RR
I/E
P
RR = 60
I/E = 1/1
P= 10 cm H2O
16

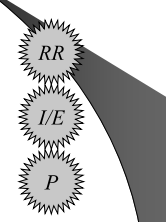

Percussion
RR
I/E
P
RR = 60
I/E = 1/1
P= 10 cm H2O
17


Decision
Ventilator dependent?
yes
no
100% ventilation
100% percussion
RR <
I/E >
P >
interaction
RR >
I/E <
P <
18

Case 1

IPV=ventilation

- Cong. MD
- 1 year old
- Permanent ventilation
- Tracheostomy
- Chronic mucus retention



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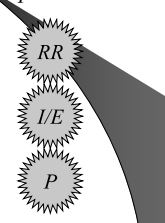
Case 2

IPV=percussion

- DMD
- 25 yrs old
- Nocturnal NIPPV
- Bronchitis



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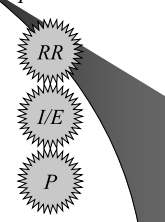
Case 3

IPV=percussion

- ALS, bulbar
- 70 yrs old
- VC>1.5L
- No NIPPV
- Chronic mucus retention



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Case 4

IPV=hyperinsufflation

- SMA 2
- 35 yrs old
- Nocturnal NIPPV

- Stable
- Chest stiffness
- No mucus retention

RR

I/E

P

22

High frequency
Rate: 240 min-1

The Pegaso ®:
IPV?

Low frequency
Rate: 90 min-1