


# Cape international 6 7 March Bruges 2012

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A. **Use of Deep Muscle Relaxation in Laparoscopic Bariatric Surgery: J P Mulier**

B. **Importance of Deep Muscle Relaxation for the Laparoscopic Surgeon: B Dillemans**

C. **Reversal of Neuromuscular Blockade (NMB) in Morbidly Obese Patients:** P Van Lancker

D. **Using ERAS (enhanced recovery after surgery) for Laparoscopic Bariatric Surgery: J P Mulier**

Jan Paul Mulier MD PhD

Anaesthesiologist

Sint-Jan Brugge-Oostende, Belgium

# A. Use of Deep muscle relaxation in laparoscopic surgery

1. Are surgeons right to complain of insufficient use of NMB during a pneumoperitoneum?

2. Impact of muscle relaxation on the abdominal compliance in normal and obese patients.

3. Need every laparoscopic procedure deep muscle relaxation till the end of surgery?

# Classical Indications for NMB

- Textbook indication for NMB:
  - To facilitate vocal records relaxation during endotracheal intubation.
  - To establish and maintain good surgical conditions: good relaxation of muscles within the surgical field.
  - NMB can sometimes be combined with a lighter level of anesthesia;
  - Profound NMB can avoid even the slightest patient movement when precision is critical

NMB=neuromuscular blockade.



iller RD. In: Miller's Anesthesia Seventh Edition, 2010, Churchill Livingstone

# Why are we trained to give insufficient NMB?

- Stop relaxation early to allow neostigmine to work
  - TOF two counts is deep enough?
- To prevent post operative bad respiration, low saturation, hypercarbia, respiratory failure.
- Rest relaxation is very anxious for the patient.
- Use spontaneous recovery to avoid neostigmine induced:
  - Bradycardia - total AV block
  - Bronchospasm
  - PONV

No reason now with Sugammadex

But some anesthesiologists question the use of NMB during laparoscopy now.

# Limited literature on the use of NMB during laparoscopy!

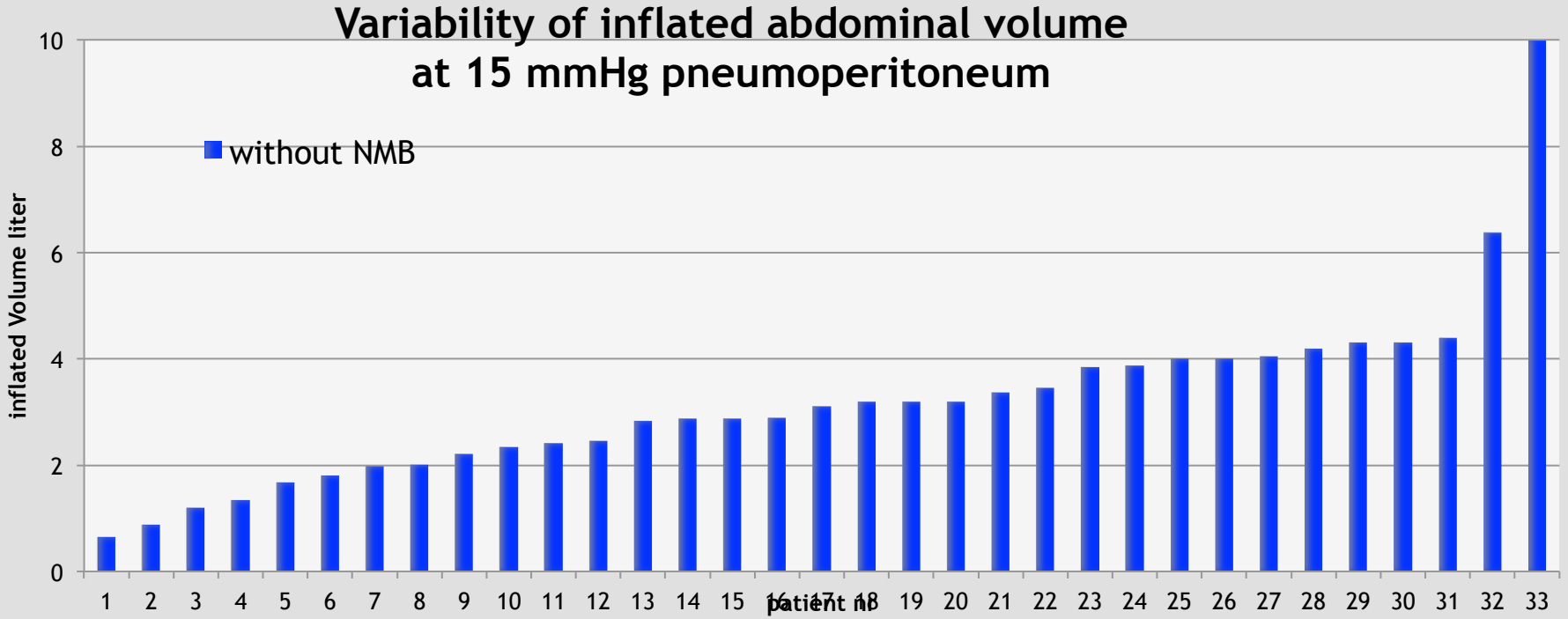
- The effects of NMB on peak airway pressure and abdominal elastance during pneumoperitoneum.
  - Chassard D Anesth Analg 1996; 82: 525
  - *Pigs have a non linear behaviour different from humans*
  - *Elastance is not changing either in humans*
- Gynecologic laparoscopy with or without curare?
  - Chassard D Ann Fr Anesth Reanim 1996; 15: 1013
  - *Surgeon was asked if he could work. Additional dose is given if he could not work*
- A comparison of the effect of two anaesthetic techniques on surgical conditions during gynaecological laparoscopy
  - Williams MT. Anaesthesia. 2003; 58: 574
    - *Without curare shorter operation, higher PVO, trocar placement difficult.*
- No supplemental muscle relaxants are required during propofol and remifentanil total intravenous anesthesia for laparoscopic pelvic surgery.
  - Peak CM J laparoendosc Adv Surg Tech 2009; 19: 33
    - *Effect is not measured .*

# Nevertheless: Surgical comments

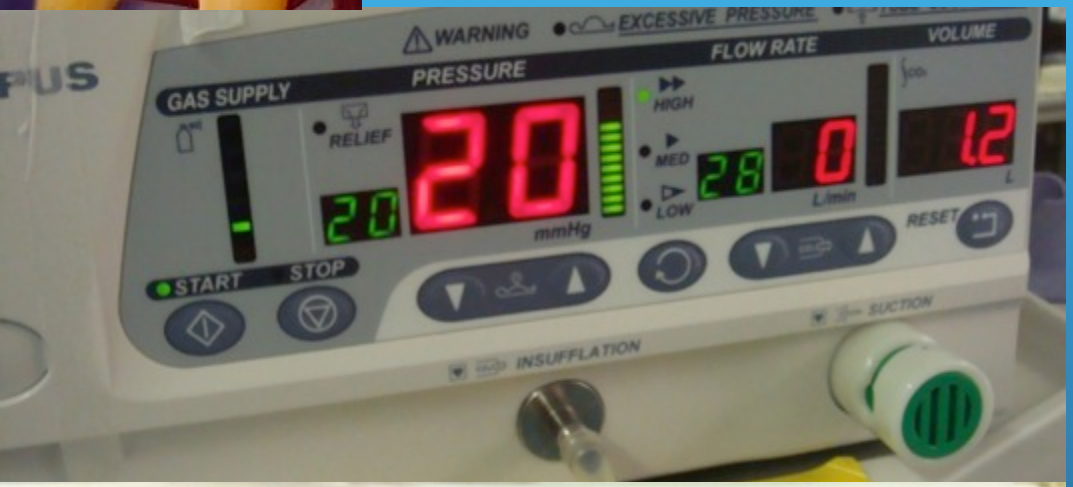
- Surgeons complain till they are tired or punished
  - I have no surgical workspace and the anesthesiologist is not willing to do anything!
  - Patient presses en still the anesthesiologist tells that the patient is relaxed. (he measures TOF = 0, I believe in what I see) !
  - Some anesthesiologists can give better relaxation than others. Why?
  - Anesthesiologist always wait with adding relaxation till it is too late and I have to complain!
  - Patient is moving at end of operation although recovery still takes a long time!
- But when anesthesiologist gives extra NMB frequently nothing changes and surgeon keeps complaining
  - Surgeons are punished by long turnover time due to slower reversal when high dose NMB are used at end.

# Patient variability

- Inflated volume at 15 mmHg without NMB varies from 0,5 L to 10 L.
- Who needs NMB?
- Will the surgeon be comfortable?



# Example: 1,2 L versus 7,2 L





Maximal NMB helps but is not sufficient alone

NMB needed? Depends on the IAP used?

# Pneumoperitoneum monitor connected between patient and inflator to measure E, the abdominal elastance and PV0, the pressure at zero volume according to the Mulier abdominal model.

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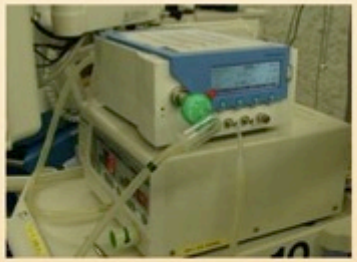
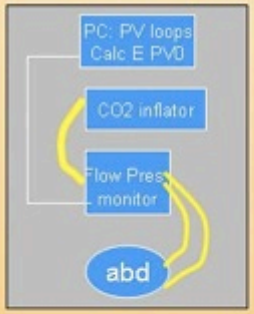
More info: www.publicationslist.com/jan.mulier

**Introduction and goal of the study.**

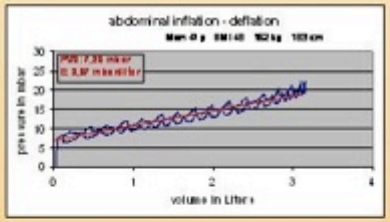
- Every patient has a different abdomen
- E and PV0 characterizes the abdomen
  - Setting the inflation pressure to reach a certain volume
  - Try to improve workspace
  - Decide to change to laparotomy
  - Understand why insufficient workspace
  - Improve lung ventilation
- Calculate automaticcally instead of manual
  - Faster
  - More accurate
  - P V loop gives more information

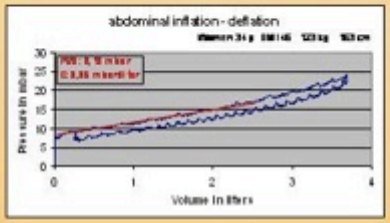
**Materials and Methods**

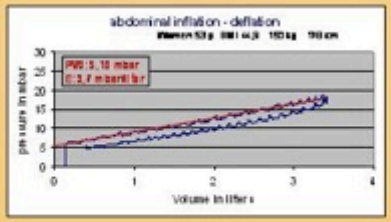





**Results: examples of measurements:**




**Conclusion**

- Monitor is possible but should be standardized.
- E and PV0 can be calculated
- Separate pressure monitoring line is needed.
- Relation not linear at higher pressure

**References**

1. Obes Surgery 2007; S
2. Anesth Analg. 2006;103:677-81.
3. Acta Clinica Belgica 2007; 62: SP8

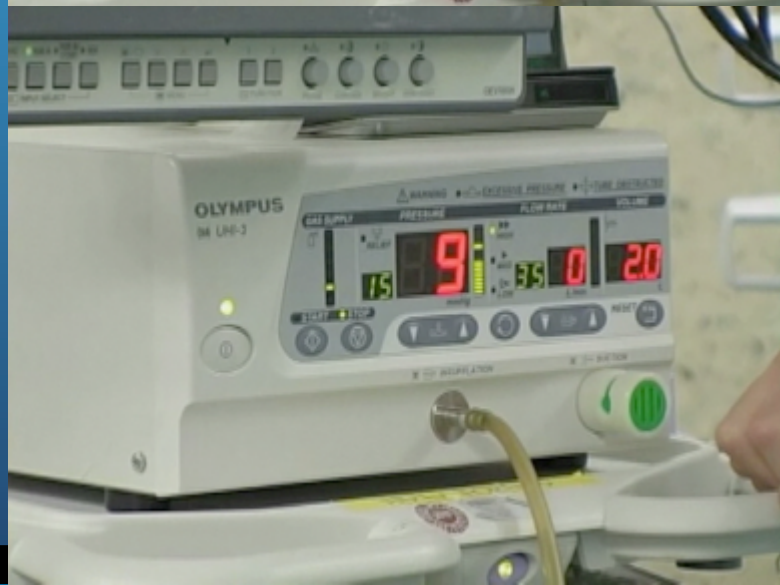
**Scientific exhibit: ASA Orlando Octobre 2008, USA**



Pressure volume loops
or
Simplified 3 points measurement
or
Look to max vol at 15

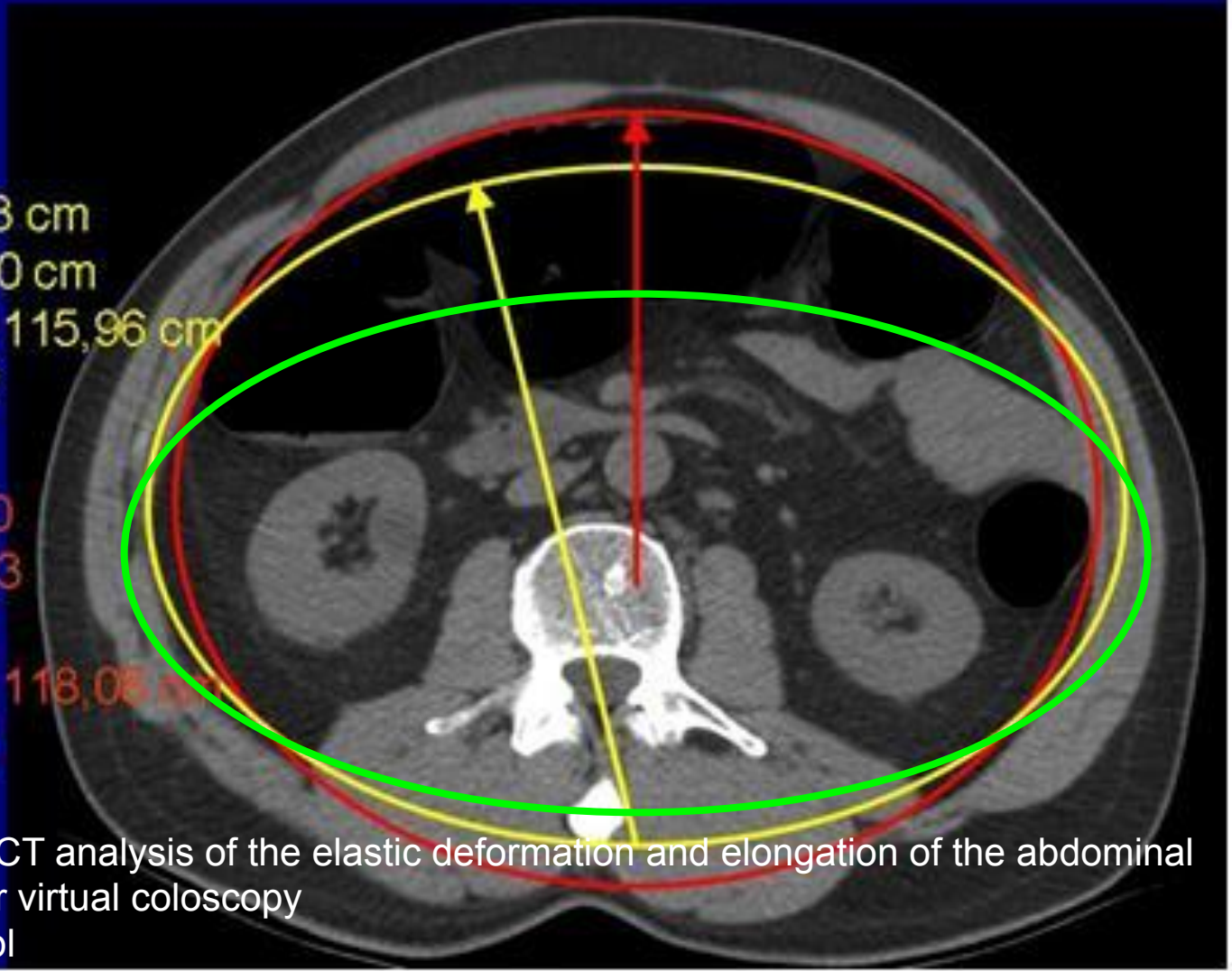
PV0 : 7

E: 1 mmHg/L

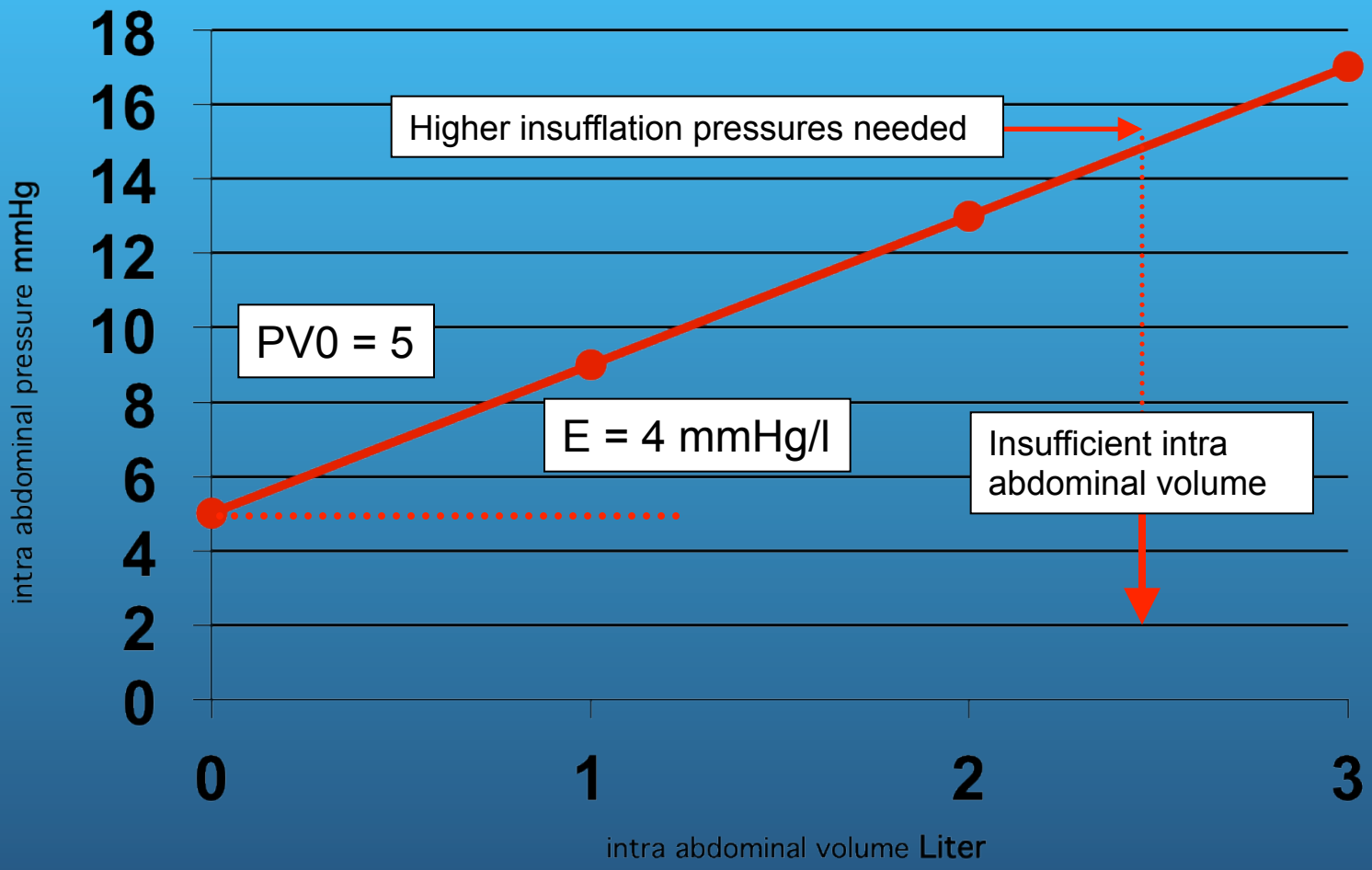
# Fitting of cross section abdomen when inflated at 15 (yellow) versus 25 (red) mmHg

- Yellow:
  - Long axis: 43,23 cm
  - Short axis: 30,00 cm
  - Circumference: 115,96 cm
  - Area: 1018 cm2
- Red:
  - Long axis: 40,80
  - Short axis: 34,23
  - Circumference: 118,05 cm
  - Area:1097 cm2



•Mulier J.P., Coenegrachts CT analysis of the elastic deformation and elongation of the abdominal wall during colon inflation for virtual coloscopy
Eur J Anesthesia 2008 Suppl

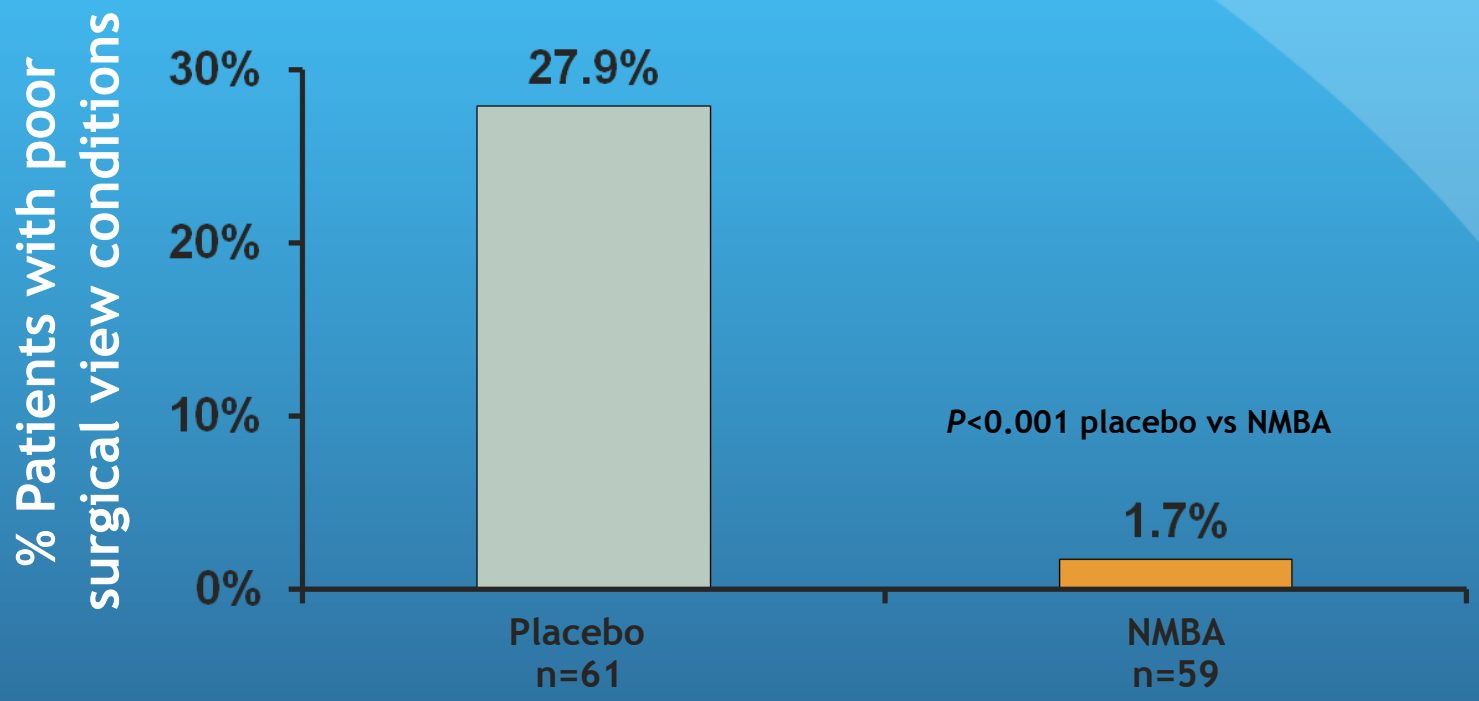
# Compliance (C) and Elastance (E)
# C=change in V/change in P (C= 1/E)




J Mulier, B Dillemans, M Crombach, C Missant, A Sels
On the abdominal pressure volume relationship.
*The Internet Journal of Anesthesiology. 2009; 21: 1.*

# Measuring abdominal compliance

# Use of NMBA is Associated With Decreased Frequency of Poor Surgical View Conditions[1,a]




[a] In a randomized, blinded, placebo-controlled study of 120 patients undergoing radical retropubic prostatectomy, patients received an infusion of NMBA (n=59) or saline (placebo, n=61) beginning 5 minutes after fascial incision. At 15 minute intervals, the surgical field was graded from 1 (excellent) to 4 (unacceptable). Patients who were graded as having an unacceptable surgical field received rescue NMBA.

NMBA=neuromuscular blocking agent.

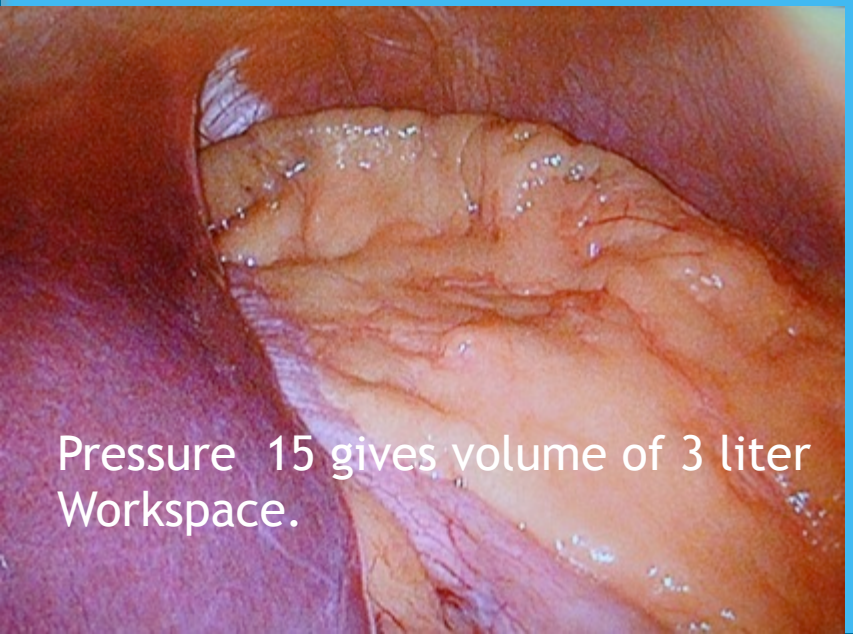


1. King M. *Anesthesiology*. 2000;93:1392–1397.

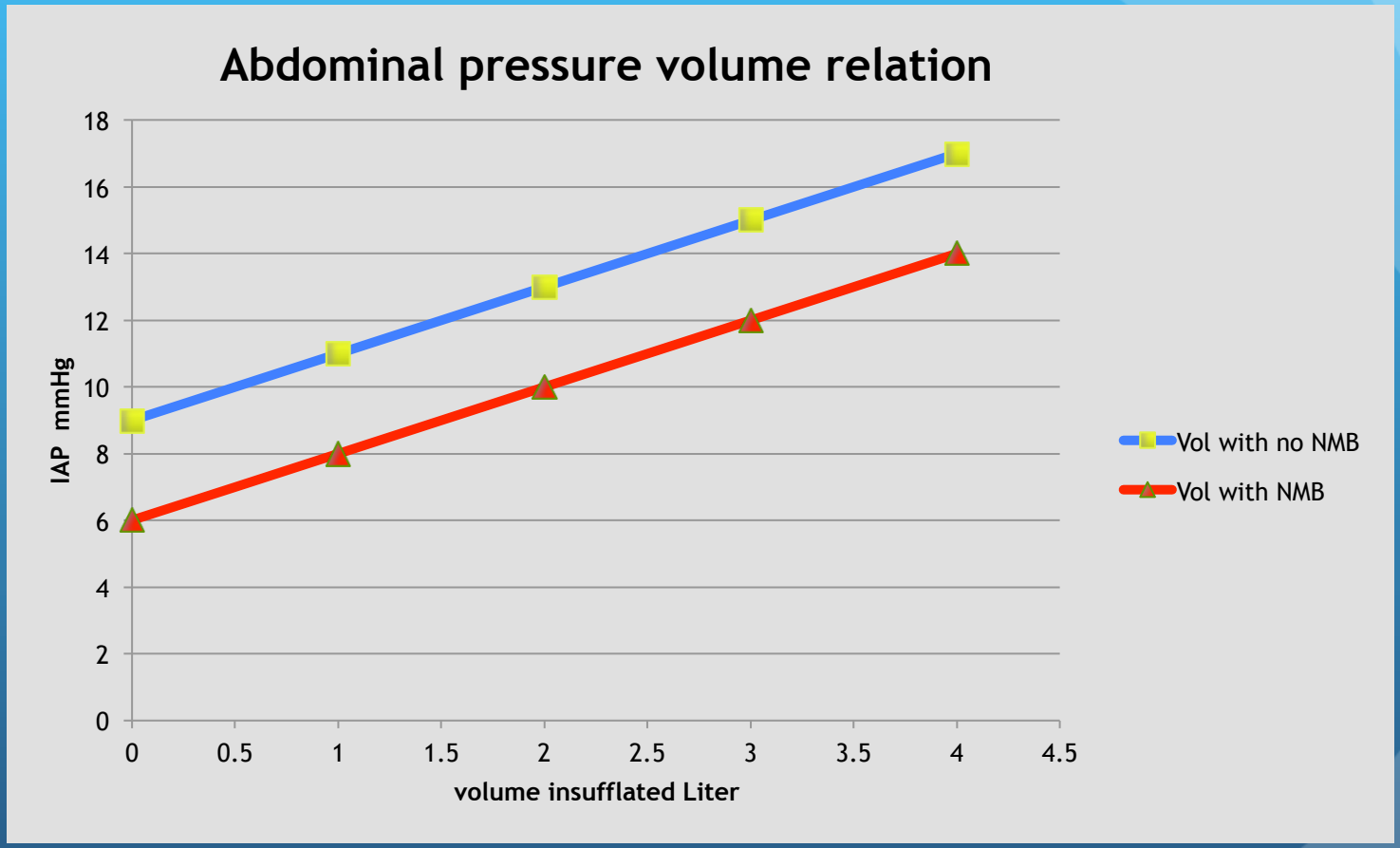
# Surgical workspace without - with NMB
## in one obese patient BMI 46:
PV0 = 9 mmHg drops to 6 mmHg.  E remains constant at 2 mmHg/liter

| Volume | Pressure without NMB | Pressure with NMB TOF 0 |
|---|---|---|
| 1 liter | 11 mmHg | 8 mmHg |
| 2 liter | 13 mmHg | 10 mmHg |
| 3 liter | 15 mmHg | 12 mmHg |
| 4 liter | - | 14 mmHg |


Patient got inhalation Desflurane 1 Mac (what is having a little relaxation as well)
Remifentanyl infusion with no effect on relaxation
Ventilation 600 ml 12 x with 7 cm H20 peep
Rocuronium bolus of 1,2 mg/kg IBW with continuous infusion of 50 mg/hour was given after first measurements
Second measurements when TOF = 0  at the thumb



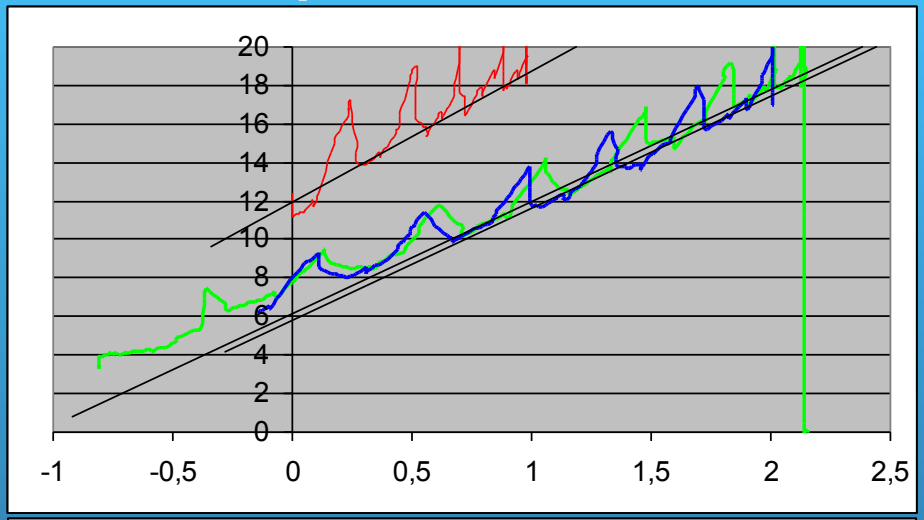

# Pressure volume relation without vs with NMB

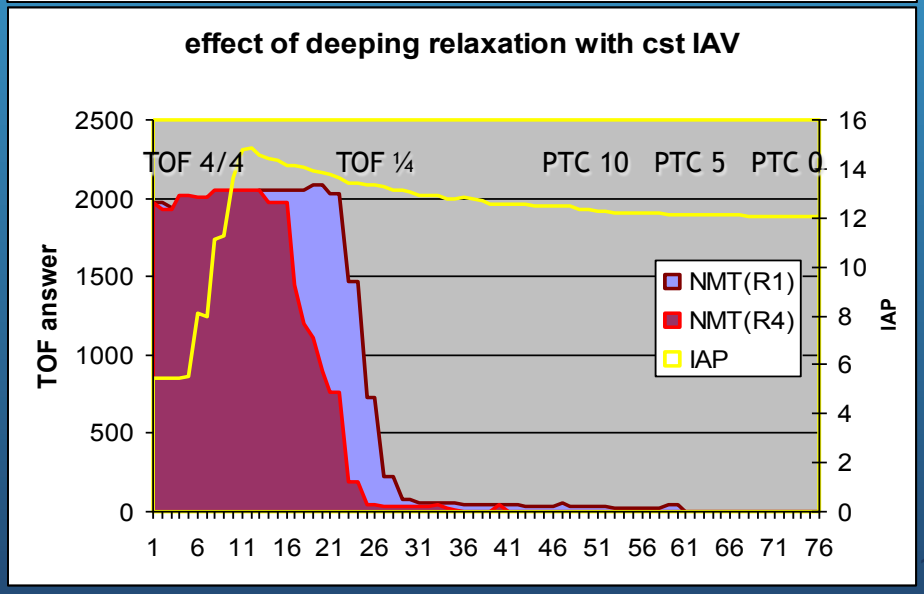


# Deep muscle relaxation is useful in morbid obese patients

- TOF > 90%
- TOF = 0/4 and PTC < 10
- TOF 0/4 and PTC < 5

J Mulier 2008 ASA



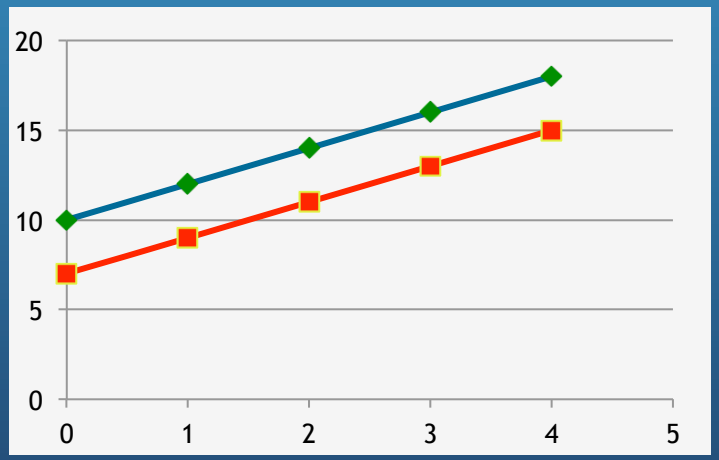

- Gradual pressure drop until flat line
- Max effect at TOF = 0/4
- No need to drop until PTC = 0

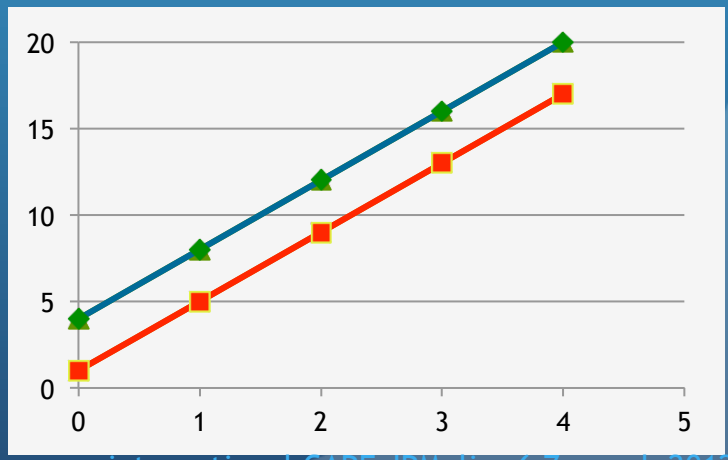
Mulier JP 2009 PGA

# How improving workspace?

- If high PV0  easy to improve
  - NMB most effective, trendelenburg, IAP increase
- If low C  difficult to improve
  - Flexing legs, higher IAP and NMB are less effective

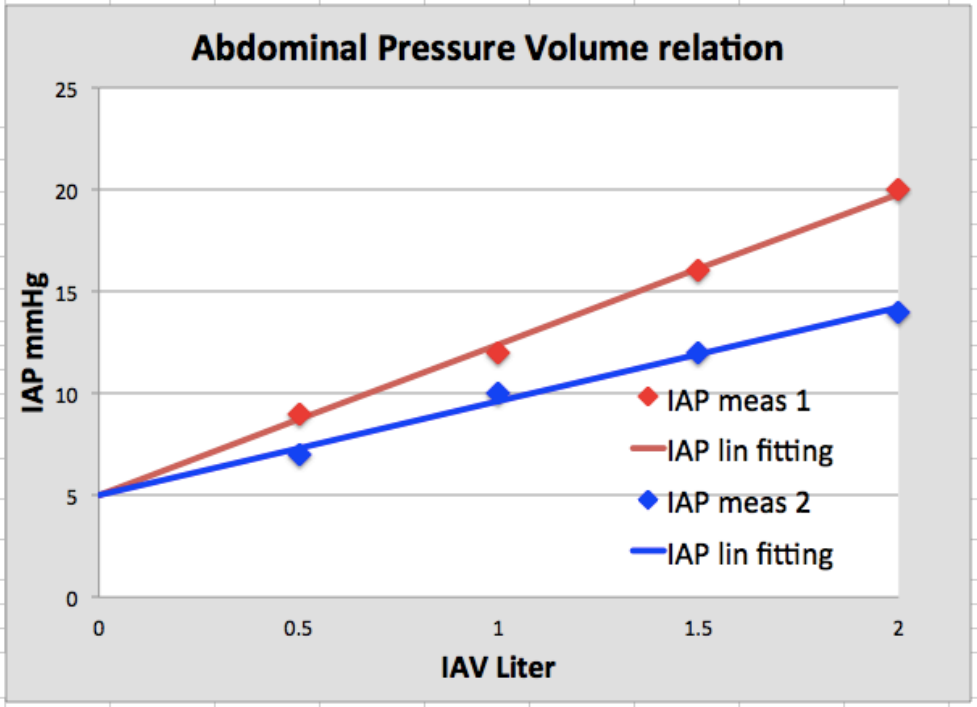
NMB helps in both situations!



# Ex. of three point calculation in the OR

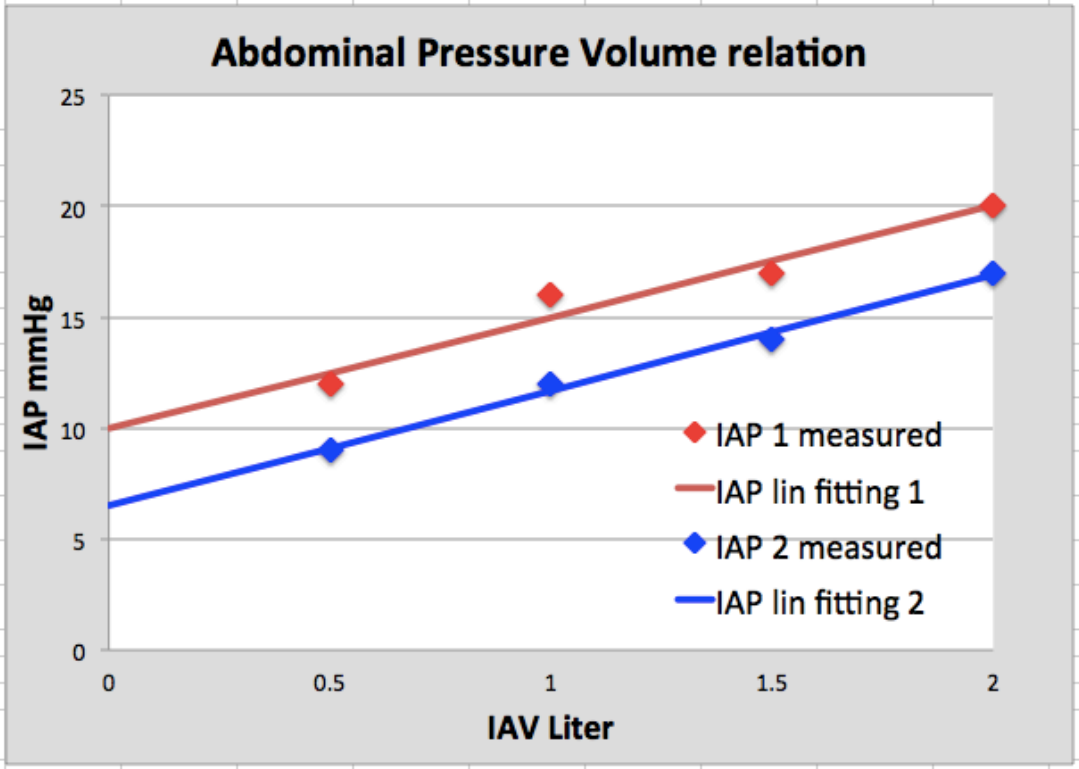
| | IAV | IAP meas 1 | IAP lin fitting | | IAV | IAP meas 2 | IAP lin fitting |
|---|---|---|---|---|---|---|---|
| | 0 | | 5 | | 0 | | 5 |
| | 0,5 | 9 | 8,7 | | 0,5 | 7 | 7,3 |
| | 1 | 12 | 12,4 | | 1 | 10 | 9,6 |
| | 1,5 | 16 | 16,1 | | 1,5 | 12 | 11,9 |
| | 2 | 20 | 19,8 | | 2 | 14 | 14,2 |
| | **7,4** | **5** | | | **4,6** | **5** | |
| | **PV0** | **5** | mmHG | | **PV0** | **5** | mmHG |
| | **E** | **7,4** | mmMHg/L | | **E** | **4,6** | mmMHg/L |
| | c | 0,13514 | | | | | |
| to reach 3 L | | **27** | mmHg: to reach 3 L | | | **19** | mmHg: to reach |



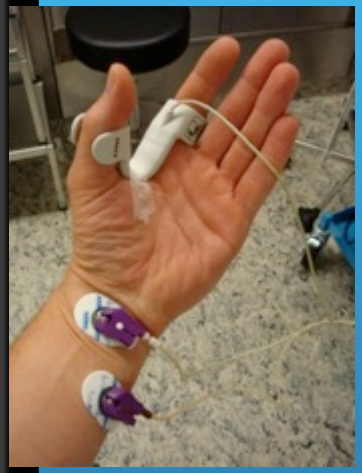
# Per operative measurements at first inflation

| IAV | IAP 1 measured | IAP lin fitting 1 | IAV | IAP 2 measured | IAP lin fitting 2 |
|---|---|---|---|---|---|
| 0 | | 10 | 0 | | 6,5 |
| 0,5 | 12 | 12,5 | 0,5 | 9 | 9,1 |
| 1 | 16 | 15 | 1 | 12 | 11,7 |
| 1,5 | 17 | 17,5 | 1,5 | 14 | 14,3 |
| 2 | 20 | 20 | 2 | 17 | 16,9 |
| **5** | **10** | | **5,2** | **6,5** | |

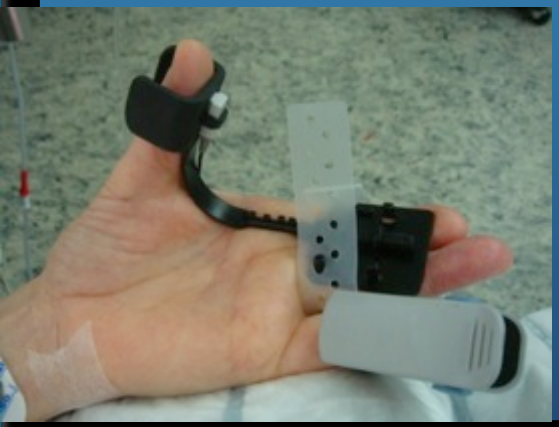
| | | | | | |
|---|---|---|---|---|---|
| **PV0** | **10** | mmHG | **PV0** | **6,5** | mmHG |
| **E** | **5** | mmMHg/L | **E** | **5,2** | mmMHg/L |
| | 25 | mmHg: pressure to reach 3 liter | | | |



# Difference between diaphragm and adductor pollicis



- Monitoring of the peripheral muscles often overestimates the degree of diaphragmatic relaxation, but is a save predictor of recovery.
  - Moerer O. Anasthesiol Intensivmed Notfallmed Schmerzther. 2005; 40: 217



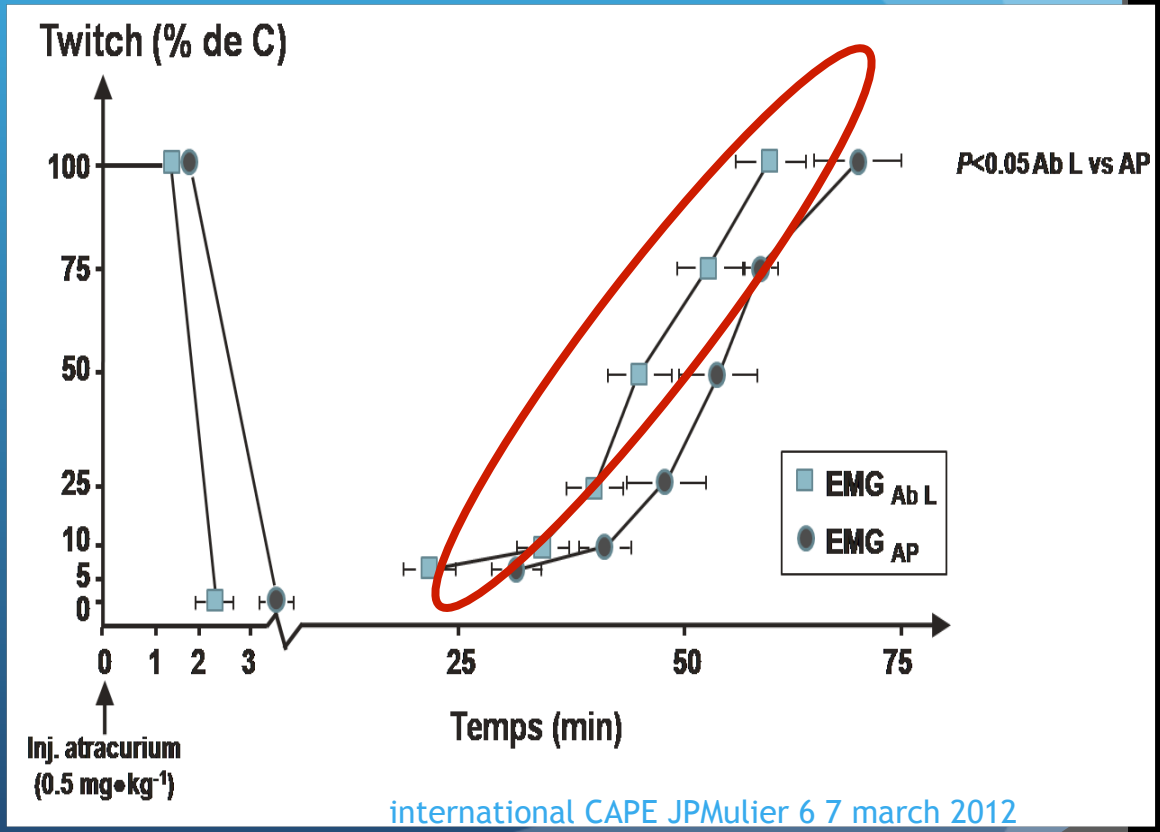
- The vocal cords and diaphragm are more resistant than the adductor pollicis to rocuronium and have a faster recovery of the twitch height.
  - Cantineau JP Anesthesiology. 1994; 81: 585

# The Benefits of Deep Neuromuscular Blockade: Surgical Procedure

**Sensibilité à l'atracurium des muscles abdominaux latéraux***

K. Kirov, C. Motamed, X. Combes, P. Duvaldestin, G. Dhonneur**

**Sensibility to atracurium of the lateral abdominal muscles**
**Objective:** To study the effect of atracurium on the electromyographic activity of the lateral abdominal muscles and adductor pollicis in anaesthetized subjects.

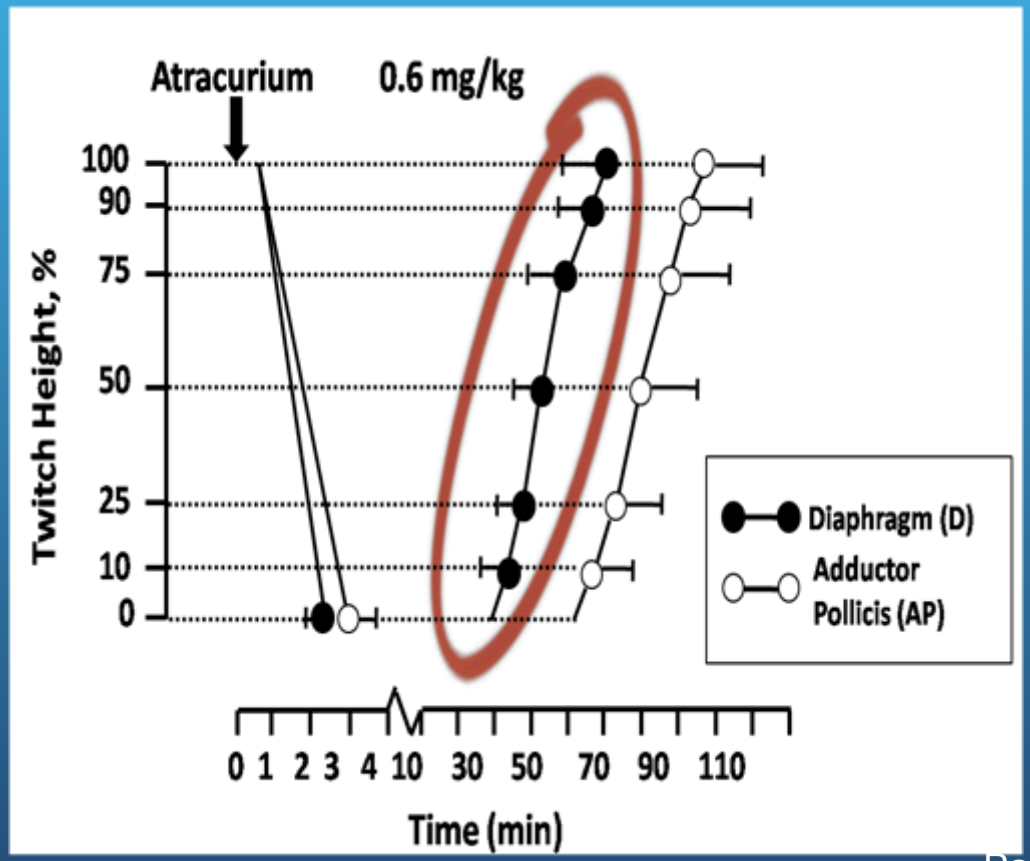



Lateral abdominal muscles blockade have a faster onset and recovery than adductor pollices

Kirov K et al. *Ann Fr Anesth Reanim.* 2000;19:734–738.

# The Benefits of Deep Neuromuscular Blockade: Surgical Procedure

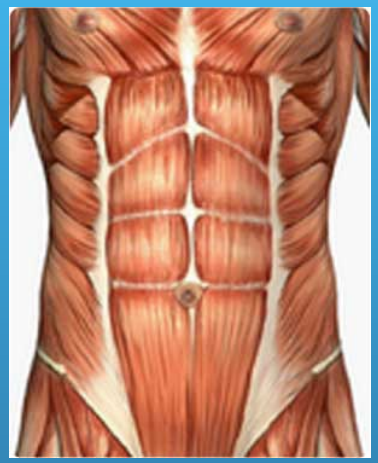
**AP and Diaphragm Neuromuscular Block**



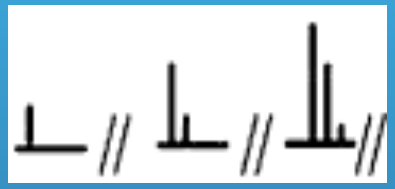

Diaphragm blockade has a faster onset and recovery than adductor pollices

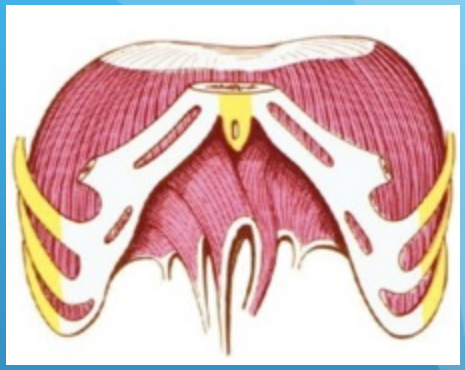
Pansard, et al. *Anesthesiology.* 1987;67:326-330.

# Deep block in abductor pollicis means moderate block in abdominal muscles and diaphragm

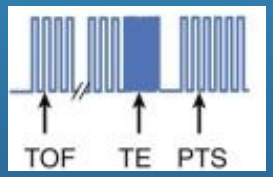


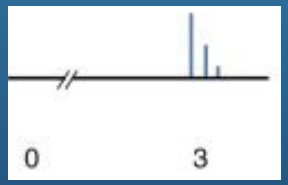
**Shadow block**

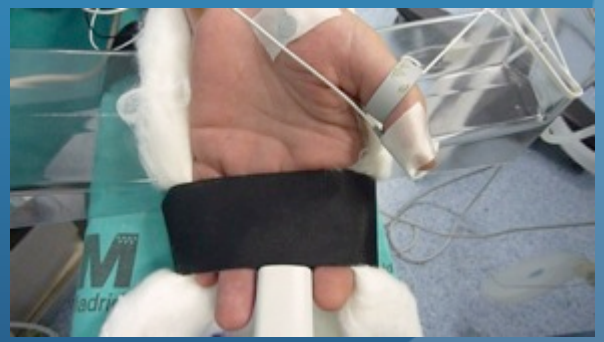




**Deep block**



**10 PTCs**

TOF-Watch® SX Monitor - hospital infanta sofia - [D:\Documents and Settings\mmmm\Mis documentos\TOF-Watch SX Monitor\Files\Obesidad patoló...

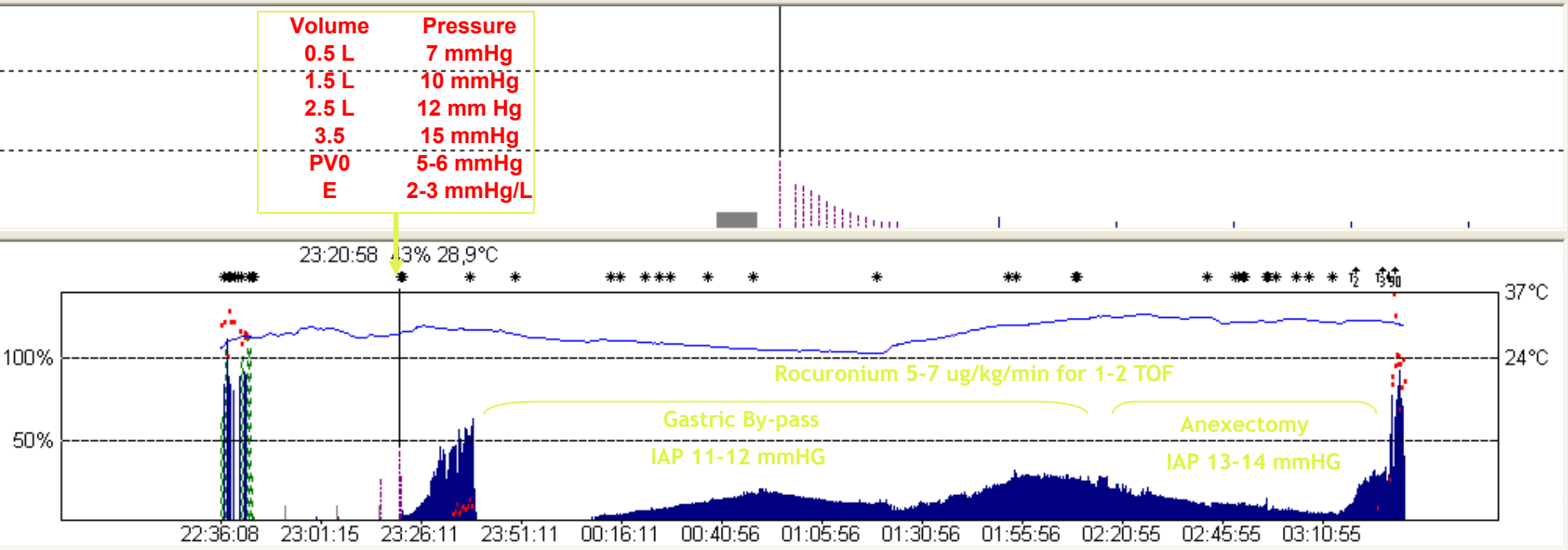
File Edit Search Options Window Help

24

19:30:18

| Time | ?!* | Mode | Tw1 | Tw2 | Tw3 | Tw4 | TOF | CNT | Temp | Stim | T | Sens. | CAL [Curr.] | TOF alarm | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04/02/2005 | | | % | % | % | % | % | | °C | mA | µs | | - [mA] | | |
| 23:20:45 | | PTC pre pulse 10 | 0 | | | | | | 28,7 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:20:46 | | PTC pre pulse 11 | 0 | | | | | | 28,7 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:20:47 | | PTC pre pulse 12 | 0 | | | | | | 28,7 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:20:48 | | PTC pre pulse 13 | 0 | | | | | | 28,8 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:20:48 | | PTC pre pulse 14 | 0 | | | | | | 28,8 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:20:49 | | PTC pre pulse 15 | 0 | | | | | | 28,8 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:20:50 | | PTC 5 sec. Tetanic | | | | | | | 28,8 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:20:58 | | PTC 1 | 43 | | | | | 1 | 28,9 | 60,00 | 200 | 151 | 2 [<20] | | |
| 23:21:00 | | PTC 2 | 28 | | | | | 2 | 28,9 | 60,00 | 200 | 151 | 2 [<20] | | |

| Volume | Pressure |
|---|---|
| 0.5 L | 7 mmHg |
| 1.5 L | 10 mmHg |
| 2.5 L | 12 mm Hg |
| 3.5 | 15 mmHg |
| PV0 | 5-6 mmHg |
| E | 2-3 mmHg/L |

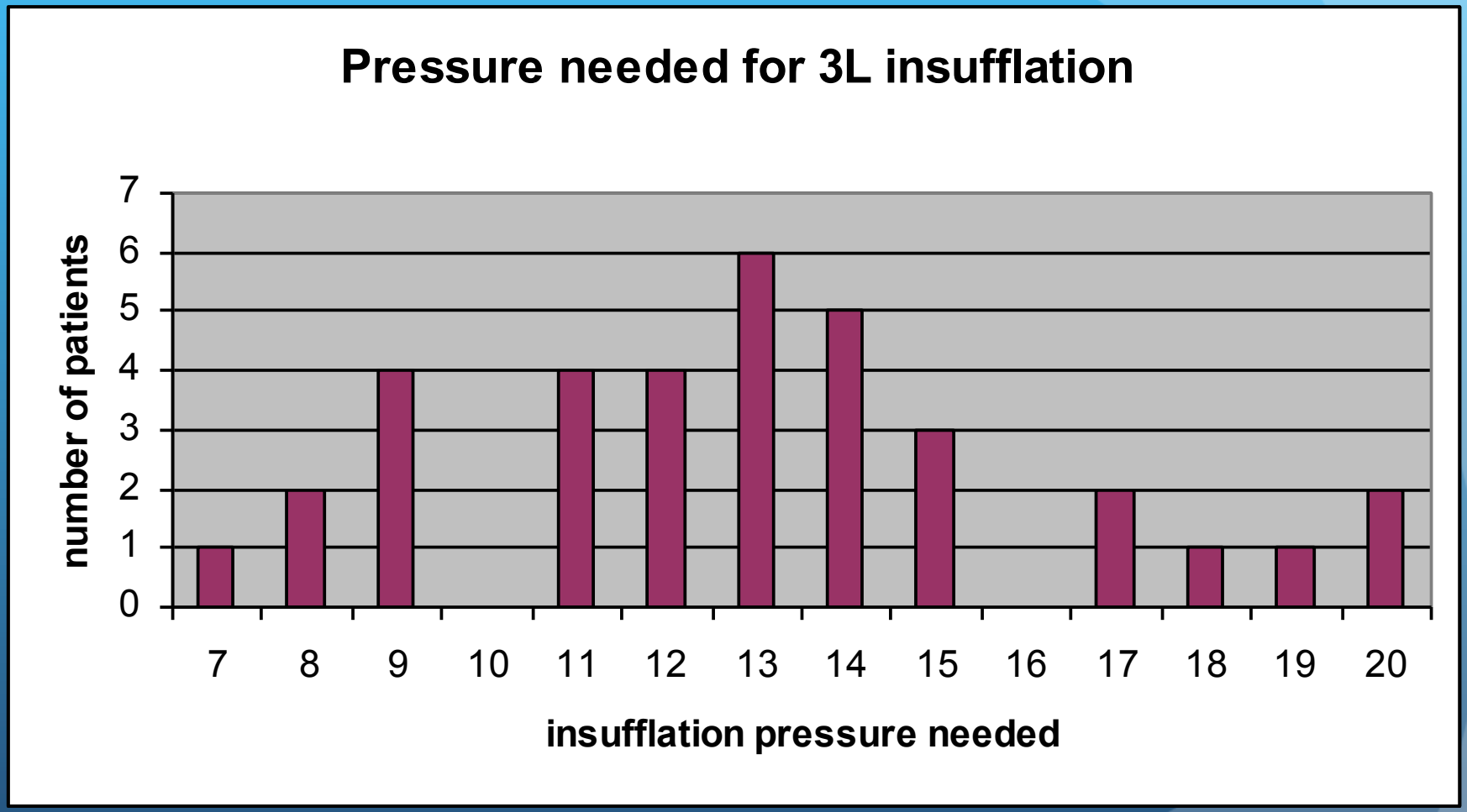



Obesidad patológica y quiste ovario



Inicio TOF-Watch® SX Mon... Microsoft PowerPoint ... 19:30

# We can choose the lowest IAP possible by using max NMB




Mulier JP 2007

# The Benefits of Deep Neuromuscular Blockade: Surgical Procedure

**Low pressure versus standard pressure pneumoperitoneum in laparoscopic cholecystectomy (Review)**

Gurusamy KS, Samraj K, Davidson BR

- Authors' conclusions
  - Low pressure pneumoperitoneum appears effective in decreasing pain after laparoscopic cholecystectomy
  - The safety of low pressure pneumoperitoneum has to be established

Could NMBAs limit increase in insufflation pressure?


Gurusamy KS, et al. Cochrane Database Syst Rev.

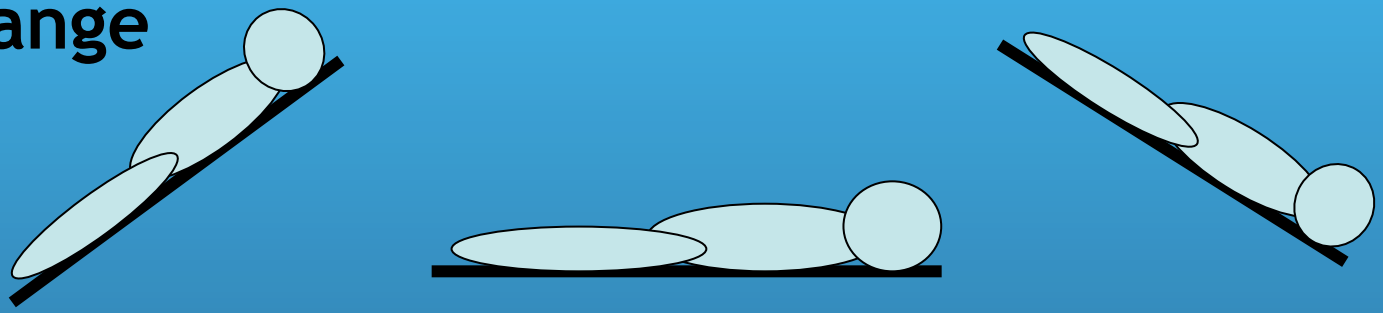
# Determinants of E and PV0

| | PV0 | $P_{VO}$ sig | E | E sig |
|---|---|---|---|---|
| Age | Neg | 0.828 | Pos | 0.003* |
| Length | Neg | 0.356 | Neg | 0.245 |
| Body weigth | Pos | 0.012* | Pos | 0.294 |
| Bmi | neg | 0.054 | Neg | 0.272 |
| Sex | Neg | 0.596 | Neg | 0.536 |
| Gravidity | Neg | 0.305 | Neg | 0.049* |
| Prev abd operation | Neg | 0.191 | Neg | 0.009* |
| Muscle relaxation | Neg | 0.001* | Neg | 0.376 |
| * Sig p<0.05 | | | | |

Mulier JP 2007

# Effect of table position on APVR

- **PV0 decreases**
- **E no change**

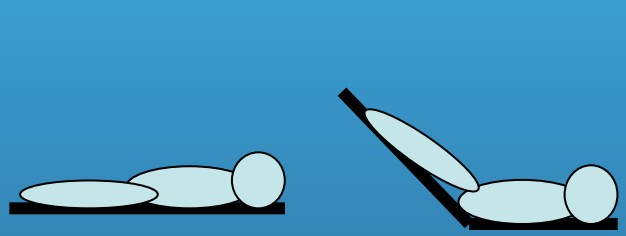


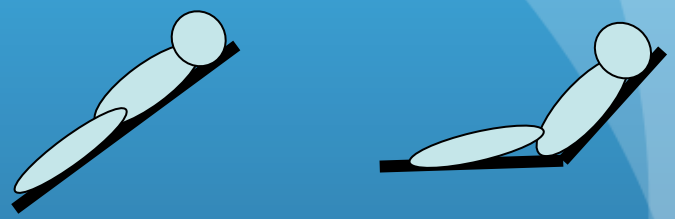
| | | | | | |
|---|---|---|---|---|---|
| **PV0** | 5,037 | > | 4,122 | **>** | 3,835 |
| **E** | 3,459 | = | 3,368 | **>** | 3,217 |

Mulier JP Obes Surg 2009

# Effect of leg flexion on APVR

- **PV0 no change**
- **E decreases**



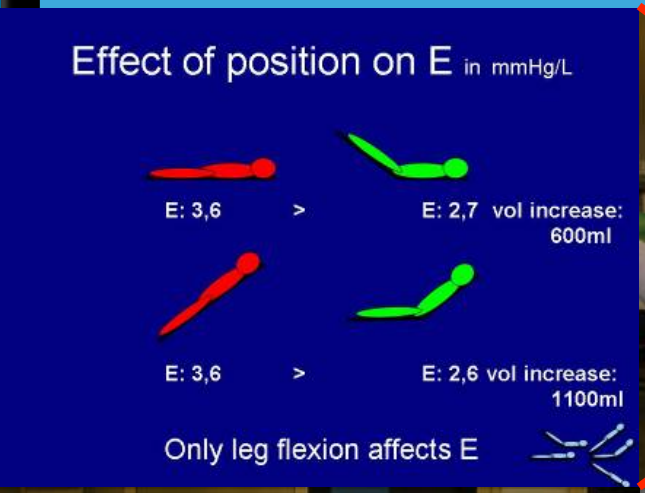


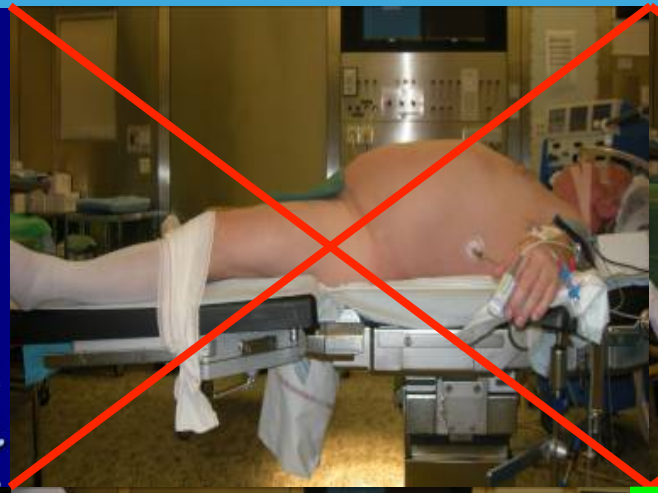
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PV0 | **4,320** | = | 4,76571 | | **5,037** | = | **4,91096** |
| E | **3,459** | > | 2,66067 | | **3,368** | > | 2,577 |

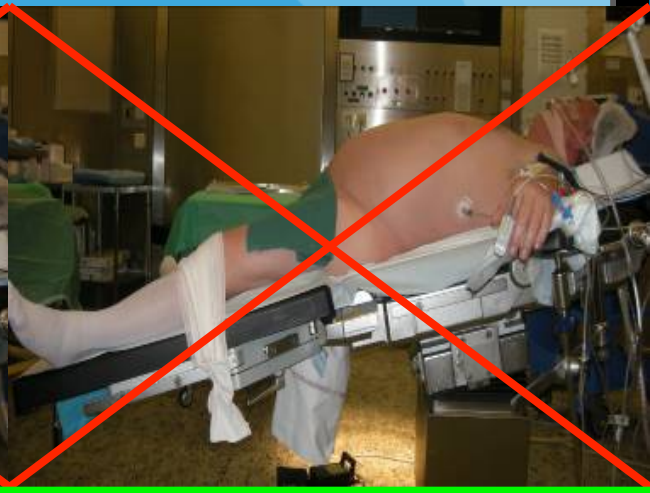
Mulier JP Obes Surg 2009

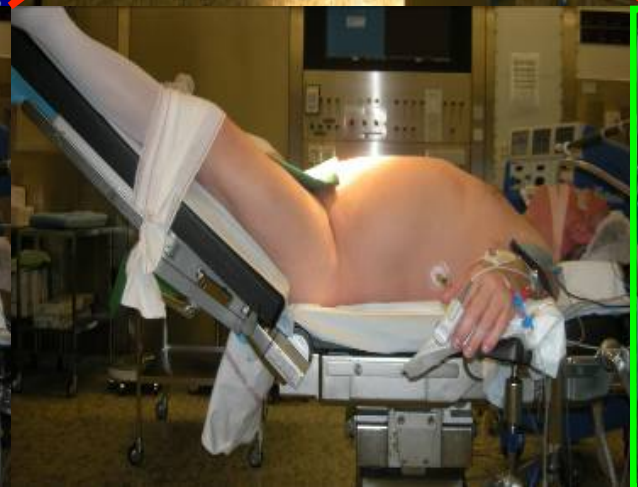
# How to change E : hip flexion

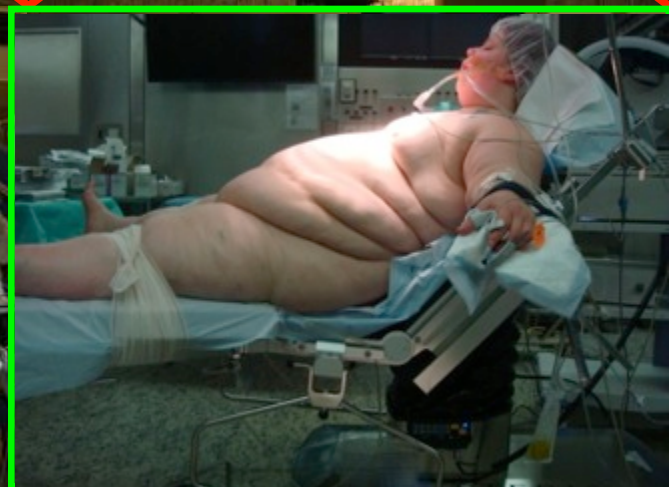
Mulier JP  Obes Surg 2009



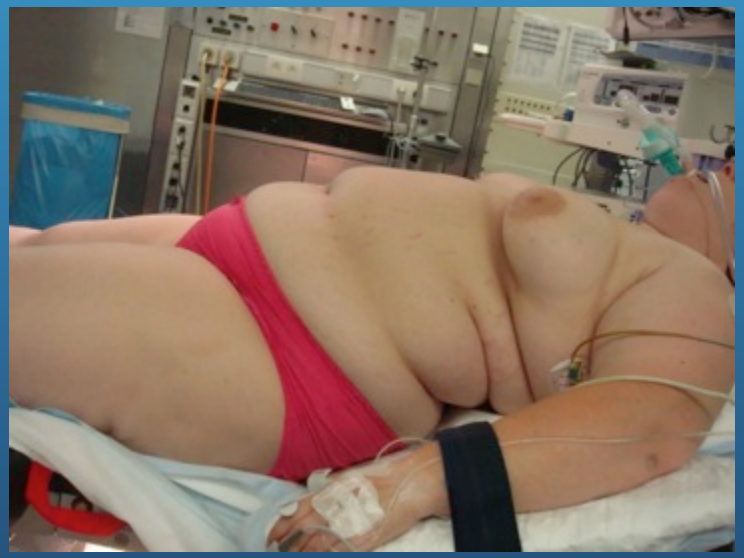


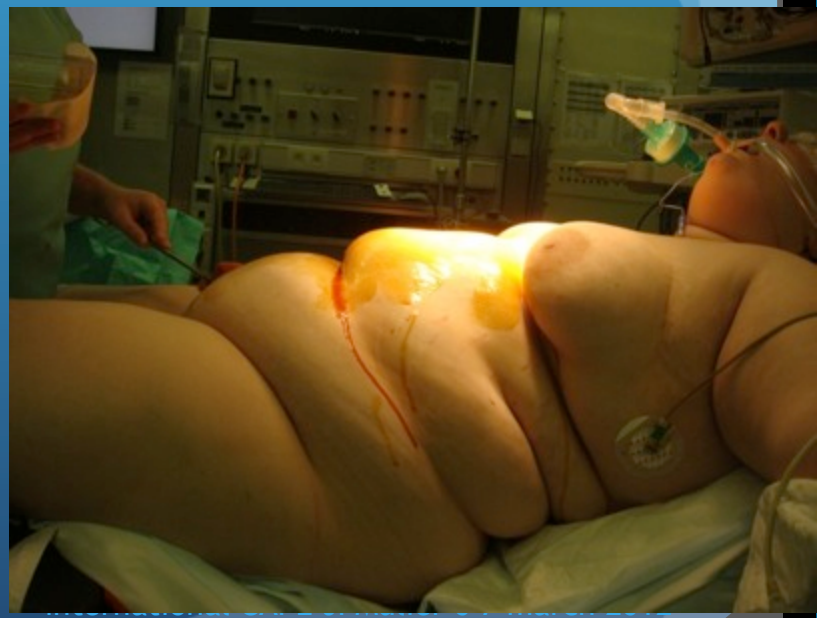




# Avoid too much leg flexion if "Double bubble abdomen"

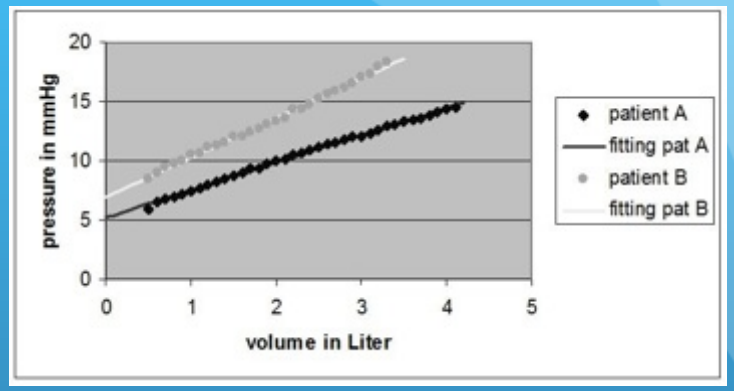
- Lift legs just above horizontal
  - Reduce venous stasis and trombosis risk
- But keep outside space free for laparoscopic instruments

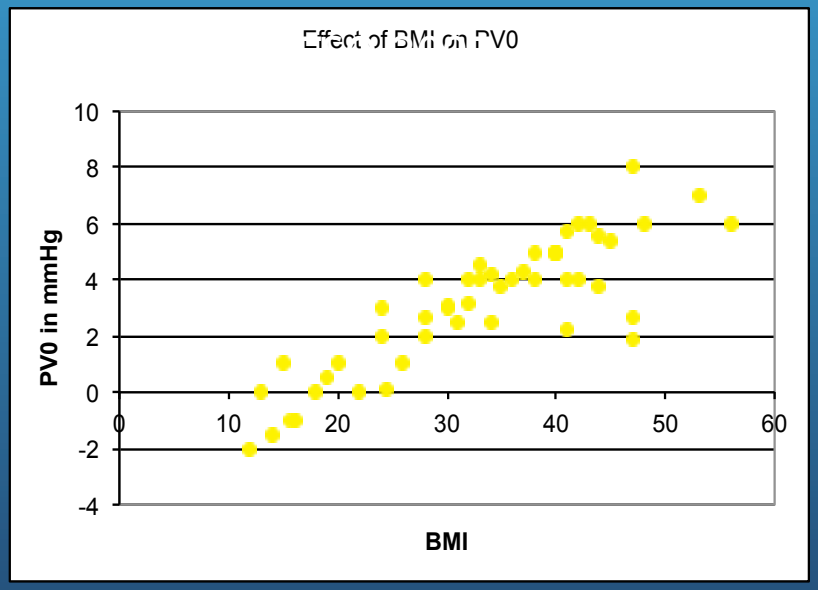


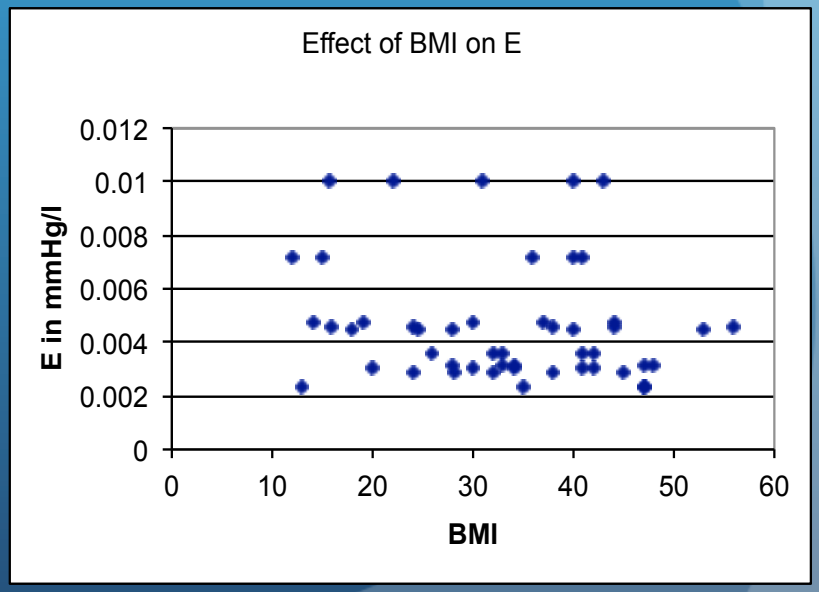


# BMI effect on abdominal P/V relation

- J Mulier ISPUB 2009
  - Pressure volume relation is linear
  - PV0 and E are patient determined

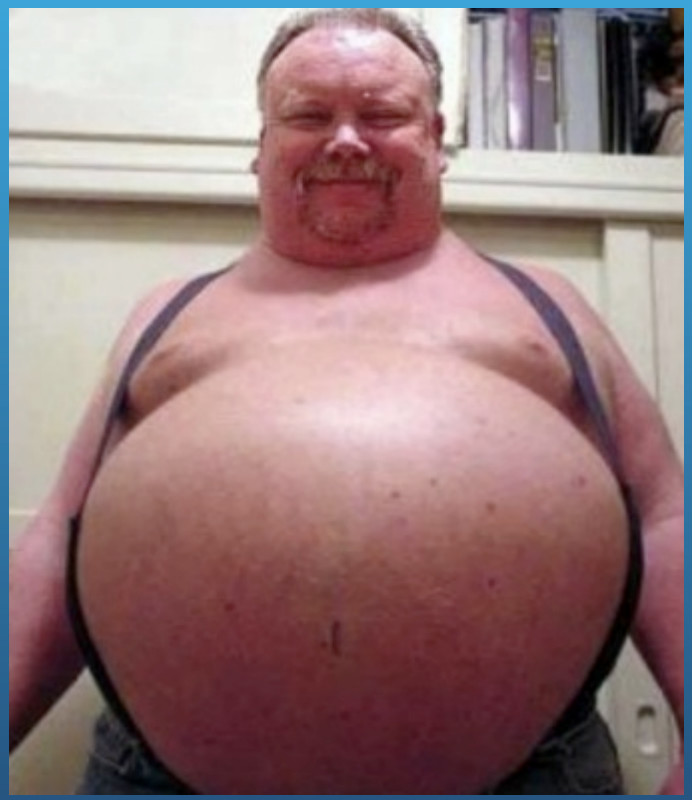


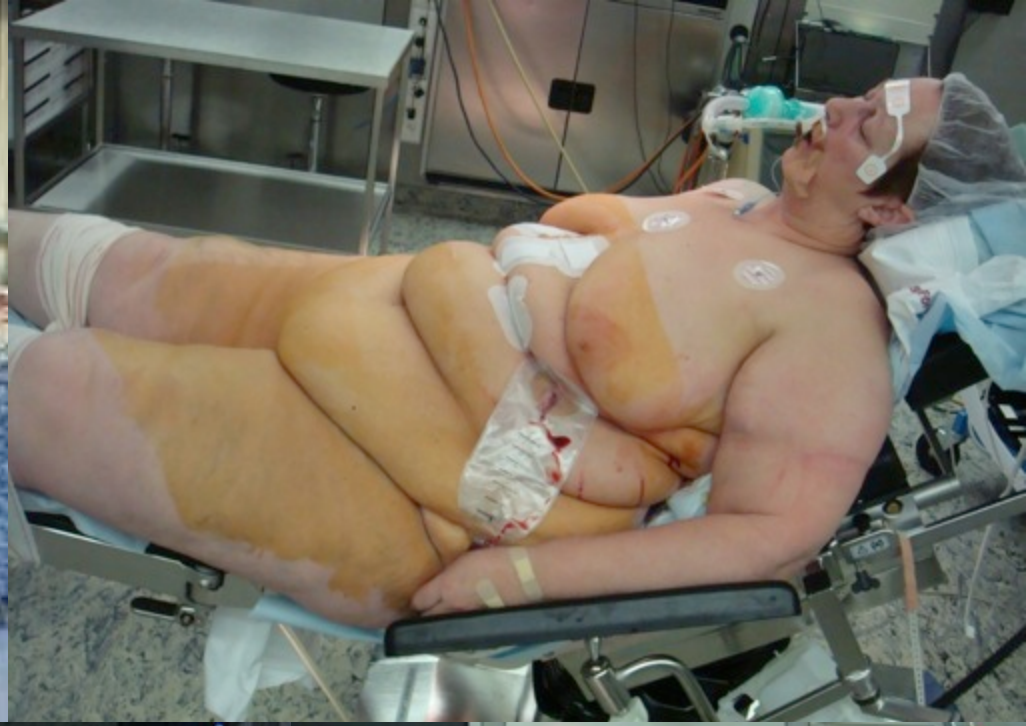
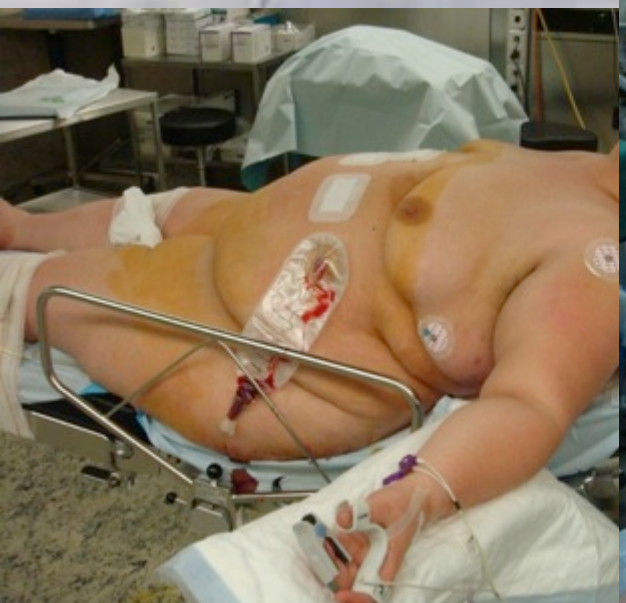
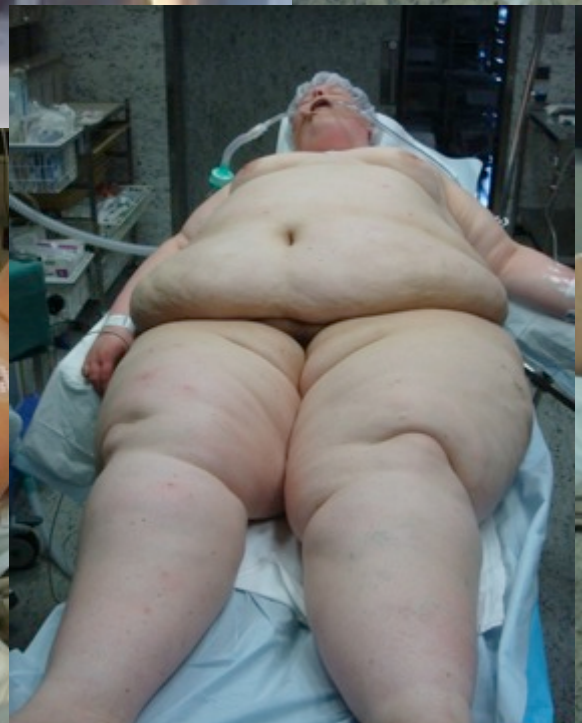
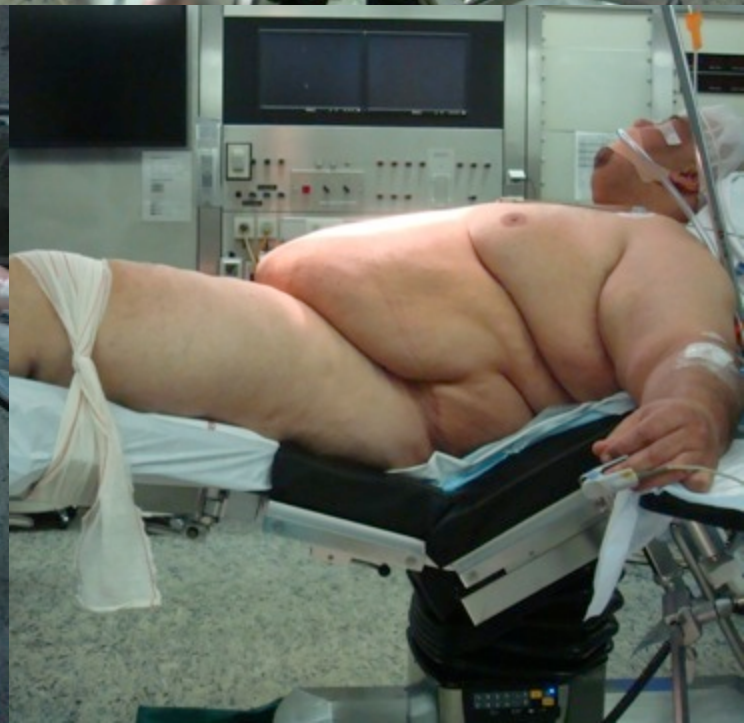



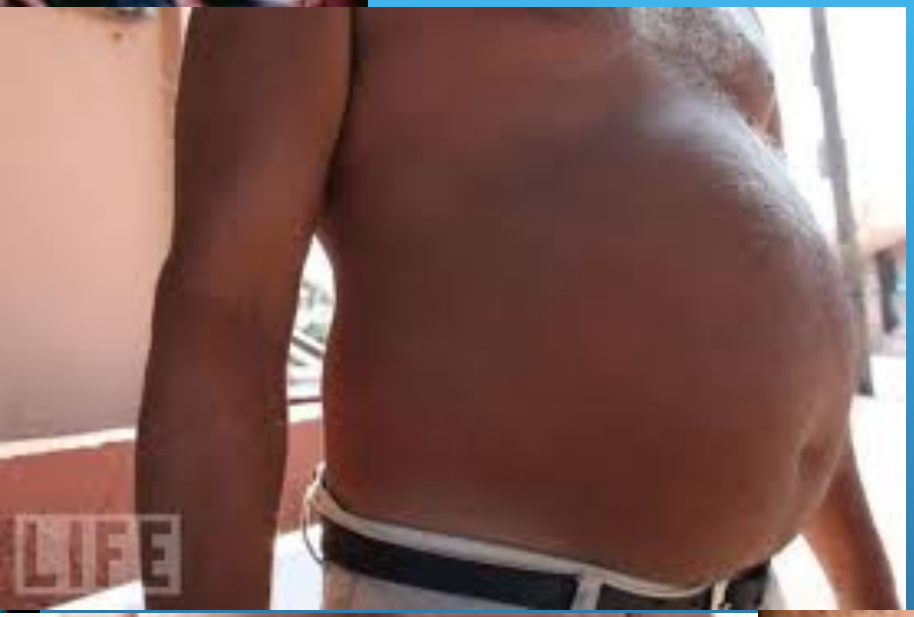

# Obesity type

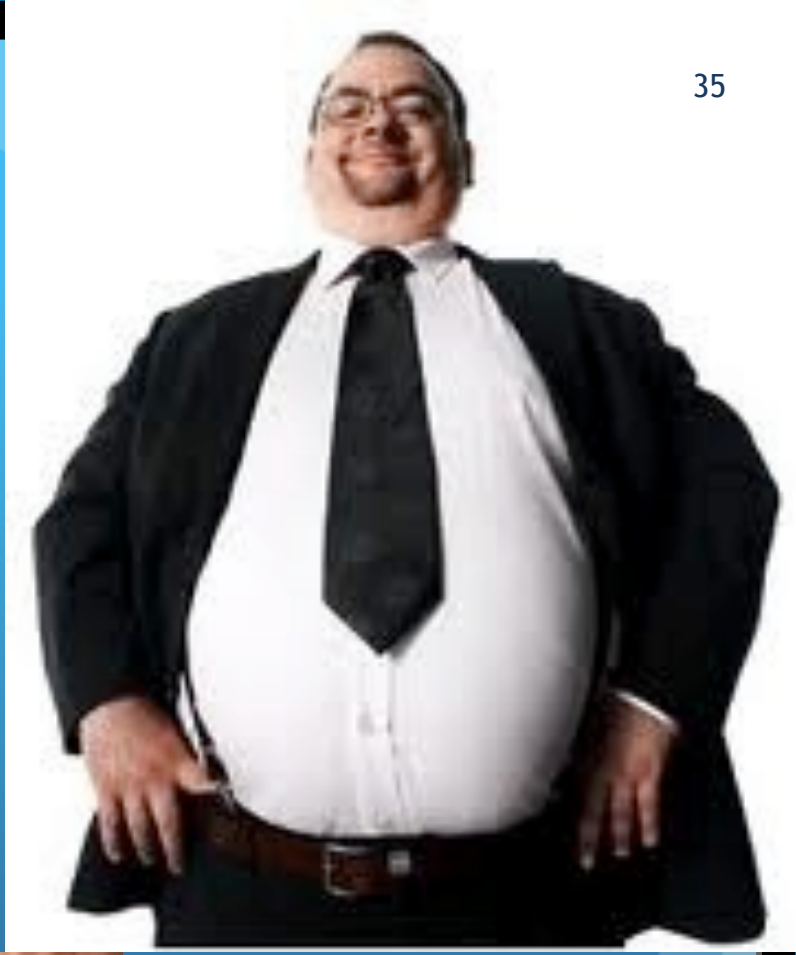
- Android vs Gynoid




The Pears





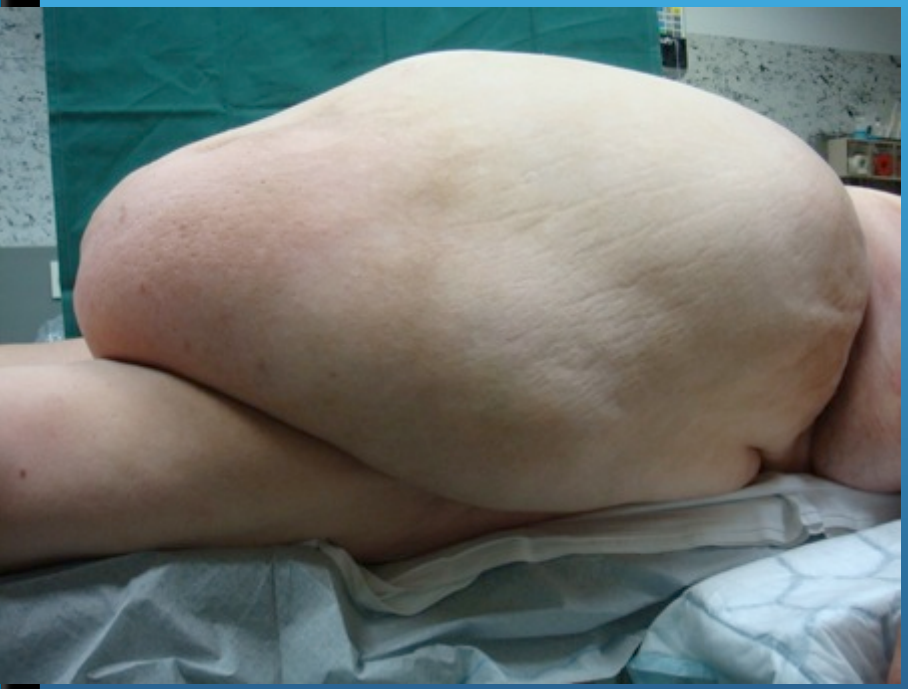
# The Apples

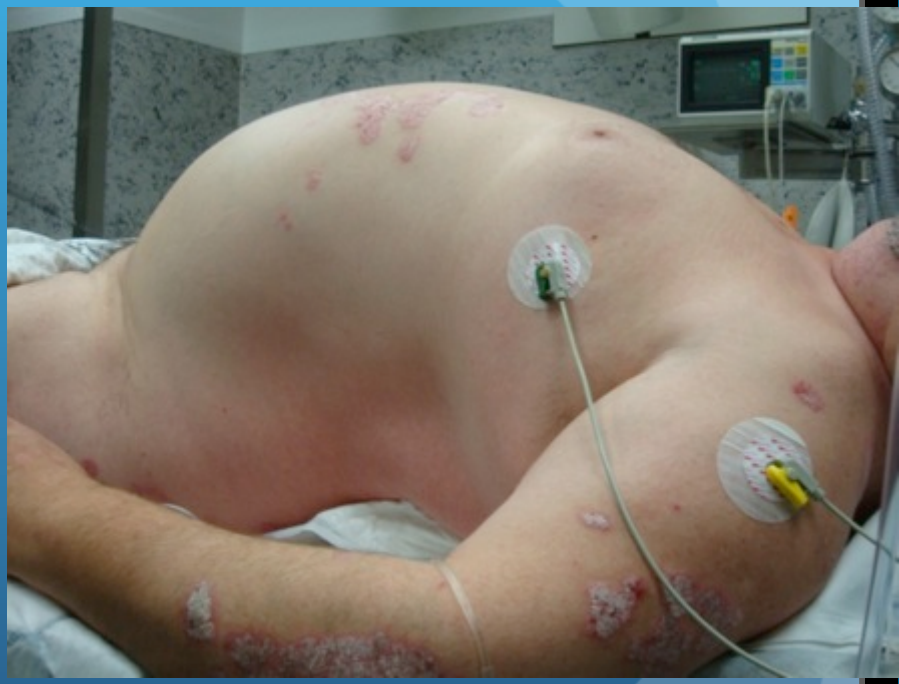


# Two apples WHR > 1,25

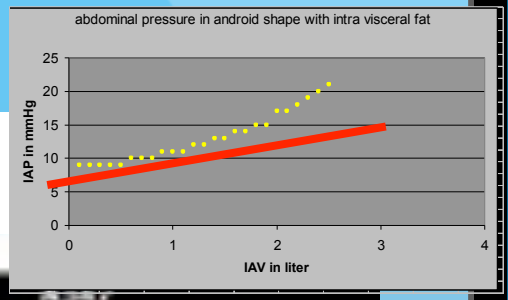
- Extra abdominal fat intra abdominal fat

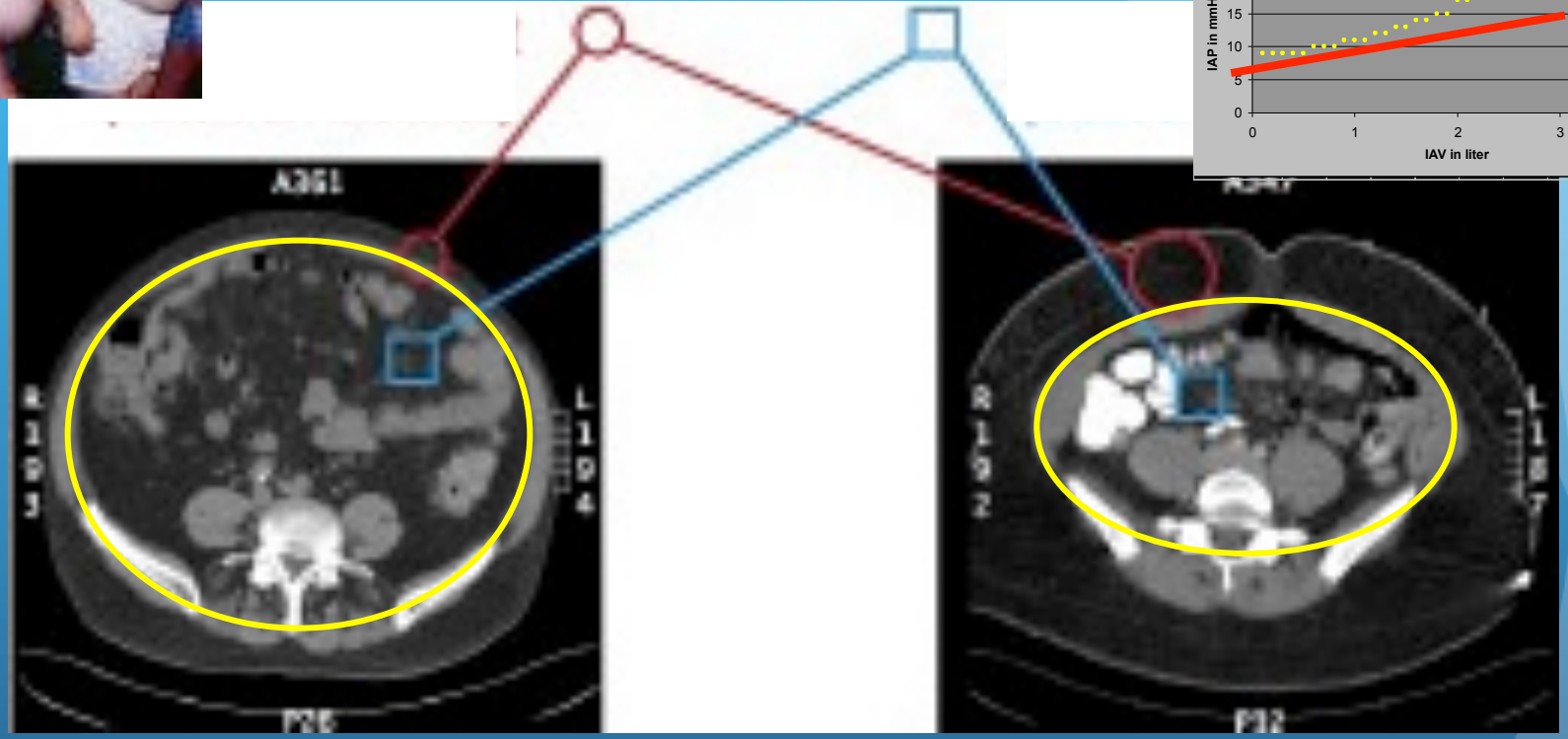




# Two types of android obesity

Subcutaneus Fat  Visceral fat



## Intra visceral adiposity

Subcutaneus fat is scant and

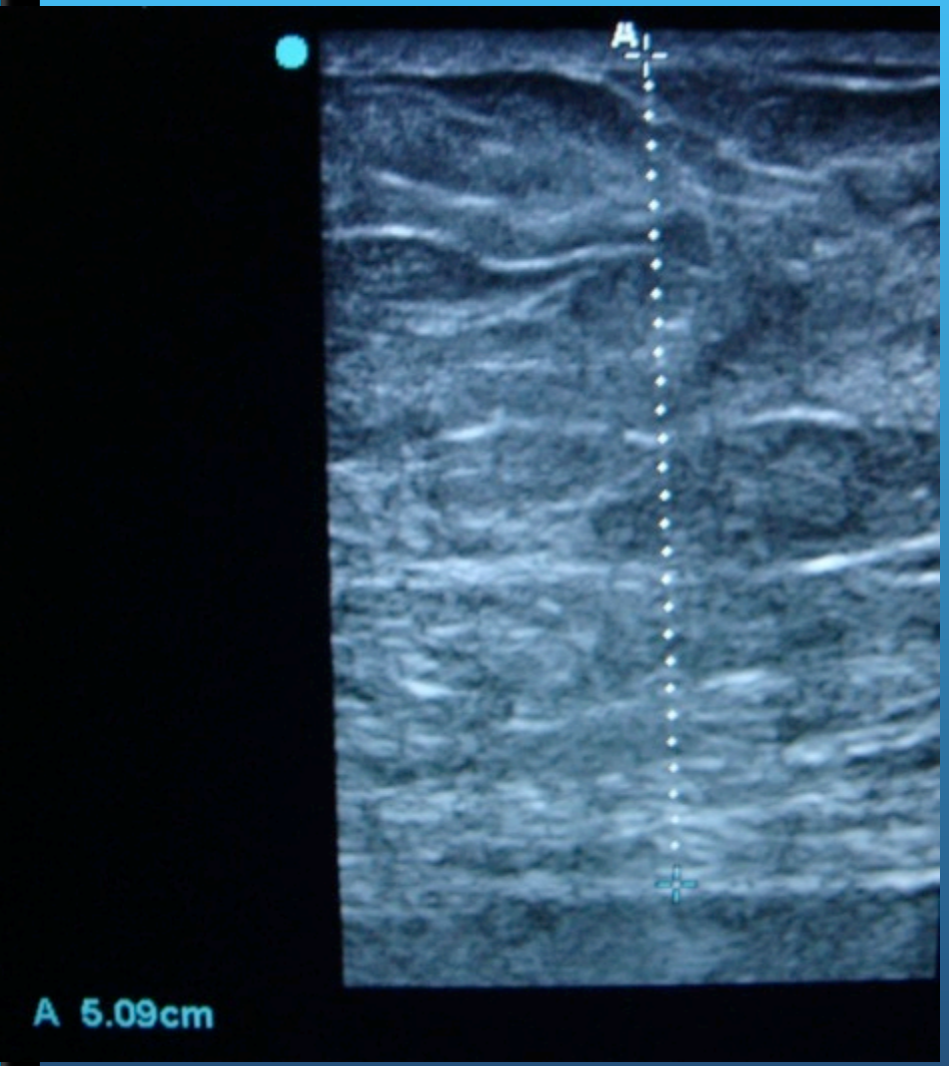
intra abdominal fat is thick and

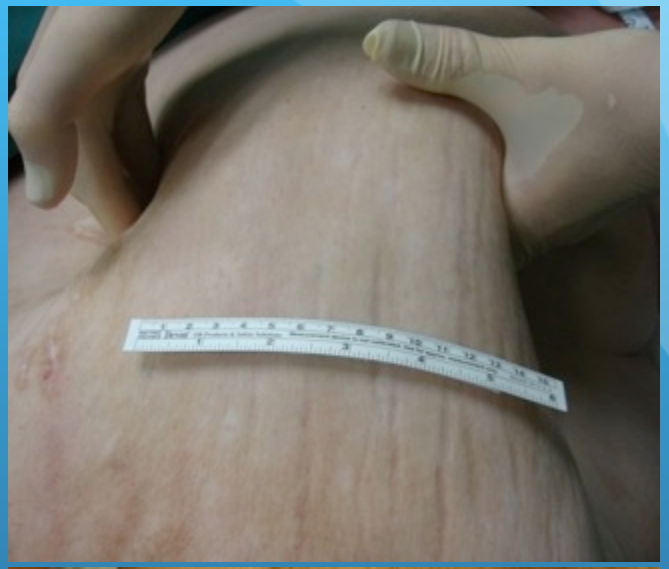
## Extra visceral adiposity

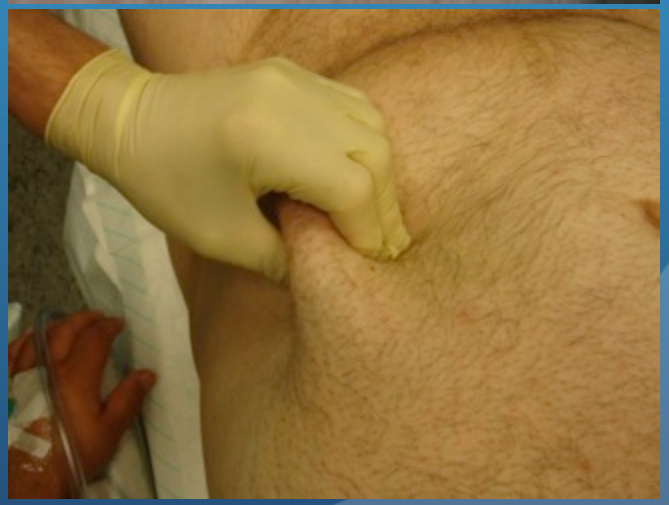
Subcutaneus fat is thick and

intra abdominal fat is scant.

# Thicness of external fat

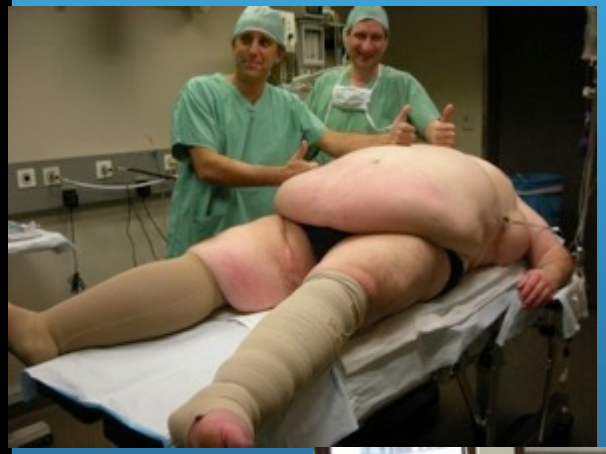


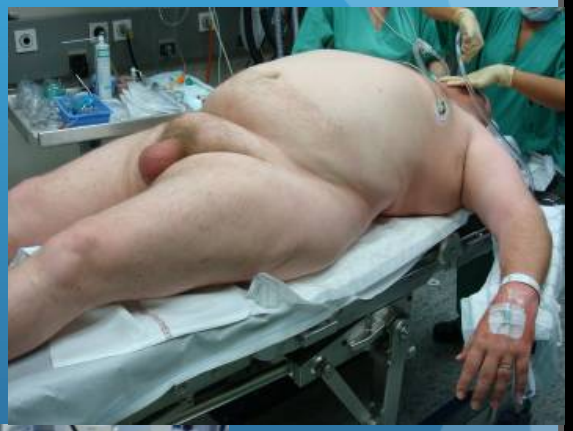



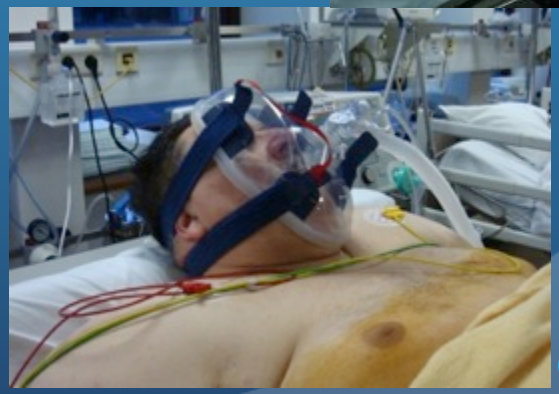


# The obese patient is a challenge for anaesthesia if android shape with intra visceral fat.

Loosing 10 kg body weight before operation changes the circle to an ellips.





# Conclusion: When are NMB needed?

Measure abd E, PV0 or IAV at 15 mmHg IAP

- If IAV < 4 liter at 15 mmHg
- If PV0 > 5 mmHg ( morbid obese patients)
- If E > 3 mmHg/L ( never pregnant, small abdomen)

Patient needs continuously NMB during laparoscopy,

Inform your surgeon that despite the increase in workspace with deep NMB, beach chair position, higher inflation pressures to 20 mmHg and ventilation adaptations sufficient space might not be reached. Measure to know

# Cape international Bruges 6 7 March 2012

1150 1850 1947 1977 2010

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Dr Bruno Dillemans

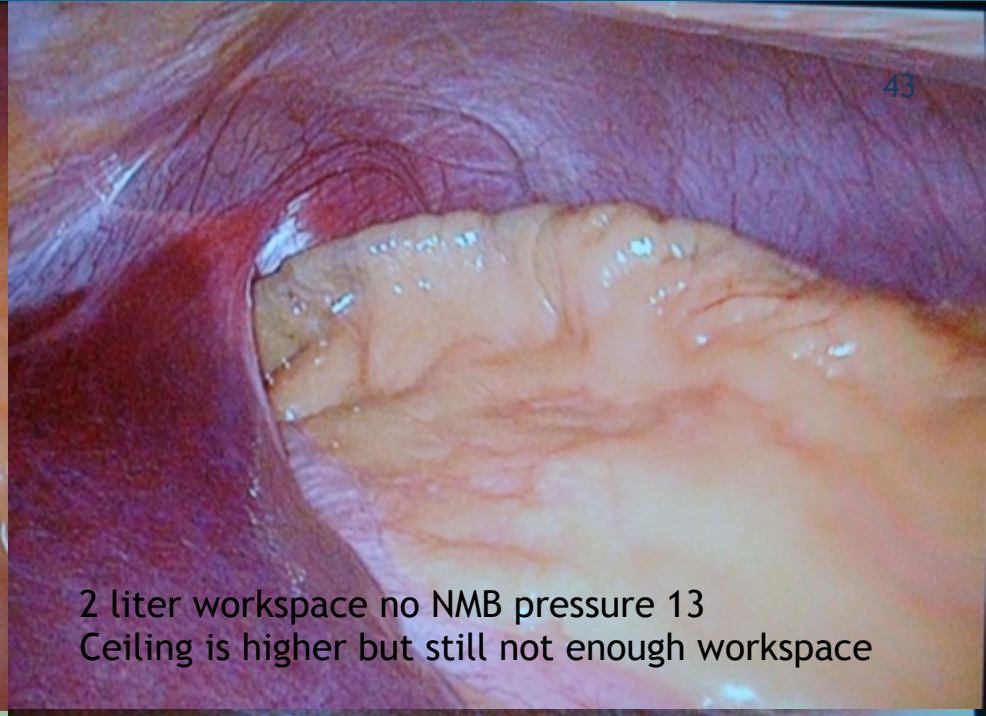
Bariatric surgeon

Sint-Jan Brugge-Oostende, Belgium

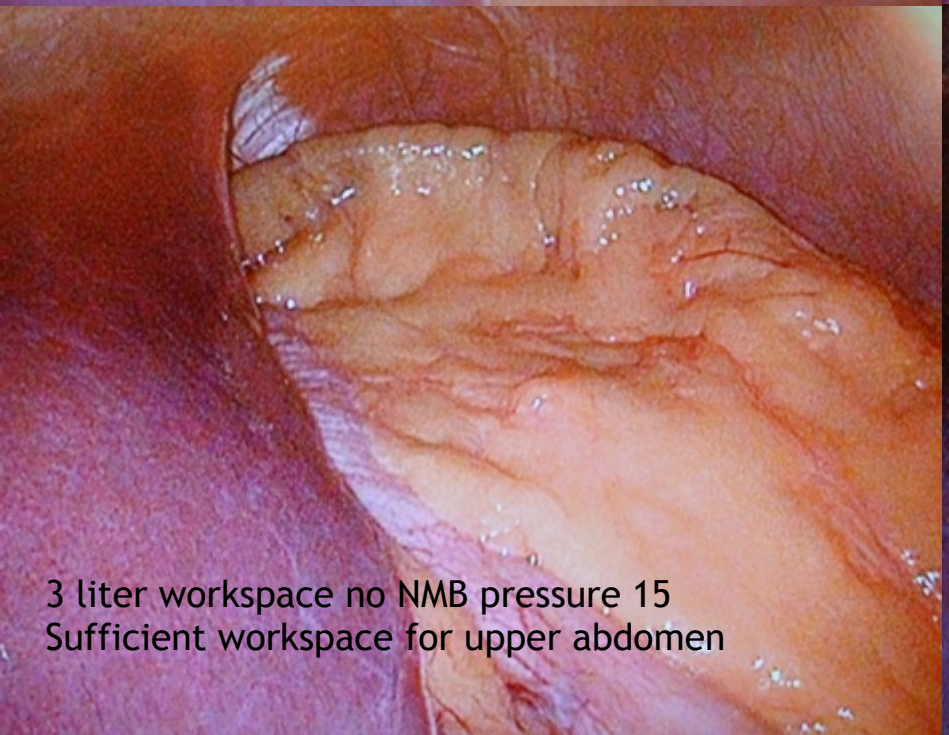
# How a surgeon recognizes insufficient neuro muscular blockade?

- At the first inflation with the verres needle
  - High abd pressure to start > 10 mmHg
  - No flow is going inside
  - Multiple attempts to reposition the verres needle
- Insufficient space to reach certain laparoscopic area's
  - Last stapler for pouch construction
  - Flat access means that insufficient different angles can be used
- During surgery or at end surgery, patient start to press suddenly
  - Abdominal wall and diaphragm movements
  - Coughing or breathing against ventilator, ventilator alarm
  - Sudden higher pressures intra abdominal than the set value, inflator alarm.
  - No laparoscopic view suddenly, lense need frequent cleaning

1 liter workspace no NMB pressure 11
Not sufficient workspace
no access to upper abdomen



2 liter workspace no NMB pressure 13
Ceiling is higher but still not enough workspace



3 liter workspace no NMB pressure 15
Sufficient workspace for upper abdomen

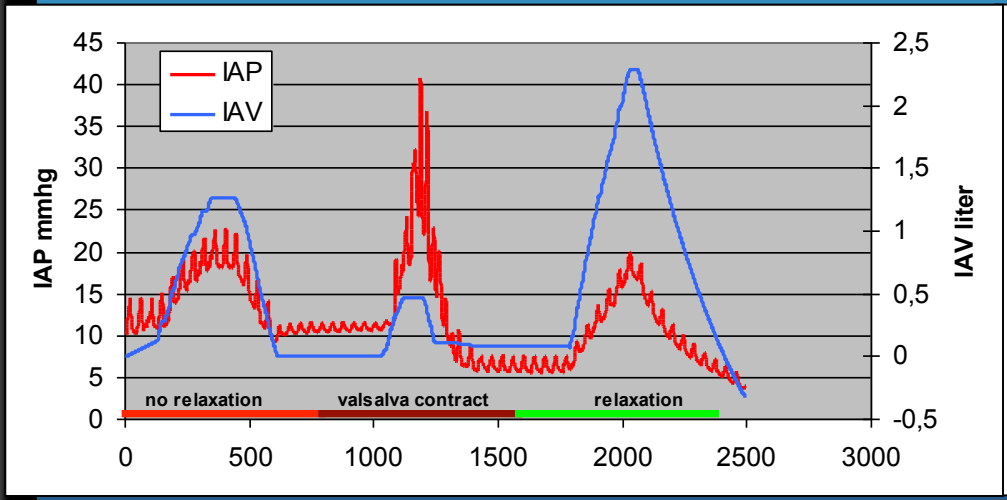
4 liter workspace with NMB pressure 14
Sufficient workspace and easy access.

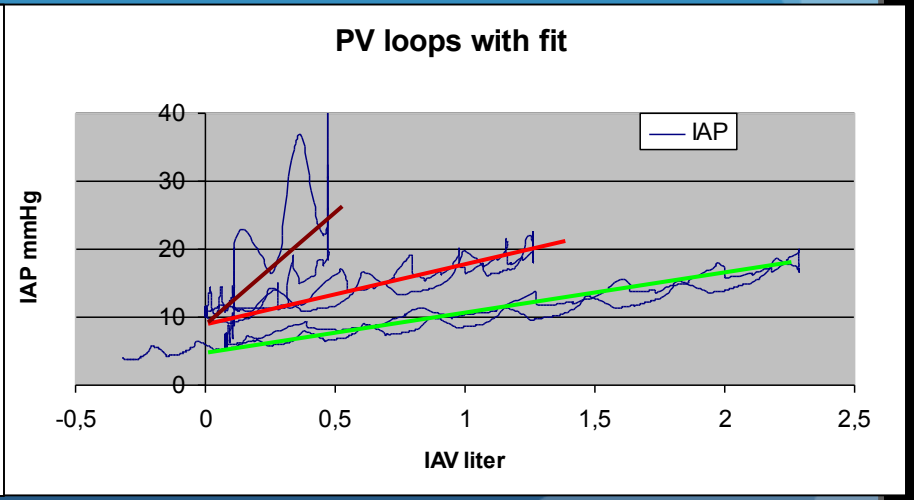
# What happens if patient breaths against ventilator?

- Inflator alarm goes off, high pressure (41), no flowc(0)
- Inflator ads flow if pressure drops, it never releases if pressure rises.
- No view at all
  - Stop surgery and wait till abdomen get relaxed
  - Sometimes never relaxed, what is given?
  - Request to give more and more without effect?

# Difference between active contraction and relaxation

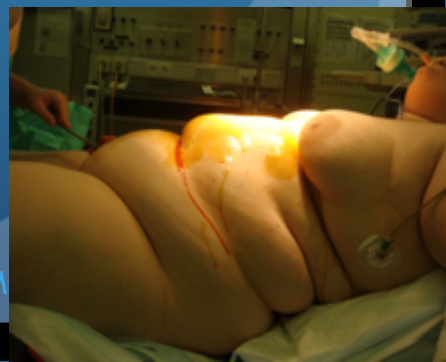
1. No muscle relaxation
2. Active contraction against ventilator
3. Full muscle relaxation



# Surgical prediction of difficult access:

1. Apple sized persons, most frequent male.
2. Women who have never been pregnant.
3. First laparoscopy.
4. Max weight at moment of surgery.
5. Double bubble abdomen.
   - Too much leg flexion makes instrument mobilisation difficult
   - Small abdomen?
6. Type of surgery and place of intervention
   - Diaphragmatic access, …



# Other techniques used to improve surgical wokspace and access:

1. Patient position

   Beach chair, anti trendelenburg improves access to upper abdomen even if workspace declines.

2. Higher intra abdominal pressures

   Max 20 mmHg possible

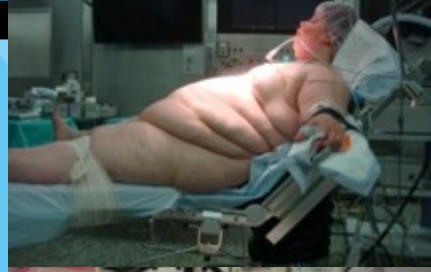
3. Standardisation of surgical procedure

   Know what to do

4. Short overstretching of abdomen at moment of difficult access. ARM procedure.

5. Longer overstretching during surgery

6. Weight reduction with modifast to create abdominal space.



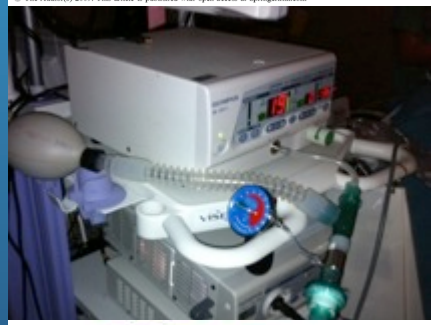

OBES SURG
DOI 10.1007/s11695-009-9933-4

CLINICAL REPORT

**Standardization of the Fully Stapled Laparoscopic Roux-en-Y Gastric Bypass for Obesity Reduces Early Immediate Postoperative Morbidity and Mortality: A Single Center Study on 2606 Patients**

Bruno Dillemans · Nasser Sakran · Sebastiaan Van Cauwenberge · Thibault Sablon · Barbara Defoort · Ek Van Dessel · Faki Akin · Nathalie Morcels · Sebastiaan Lambert · Jan Mulier · Ravindra Date · Michel Vandelanotte · Tom Feryn · Luc Proot

Received: 17 February 2009 / Accepted: 28 July 2009

# Deep NMB is needed

- When we have no space

1. Or the patient has a small abdomen to start
2. Or NMB is not very deep anymore at the diaphragm and abdominal wall
   - Even with TOF = 0 we can see sometimes movements
   - Intermittent bolus gives moments of insufficient NMB

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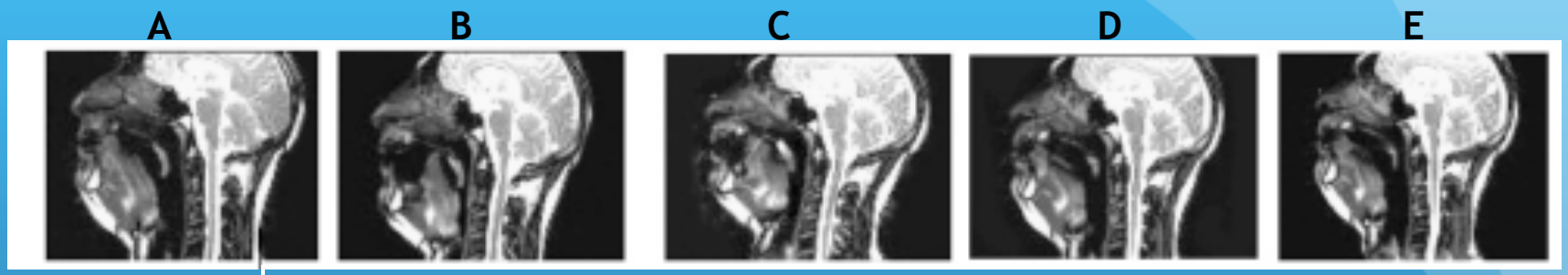
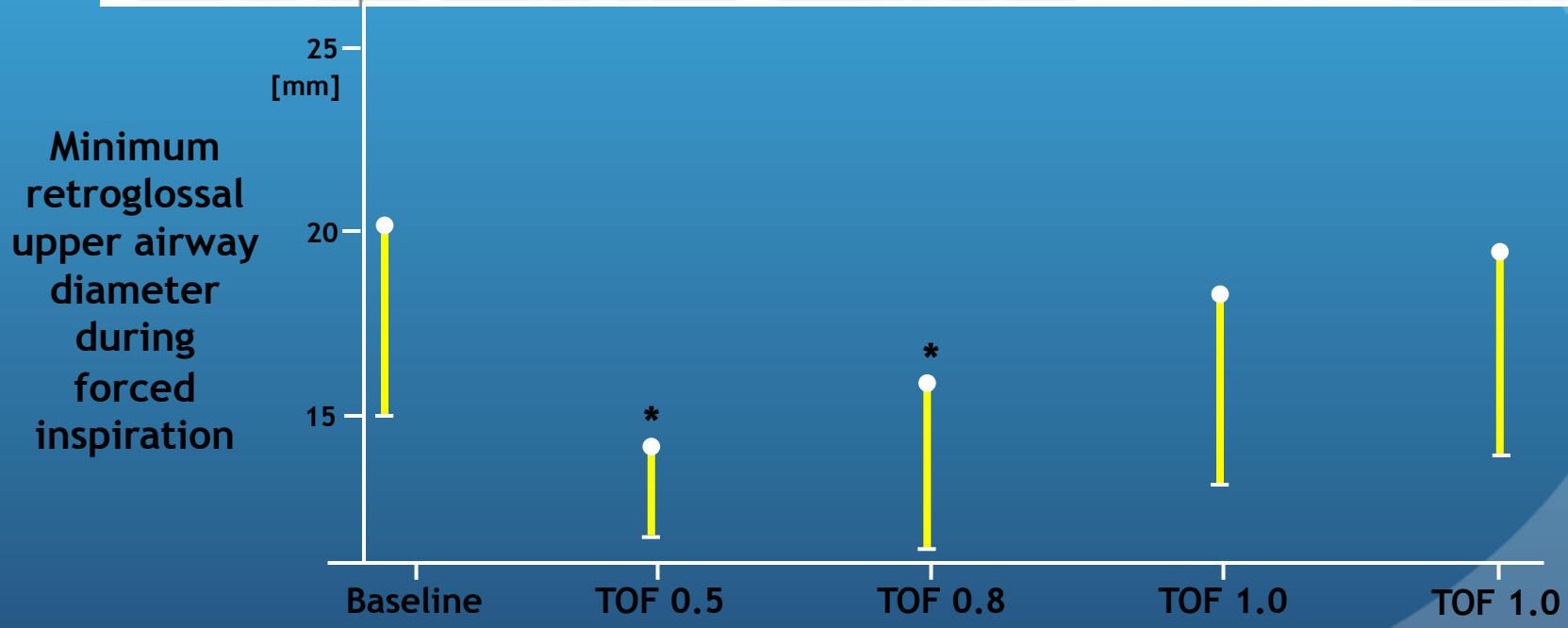
Dr Philippe Van Lancker

Anaesthesiologist

Sint-Jan Brugge-Oostende, Belgium

# Importance of Achieving TOF ≥0.9



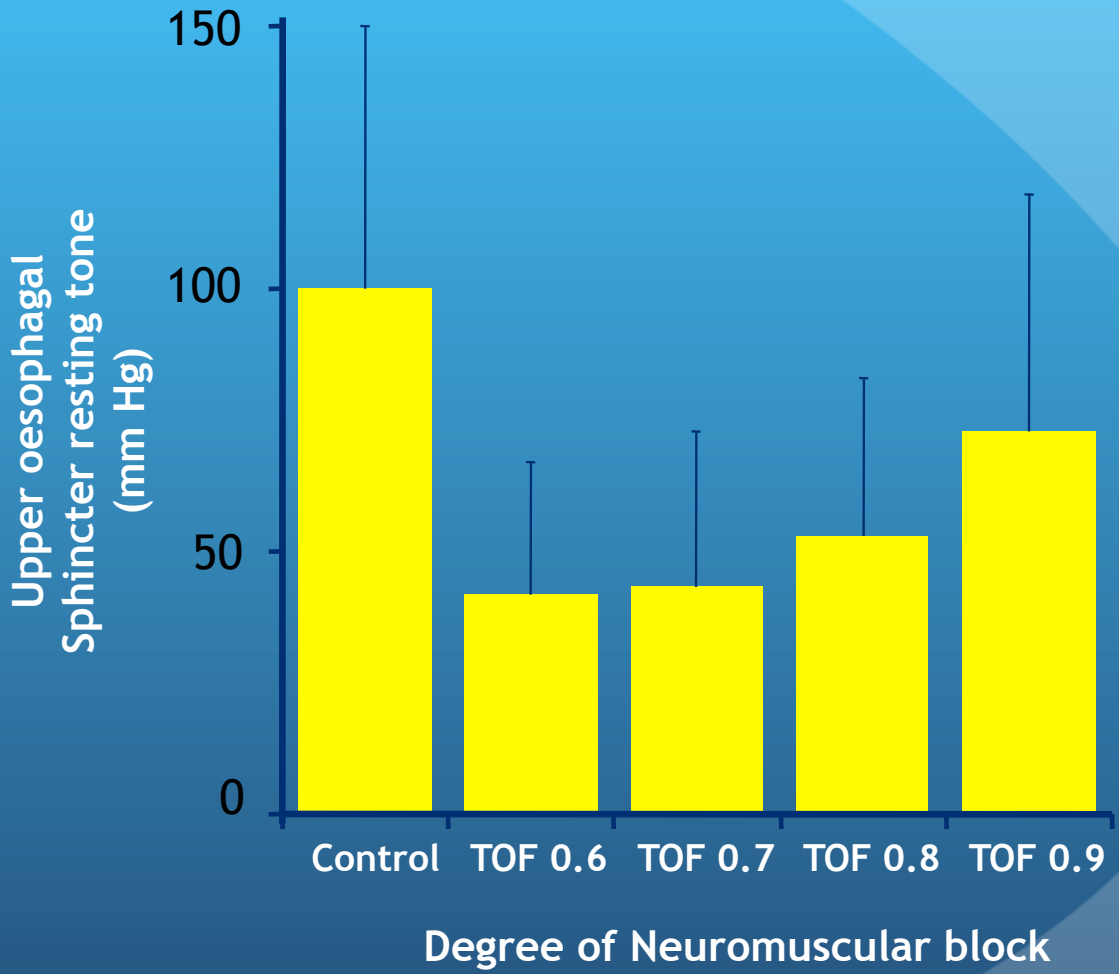



Eikermann, et al. *Am J Respir Crit Care Med.* 2007;175:9-15

* *P*<0.05 versus baseline

# Pharynx Dysfunction Increases the Aspiration Risk

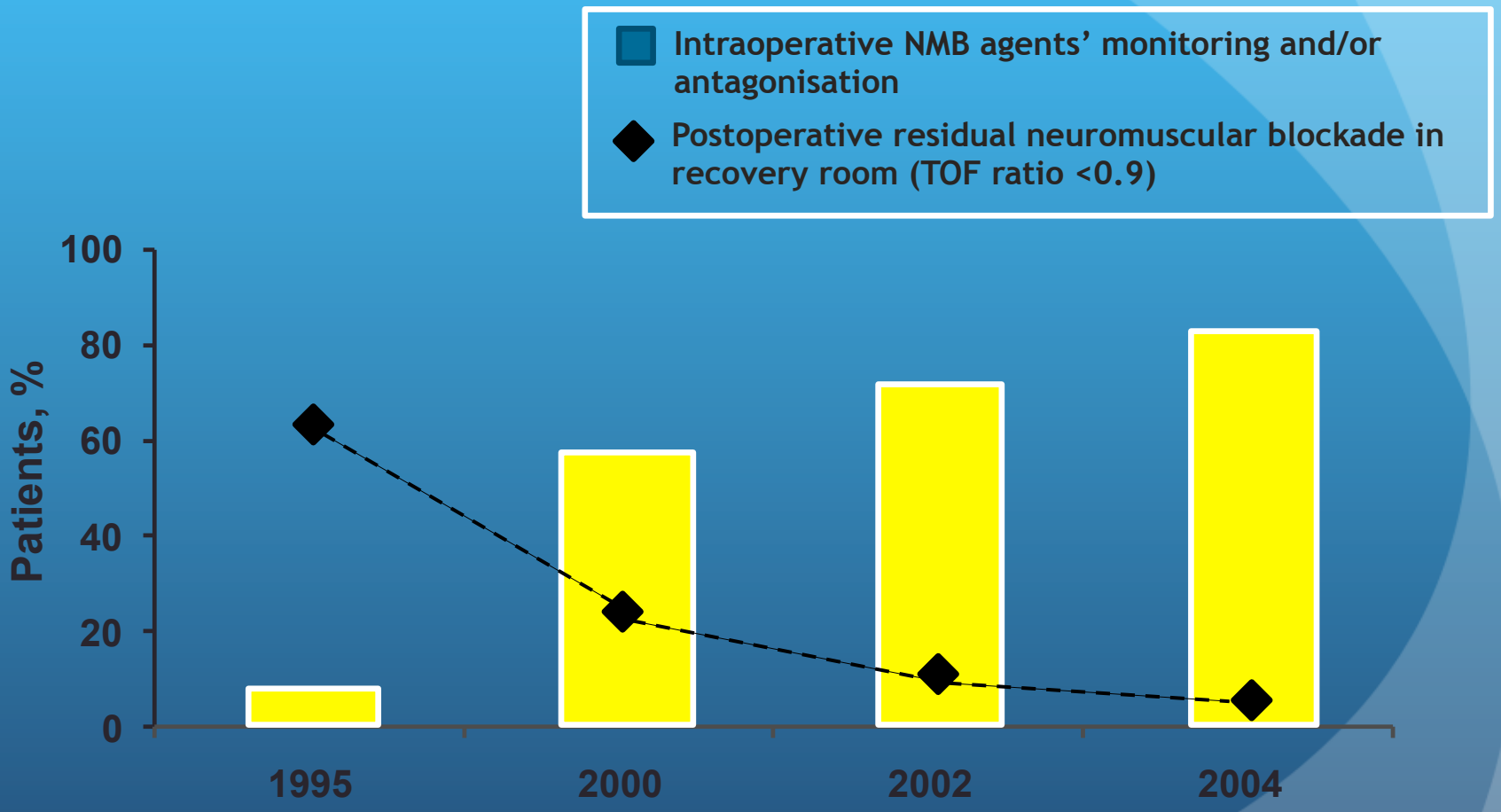
Human volunteers
Partially paralyzed






Eriksson LI, et al. *Anesthesiology*. 1997;87:1035

# The Clinical Benefits of Routine Monitoring and Reversal[1]



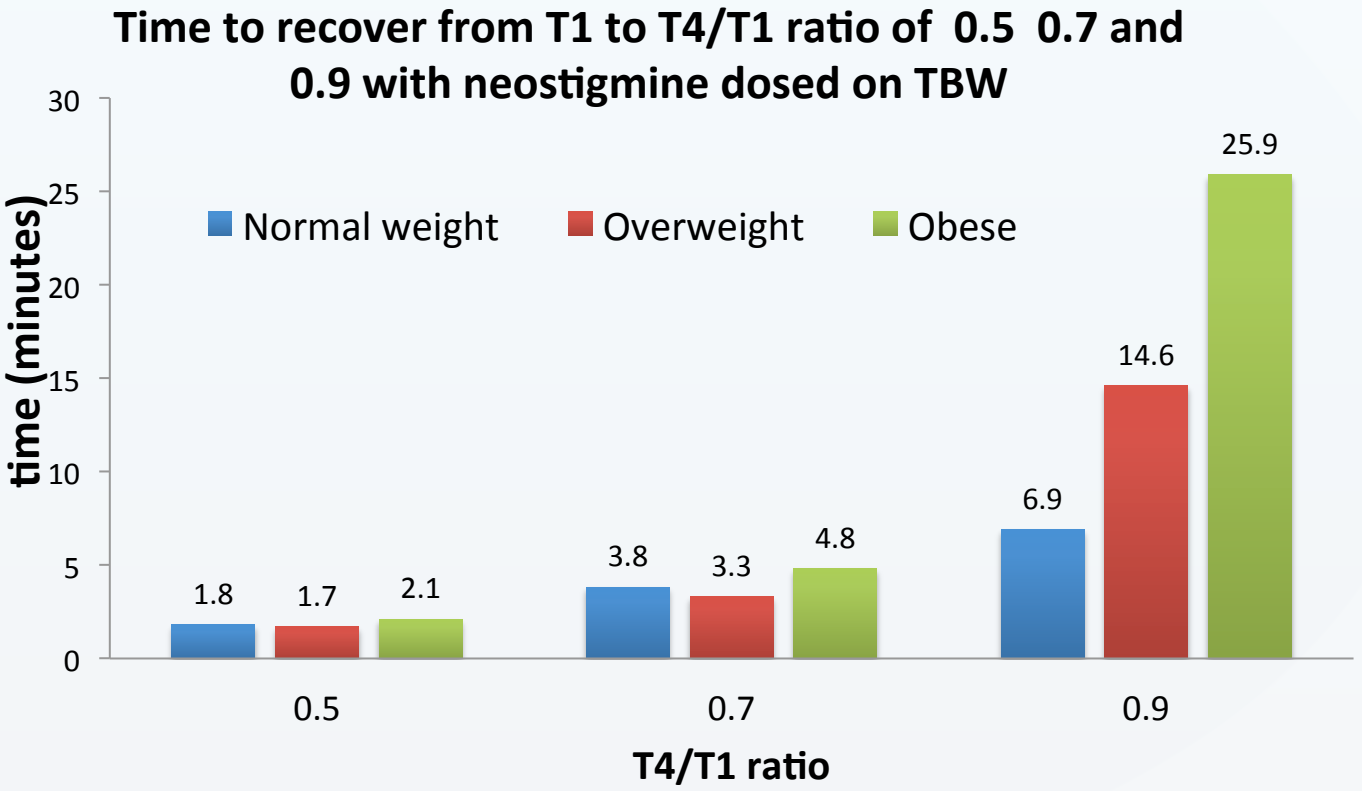

NMB=neuromuscular blockade; TOF=train of four.



1. Baillard C et al. *Br J Anaesth*. 2005;95:622-626.

# Neostigmine is Less Effective in Obese Patients

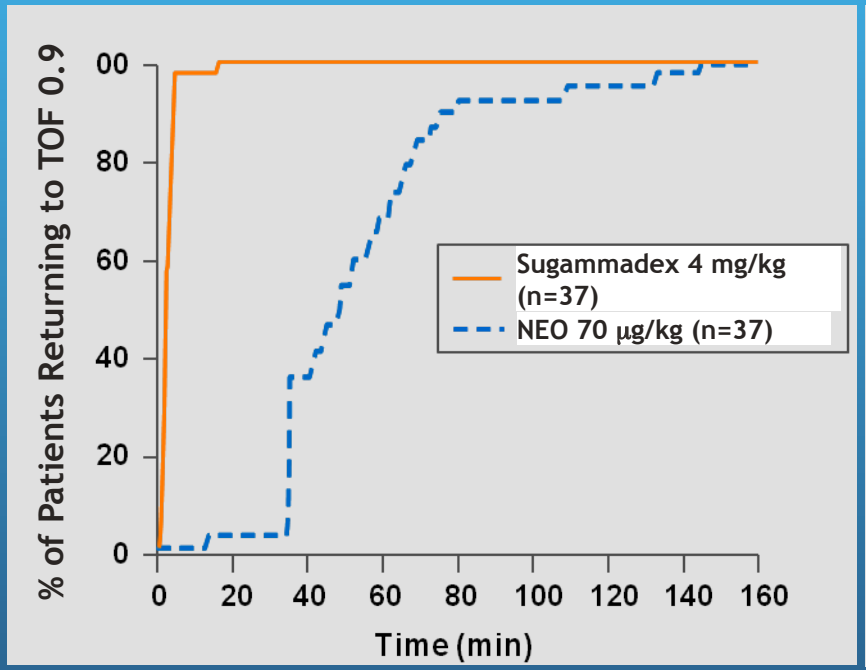
- Obese patients are more difficult to reverse with neostigmine.



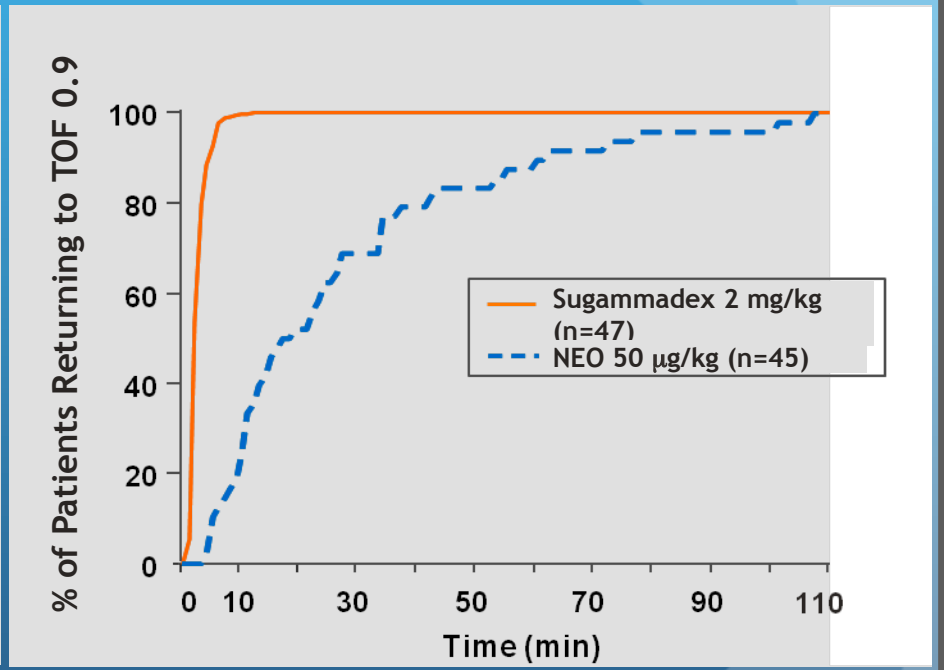

Suzuki T, et al. *Br J Anaesth*. 2006; 97 (2): 160-163.

# Predictability and Consistency of Sugammadex Reversal in Moderate and Deep NMB

**Reversal from 1 to 2 PTCs following rocuronium[1] 0.6 mg/kg**



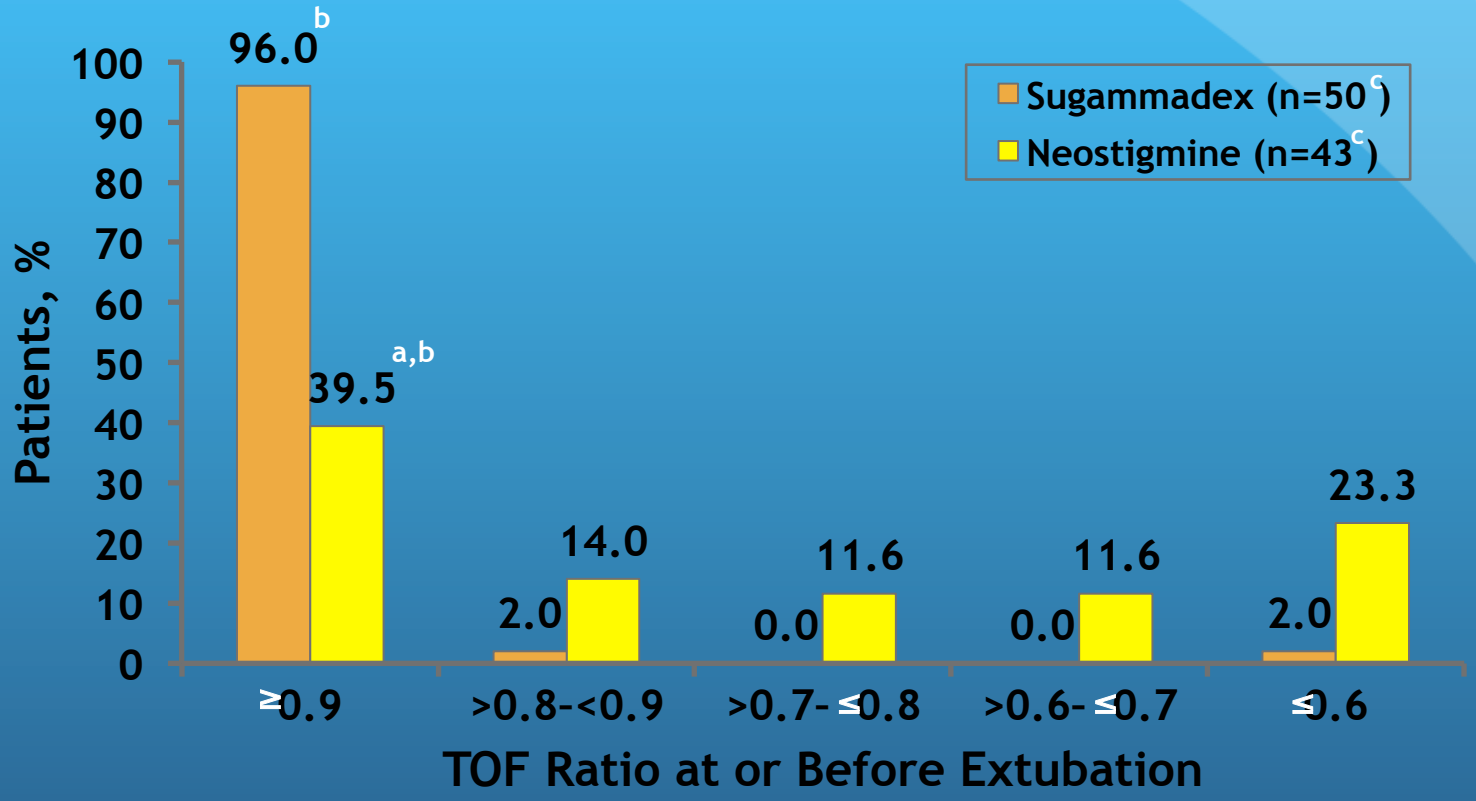

**Reversal from T2 following rocuronium[2] 0.6 mg/kg**




NMB=neuromuscular blockade; PTCs=posttetanic counts; TOF=train of four; NEO=neostigmine.

1. Adapted from Jones RK et al. *Anesthesiology*. 2008;109:816–824. 2. Adapted from Sorgenfrei IF et al. *Eur J Anaesthesiol*. 2010;27:874-881.

# Sugammadex Increases Likelihood that Extubation Occurs at TOF ≥0.9[1]




[a] *P*<0.0001 for sugammadex vs neostigmine (Fisher's exact test).
[b] Includes 7 patients in the sugammadex group and 5 patients in the neostigmine group in whom the monitor was switched off before extubation because the patient was already awake or moving but who had reached a train-of-four (TOF) ratio of ≥0.9.
[c] Patients with data available: In total, 3 patients (1 sugammadex and 2 neostigmine) were excluded from the figure because monitoring was stopped before extubation, as the patient moved or woke up. In addition, 1 neostigmine patient was not included because the TOF trace was considered to be unreliable.



1. Sabo et al. *J Anesthe Clinic Res.* 2011;2:1-7.

# Effects Of Rocuronium on Morbidly Obese Patients

Rocuronium 0.6 mg/kg:

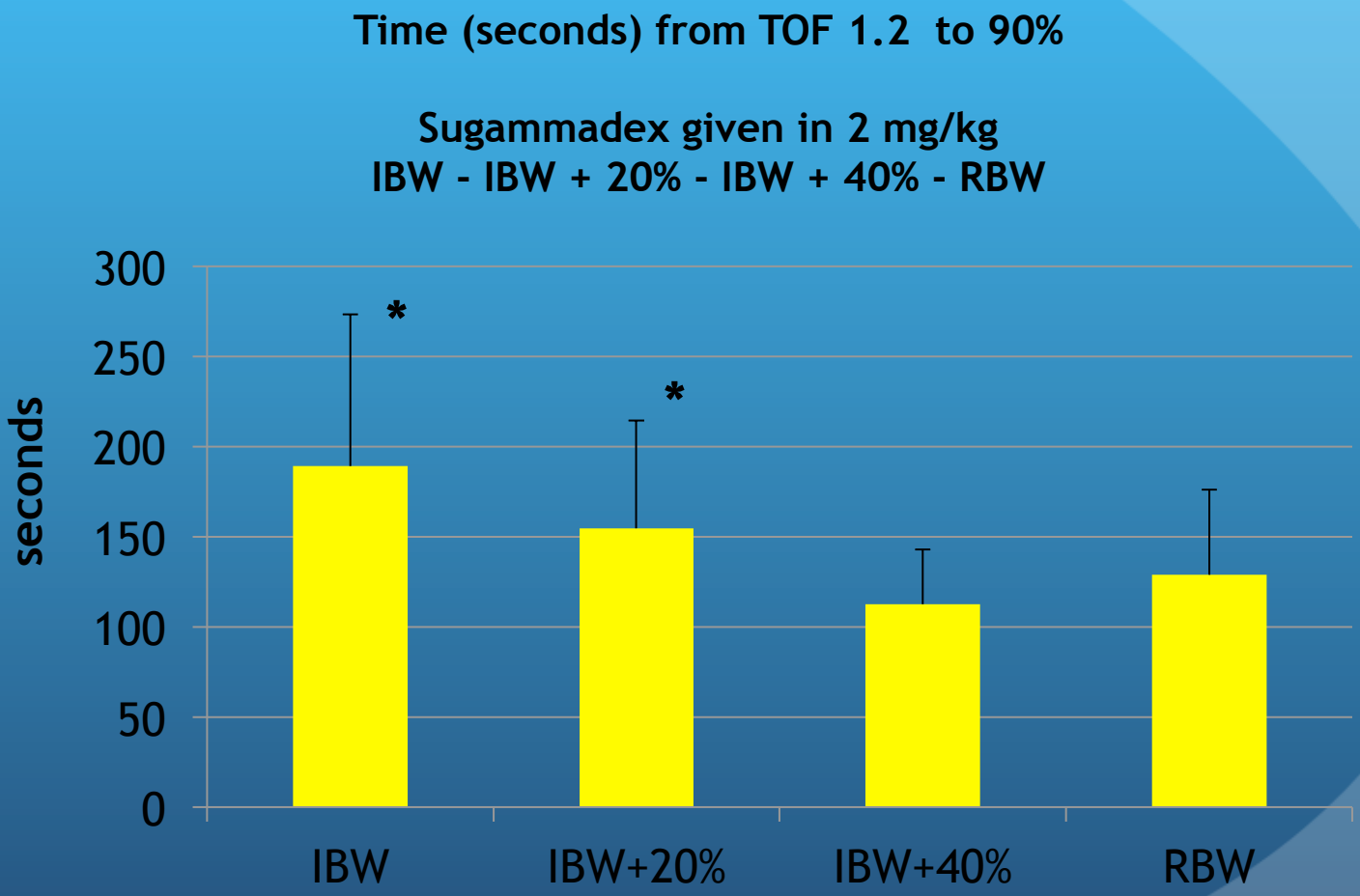
- RBW: Real body weight (BMI>40)
- IBW: ideal body weight (BMI>40)
- NBW: RBW in non obese patients (BMI < 25)

| Group | BMI | Weight (kg) | Onset (sec) | Duration 25% (min) |
|---|---|---|---|---|
| RBW (*n*=6) | 43.8 ± 2.1 | 111 ± 13 | 77.0 (37-92) | **55.5** (43.6-60.1) |
| IBW (*n*=6) | 43.3 ± 5.8 | 114 ± 21 | 87.5 (54-99) | **22.3*** (21.1-24.9) |
| NBW (*n*=6) | 22.1 ± 1.8 | 62 ± 8 | 66.5 (50-85) | **25.4*** (18.4-31.1) |

* *P*<0.001 vs Real Body Weight

Leykin Y et al. *Anesthesia Analgesia*. 2004;99:1086-1089.

# Ideal vs Corrected Body Weight for Dosage of Sugammadex in Morbidly Obese Patients




IBW=ideal body weight; RBW: real body weight

Van Lancker P, et al. *Anaesthesia*. 2011;66(8):721-725.



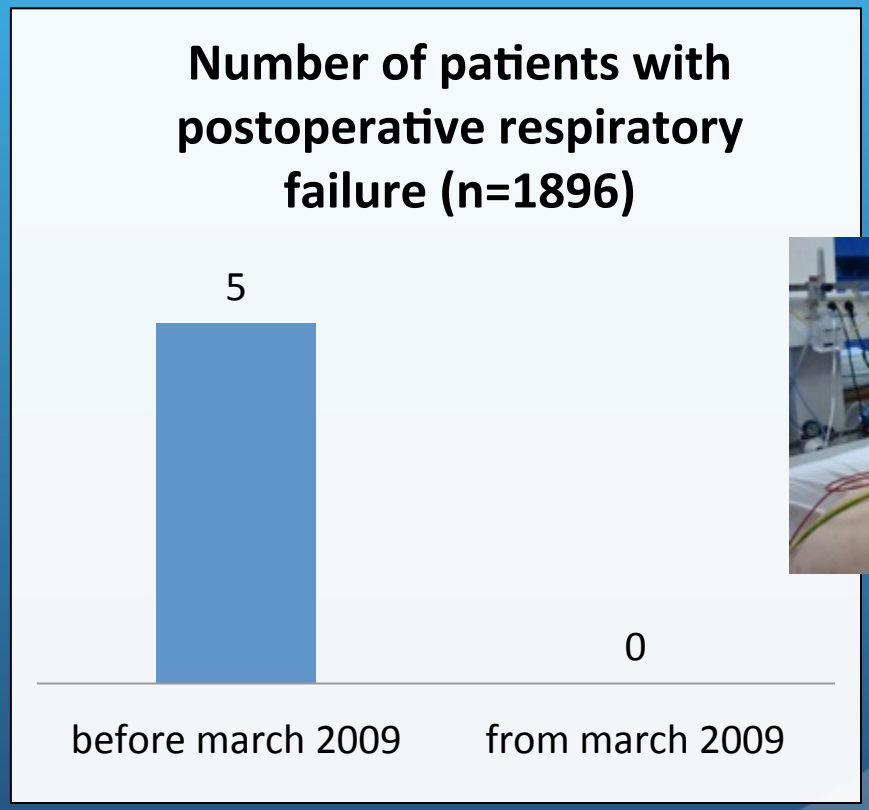
*P<0.001 versus RBW

# NMB During Laparoscopic Surgery in Morbidly Obese Patients

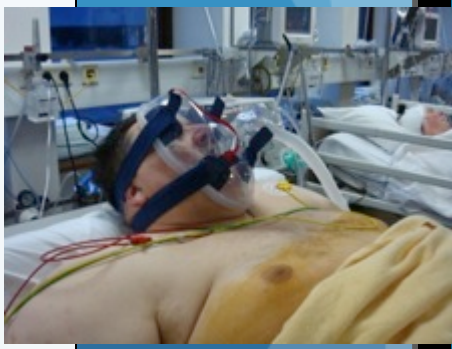
- Deep muscle relaxation may provide and maintain sufficient surgical workspace
- A patient being fully awake and able to take deep breaths postoperatively is important
- Neostigmine has an unpredictable and very long decurarisation time to reach a TOF ratio >0.9
- Sugammadex provides predictable reversal in moderate and deep NMB

# Perfect reversal in morbidly obese patients prevents pulmonary complications

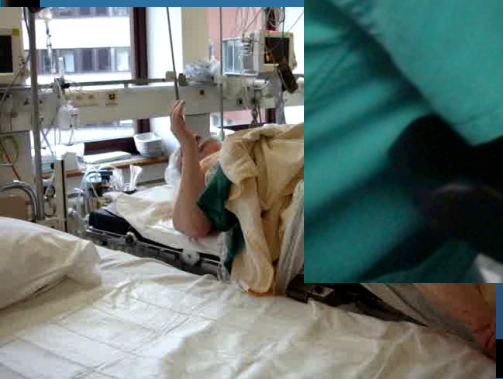
- Retrospective analysis of 948 consecutive morbid obese patients before vs. 948 consecutive morbid obese patients after availability of sugammadex.
- 1st march 2009: sugammadex available
- Mulier JP, ESA 2011




- Respiratory failure
- Re intubation
- CPAP different from OSA
- Hypercapnia post op
- Intensive care admission



# Self in bed is possible after sugammadex



# Conclusion B: Laparoscopy in morbid obese patients

1. deep muscle relaxation is needed
2. reaching a TOF 90 % is essential
3. being full awake and taking deep breaths is important

- Neostigmine has a total unpredictable and very long decurarisation time to reach a TOF 90% in comparison with non obese patients.
- Neostigmine has not a central arousal effect.

This is easily achieved with Sugammadex whatever the NMB depth.

Dosis in morbid obese patients follows TBW till a BMI of 40.

Above BMI 40 keep dosis constant.




# Cape international Bruges 2011

1150 1850 1947 1977 2010

A. Use of Deep Muscle Relaxation in Laparoscopic Bariatric Surgery: J P Mulier

B. Importance of Deep Muscle Relaxation for the Laparoscopic Surgeon: B Dillemans

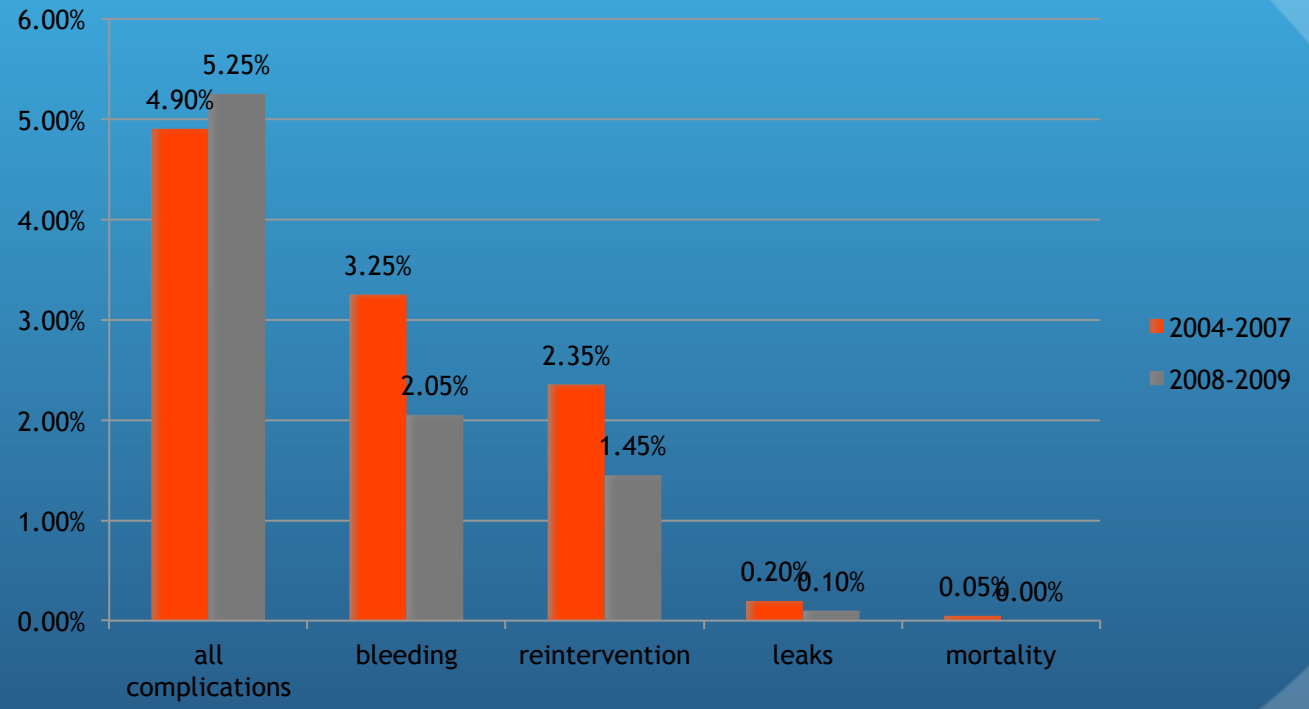
C. Reversal of Neuromuscular Blockade (NMB) in Morbidly Obese Patients: P Van Lancker

D. Using ERAS (enhanced recovery after surgery) for Laparoscopic Bariatric Surgery: J P Mulier

Sint-Jan Brugge-Oostende, Belgium

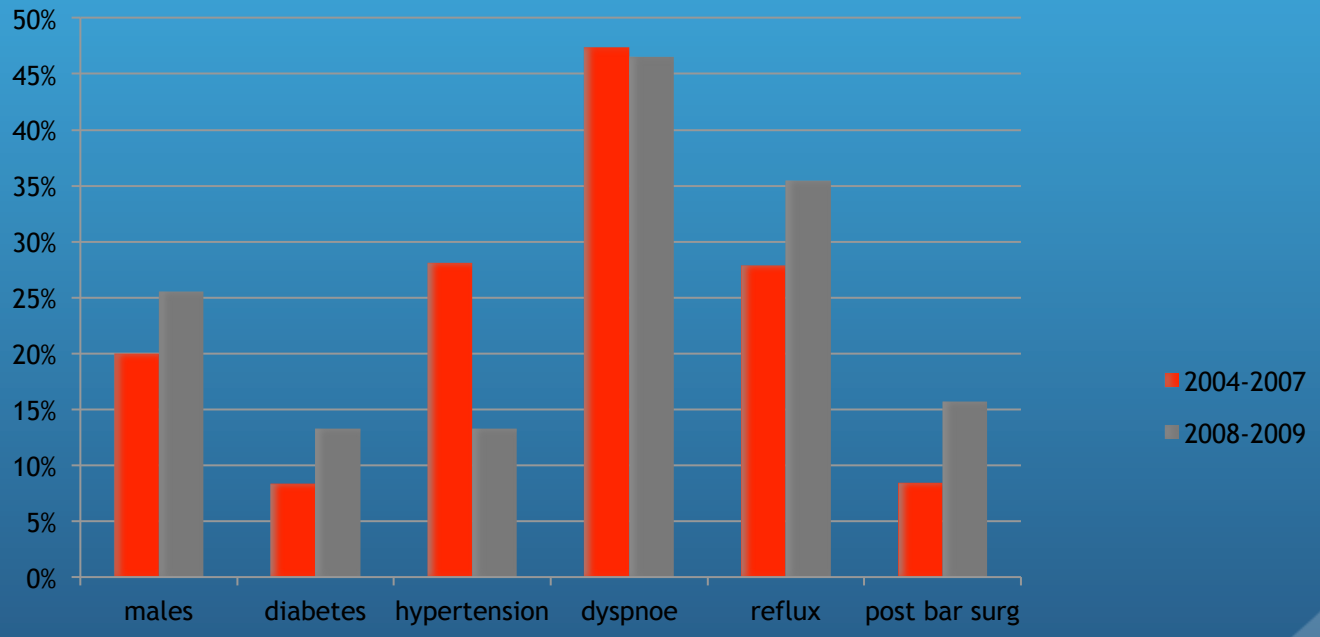
# 4000 consecutive lap RNY

- Less complications



# 4000 consecutive lap RNY

- Increase in males, diabetes, revisions



# ERAS -> short turn-over times.

## Non-surgical time: last stitch till incision next patient

- Try to reach 30 minutes "Dexter"
- We reach less than 30 min on average

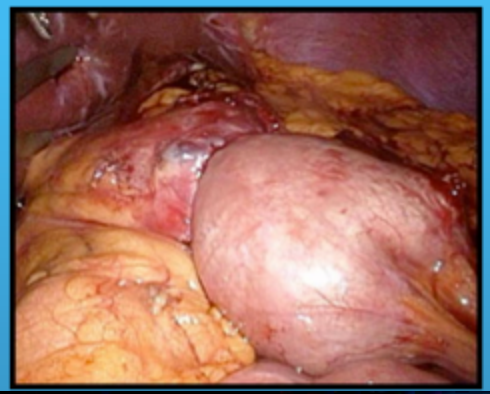
| | Dr Dillemans | other |
|---|---|---|
| Av. Surgical time | 54 | 61 |
| Av. Non-surgical time | 12.5 | 20.1 |
| Complications rate | | |
| Mortality | 0.04% | 1.02% |
| Obstructions | 0.38% | 1.5% |
| Bleedings | 3.14% | 4.38% |
| Leakage | 0.17% | 2.7% |

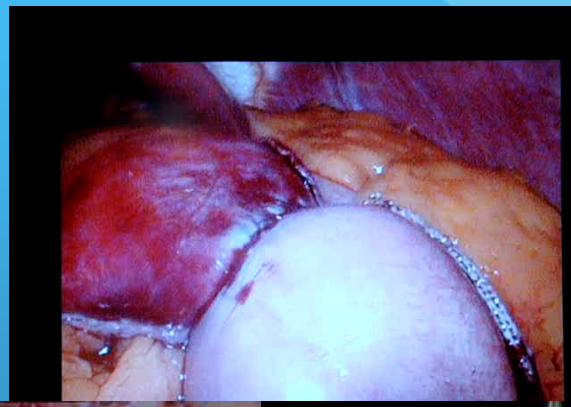
- Why is this possible?
  - Rapid awakening and extubation:
  - Induction Room use:
  - Rapid switching: patient out and next patient into room
  - SPT Short pre-incision surgical preparation time

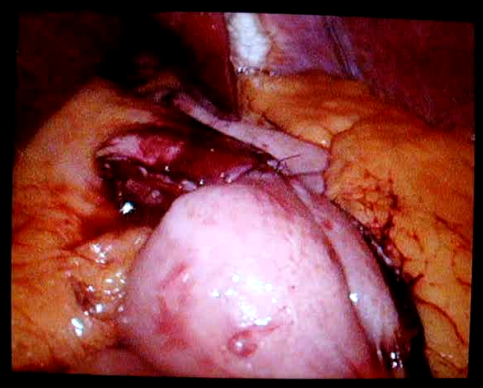
# ERAS (enhanced recovery after surgery)

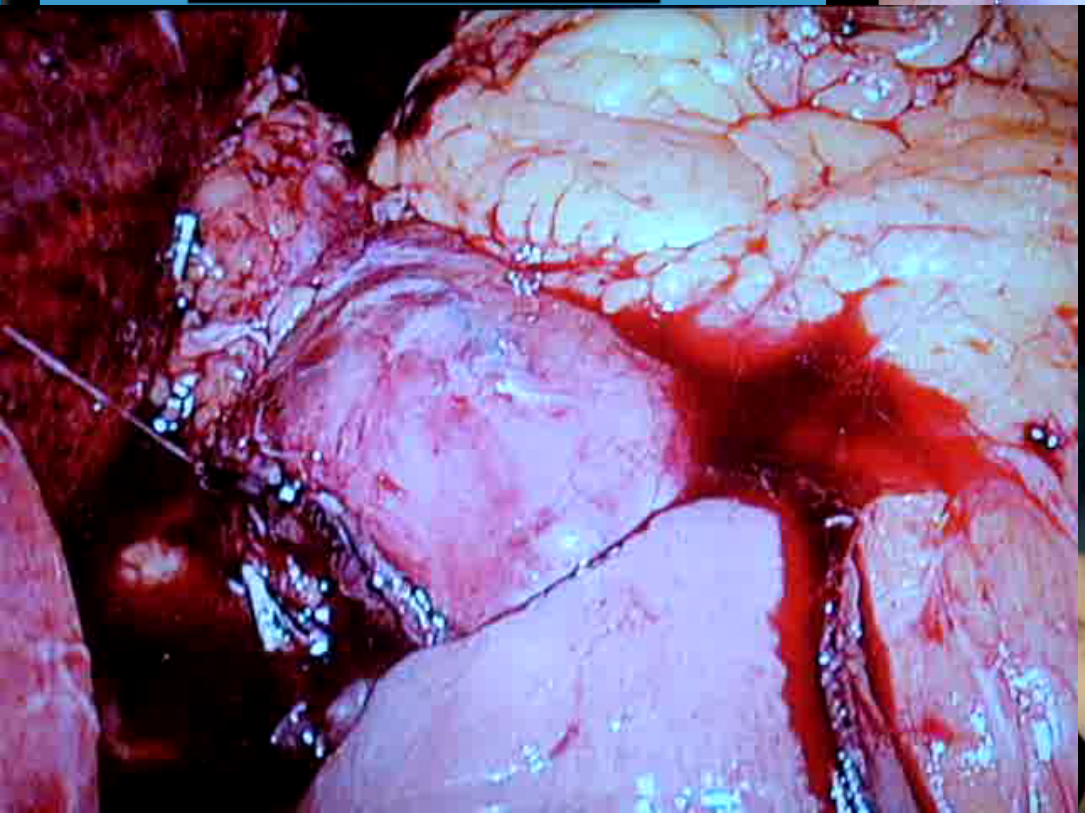
- Keep NMB till end of surgery if abomen is small
- Prevent post op leak
- Prevent post op bleeding
- Improve peripheral circulation
- Prevent post op atelectasis
- Prevent post op pain
- start spontaneous breathing early during surgery using support ventilation
- Prevent post op aspiration
- trombоprophylaxis

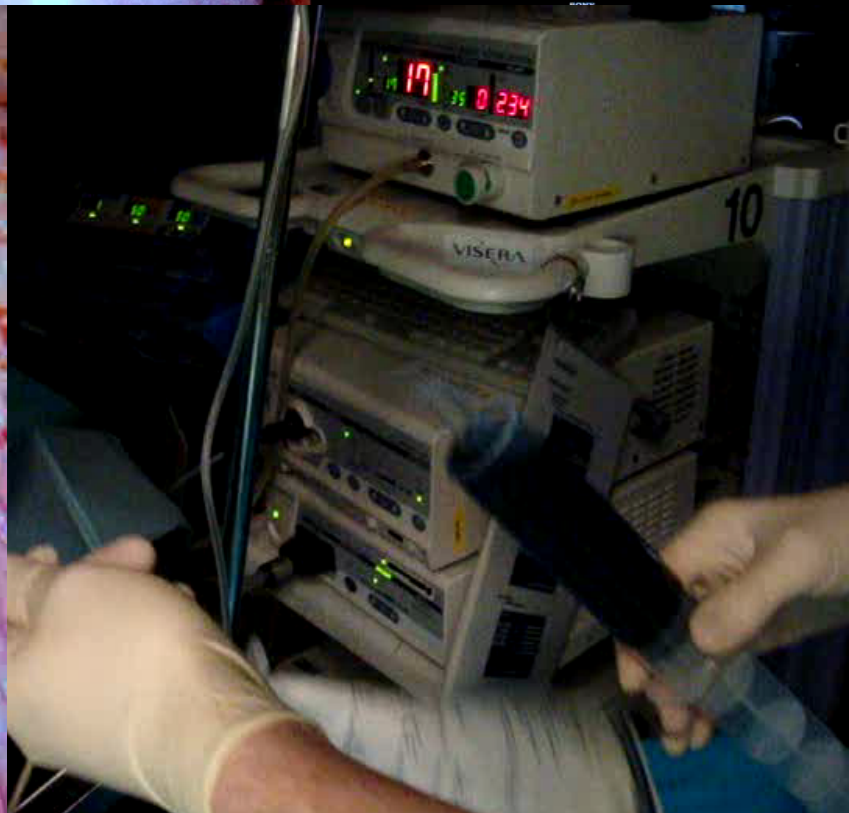
# leak test rapid injection of 150 ml blue water and air



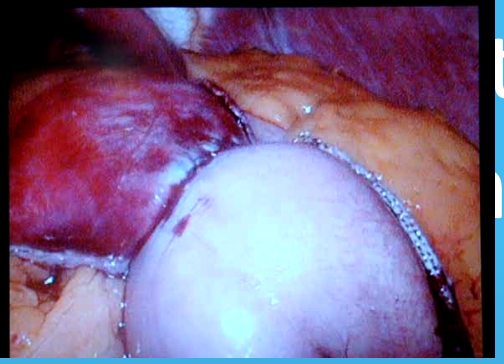




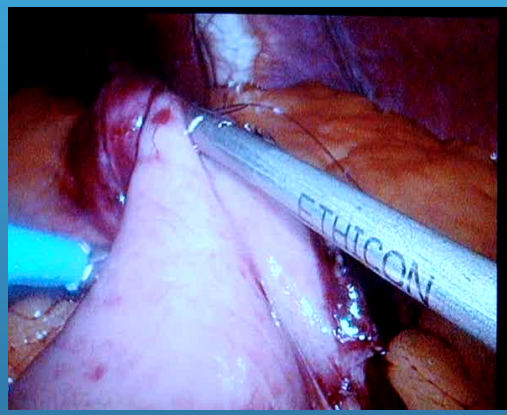




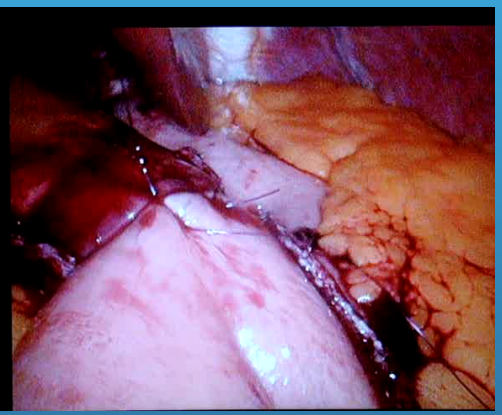
# tive leak test
# e staple line



irst leak test is positive

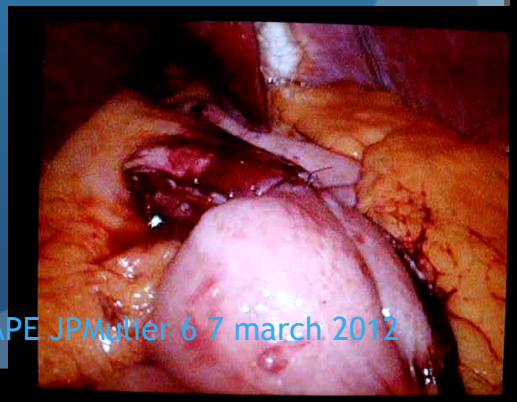



Suture 1



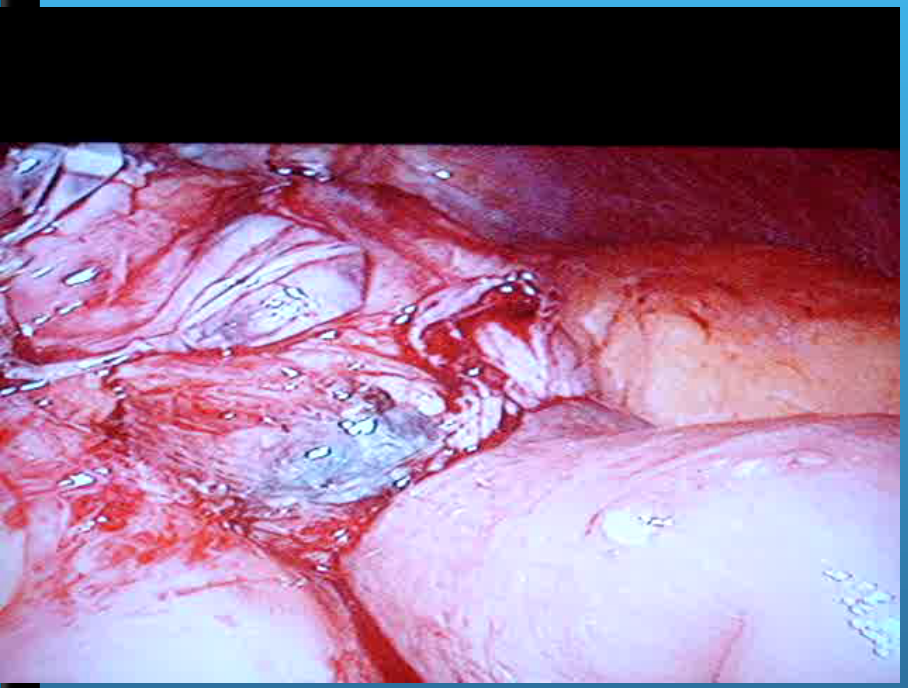
Suture 2

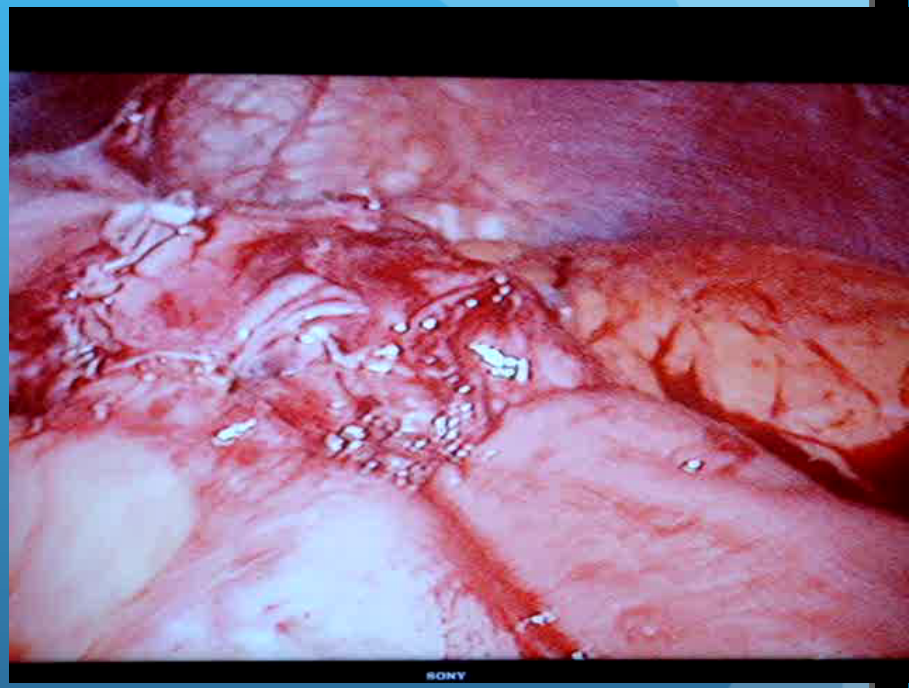
Second leak test is negative



# Positive Leak test submucosal followed by control after suture

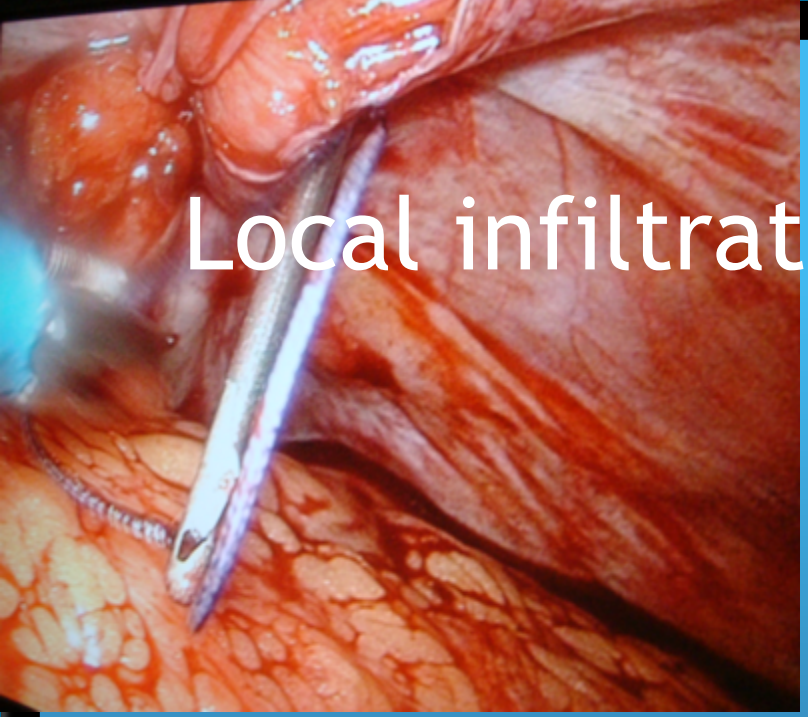


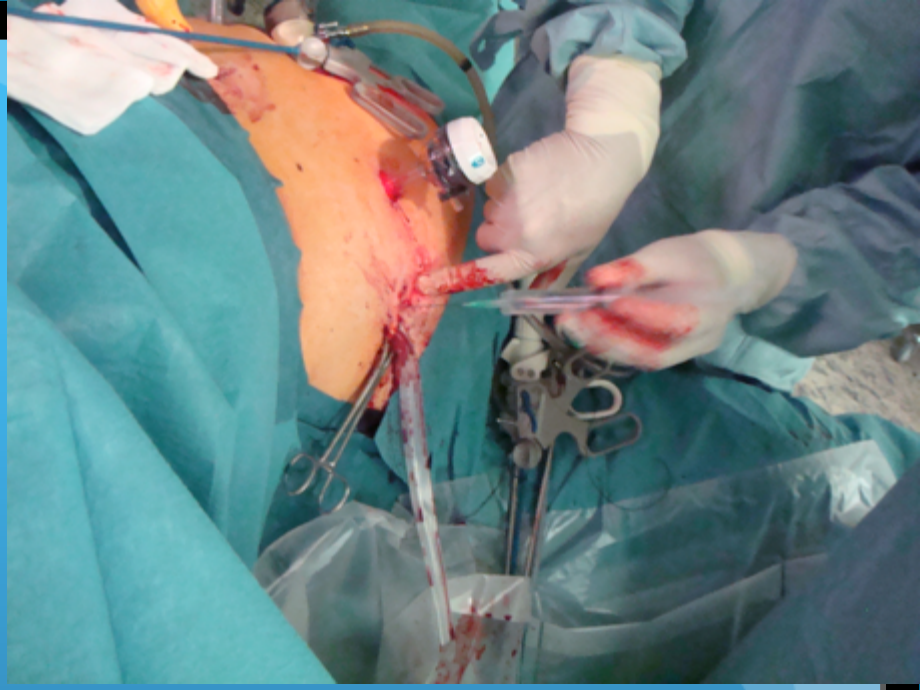


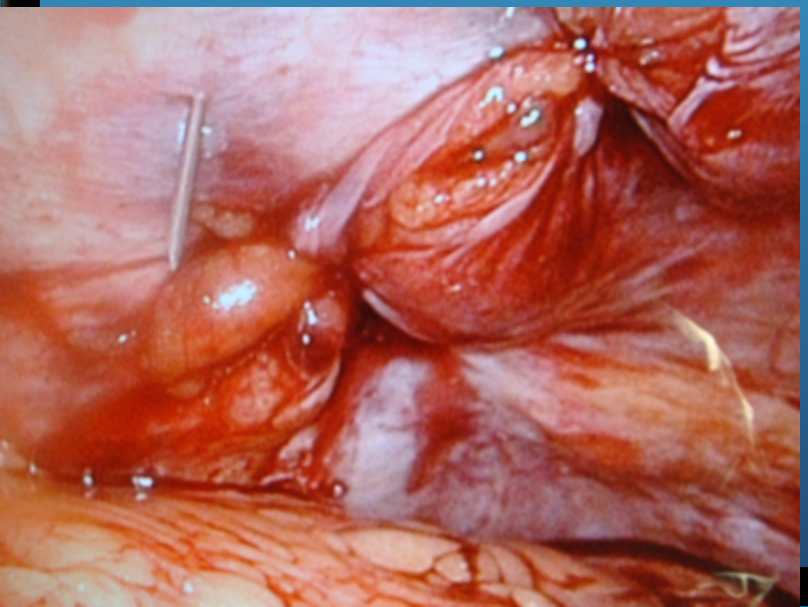


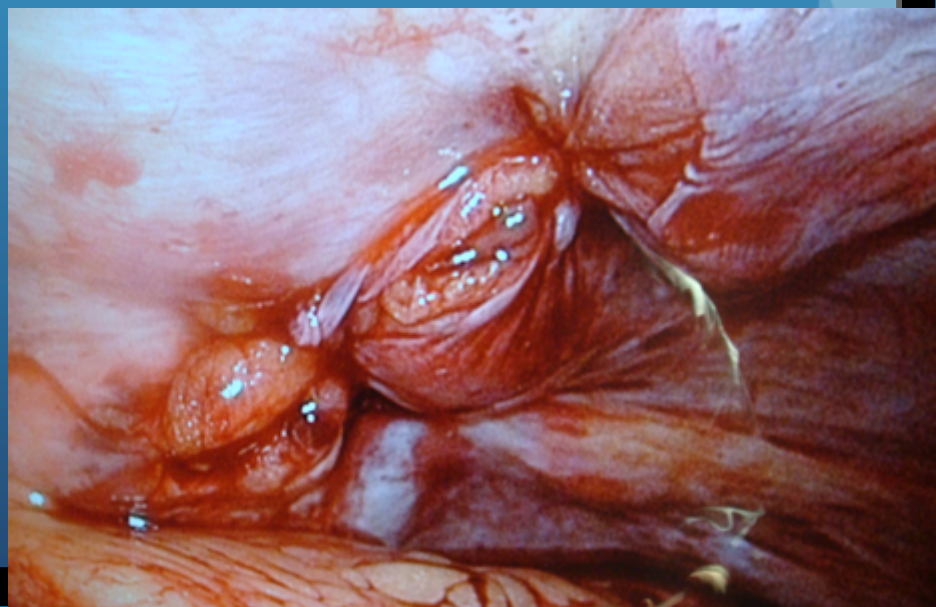

RNY: 150 -> 300 ml syringe 150 ml
Sleeve: 300 -> 600 ml air only under water

# Local infiltration



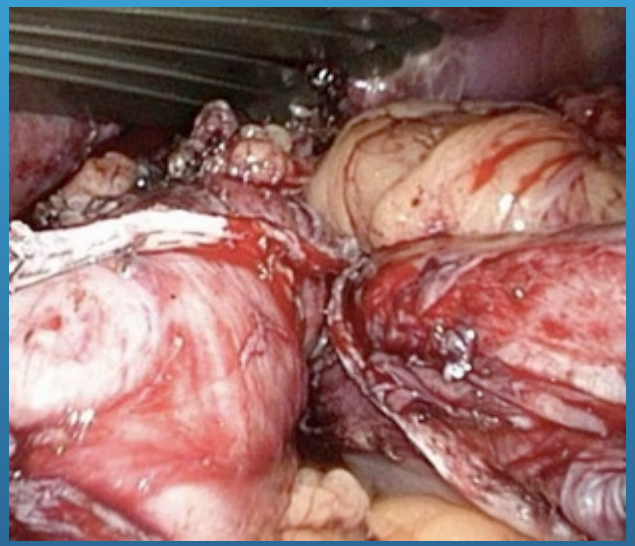






# Use SAP increase to reduce post bleeding

Increasing blood pressure at end of surgery allows surgeon to find possible bleeding arteries and by clipping preventing post operative bleeding.



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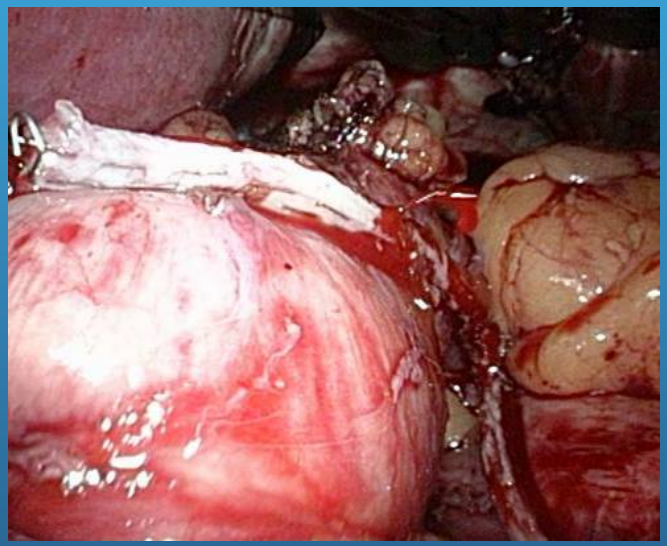

145/78

- *Mulier JP Obes Surg 2007, 17: 1051*

# Increase in systolic arterial pressure prevents post laparoscopic gastric bypass (RNY) bleeding?

Jan P Mulier, M.D., Ph.D.[1,2], Mercedes Garcia, M.D.[3], Tom Bogaert, M.D.[2], Bruno Dillemans, M.D.[4] and Sebastiaan Vancauwenberge, M.D.[4].

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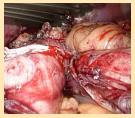
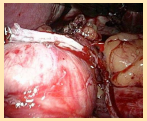
## Background and Goal of Study

- Increase of the systolic arterial pressure (SAP)
  - to 140 mmHg at the end of the surgery
  - checking haemostasis
  - introduced at the beginning of 2008
  - gradual followed by all anesthesiologists.

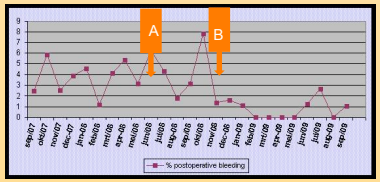
- Blood pressure rose
  - first by vaso active drugs
  - later by adding permissive hypercapnia.
- Detection of bleeding otherwise not treated. (1)

**The aim of this study:**

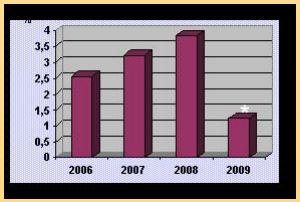
Retrospective analysis of increasing the SAP on the incidence of early postoperative bleeding.

## Results

87 patients of the 3263 patients operated for lap-RNY between 2006 and sept 2009 developed post operative bleeding.




Monthly percent of patients with bleeding




Yearly percent of bleedings.

ANOVA test: * 2009 is significant different from the other years (p = 0.002)

## Materials and Methods

- Restrospective review off all lap RNY
  - 01/2006 -> 09/2009: number of bleedings?
  - approval of ethical committee.
- Post operative bleeding first 48 hours (2,3
  - Blood transfusion,
  - Surgical reintervention for bleeding
    Clinical signs: haemoglobine drop > 1 unit.

## Discussion

- End 2008 (B) the incidence of bleeding dropped while blood pressure rise was introduced spring 2008 (A).
  - The systematic adaptation in every patient has taken more time.
- The method to raise blood pressure changed.
  - Vasoconstriction -> cardiac output rise.
- In the last years some other factors changed gradual like. (4)
  - Surgical removal of blood vessels close to the circular anastomosis
  - Changes in the quality of circular and linear staples.
- No causal relationship between SAP increase and drop in post operative bleeding can be made.
- Evaluation of the bleeding incidence when changing the medical protocol is important.

## Conclusion

✓ Bleeding incidence dropped and should be monitored when protocol changes.
✓ No proof that SAP increase is reason for reduction but ethical approval for blinded RCT became impossible in our institute.
✓ The detection of extra bleedings when SAP rises and the drop in early post op bleeding are strong enough to keep new protocol.

## References

(1) Nguyen NT. Obes Surg. 2004
(2) Mehran A. Am J Gastroenterol. 2008
(3) Mulier J P. IFSO 2007
(4) Dillemans B. Obes Surg 2009





# ASA 2010

# Hypercarbia effects

*Bille-Brahe NE Acta Chir Scand Suppl. 1976; 472: 127*
*Cardiovascular effects of induced hypercarbia during halothane-nitrous oxide anaesthesia.*

- Heart rate, cardiac index, systemic and pulmonary blood pressures rose as pCO2 was increased. Stroke volume, systemic and pulmonary vascular resistance remained unchanged.
- In conclusion the primary effect of hypercarbia was an increased heart rate and a resultant increase of cardiac output.
- The pressure changes merely reflect the effect on cardiac output.

# Hyperventilation

- **Hyperventilation prevents spontaneous ventilation**
- **Hyperventilation and normoventilation**
  - Induces lung injury by stretching. Volutrauma
  - Bronchoconstriction and increased permeability of bronchial airway epithelium
  - Systemic vasoconstriction, reduced cardiac output
- **Post operative reduced reserve of bicarbonate**
  - **Even when et CO2 returned to normal**
  - **Reduction of bic is fast, build up takes hours till 24 H?**

**Resp depression = sleep apnoe ? or = hyperventilation?**

# Hypoventilation and hypercarbia

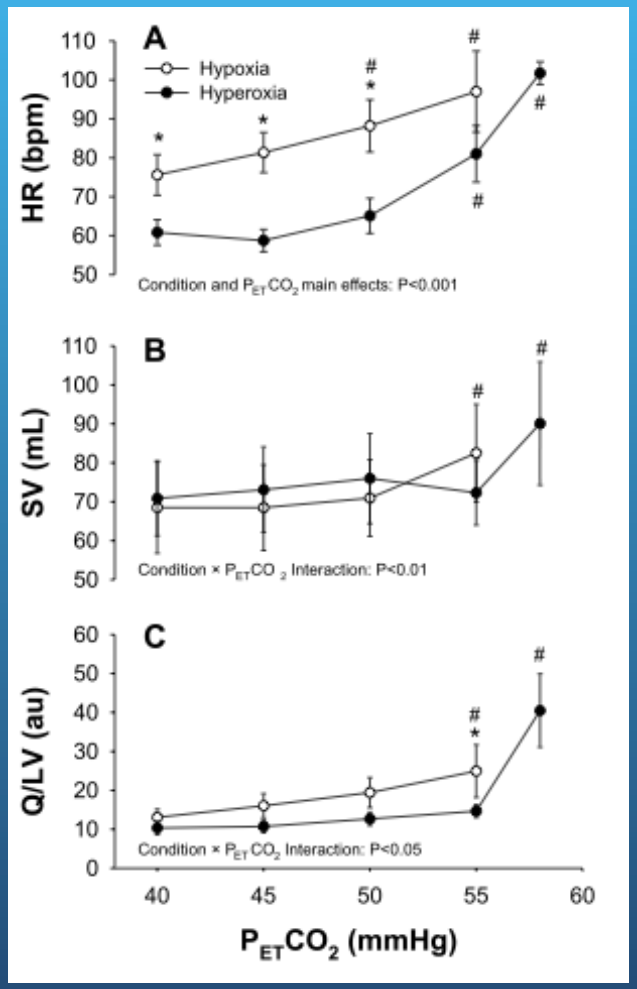
- protection of the lungs
- Hypoxic pulmonary vasoconstriction better VA/Q matching
- Rightward shift of the oxyhemoglobin dissociation curve
- Cardiac output rises
  - which appears to be directly related to both hypercapnic acidosis per se and to hypercapnia-induced sympathetic activation and release of catecholamines
- Systemic arterial vasodilation
  - 10 mmHg increases the cardiac index by about 10–15%
- Suppresses many cellular functions, the overall local effect is reduced local O2 consumption

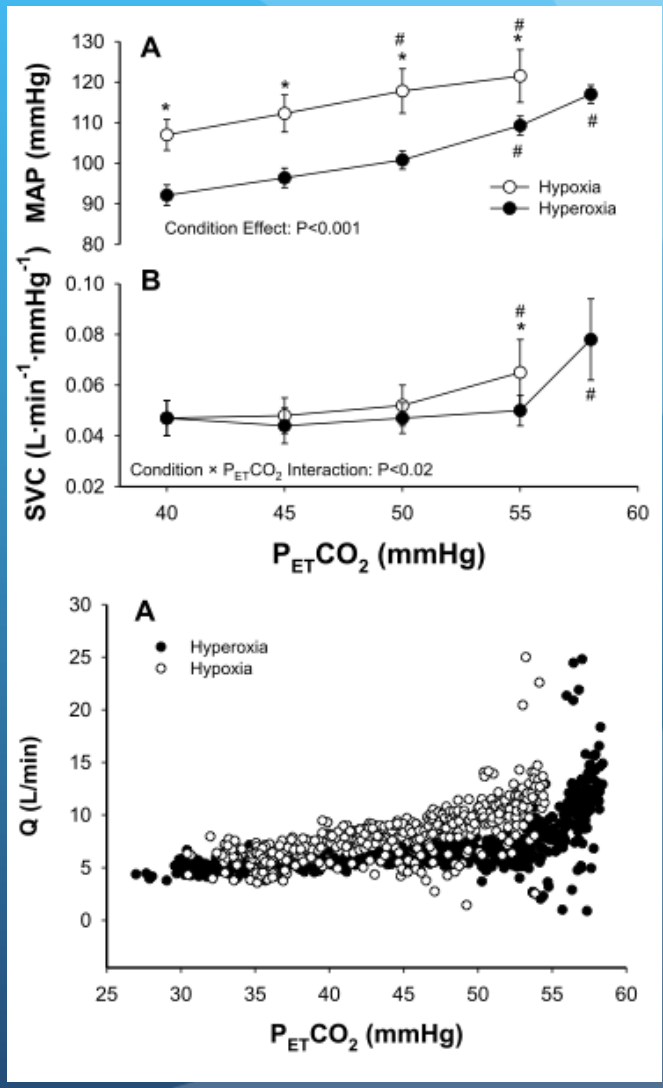
Increases oxygen availability to tissue effects ? On infection, healing, oedema,…

# Hemodynamic effects of Hypercapnia (vs hypoxia)

**Peripheral chemoreceptor contributions to sympathetic and cardiovascular responses during hypercapnia.**

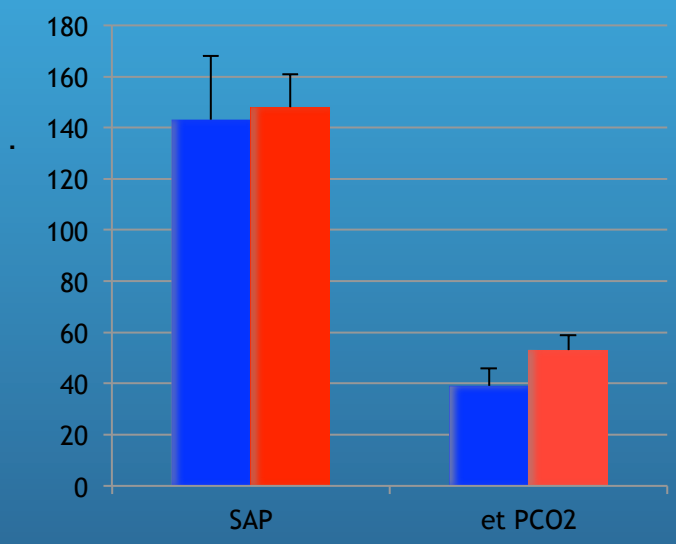
**Shoemaker JK** Can J Physiol Pharmacol. 2002; 80: 1136.

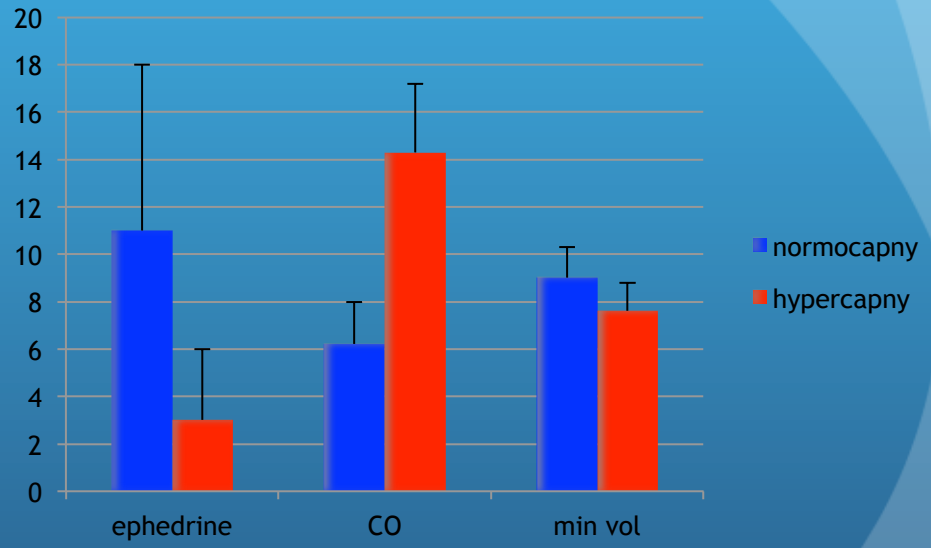


# Permissive Hypercapnia vs Normocapnia under general anesthesia in obese patients

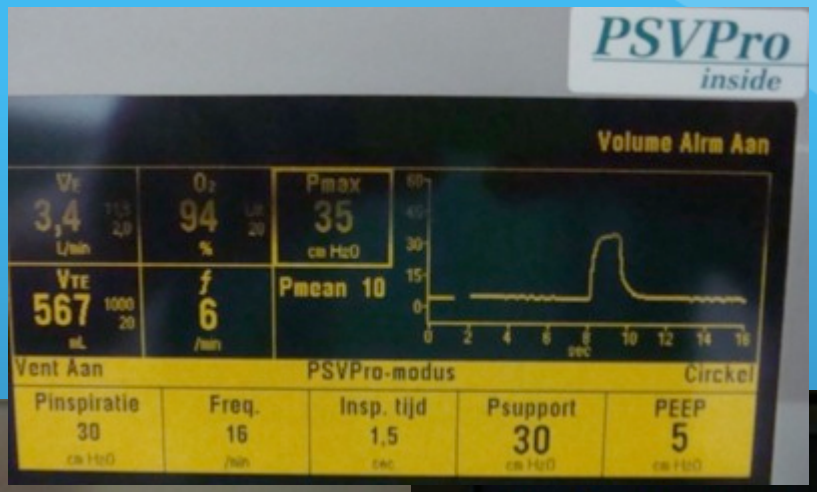
Mulier JP Anesthesiology ESA 2008 A174

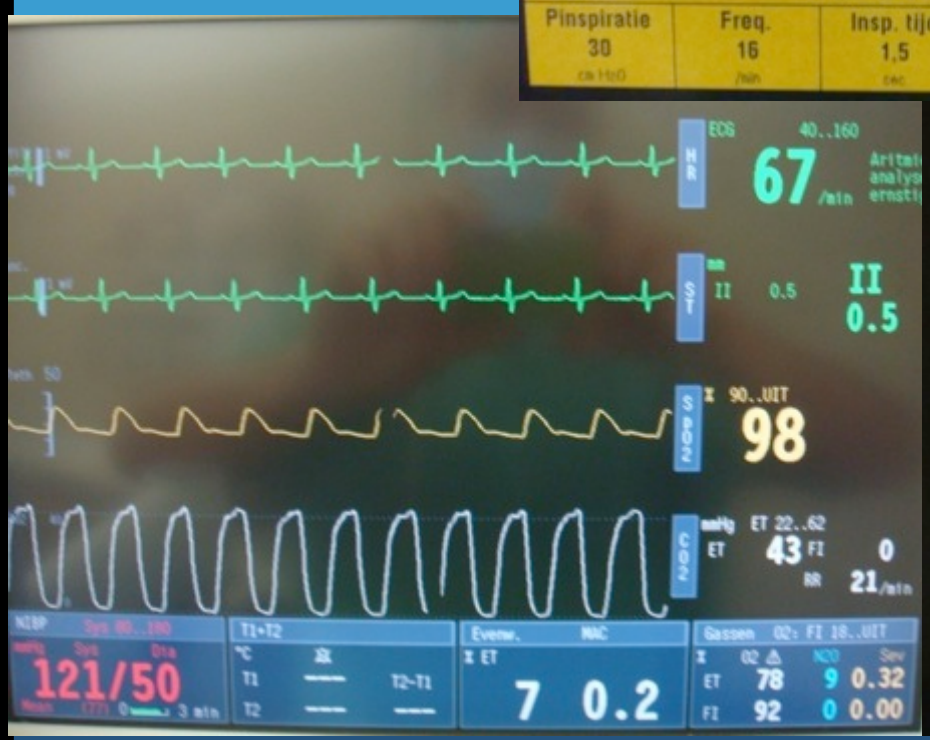


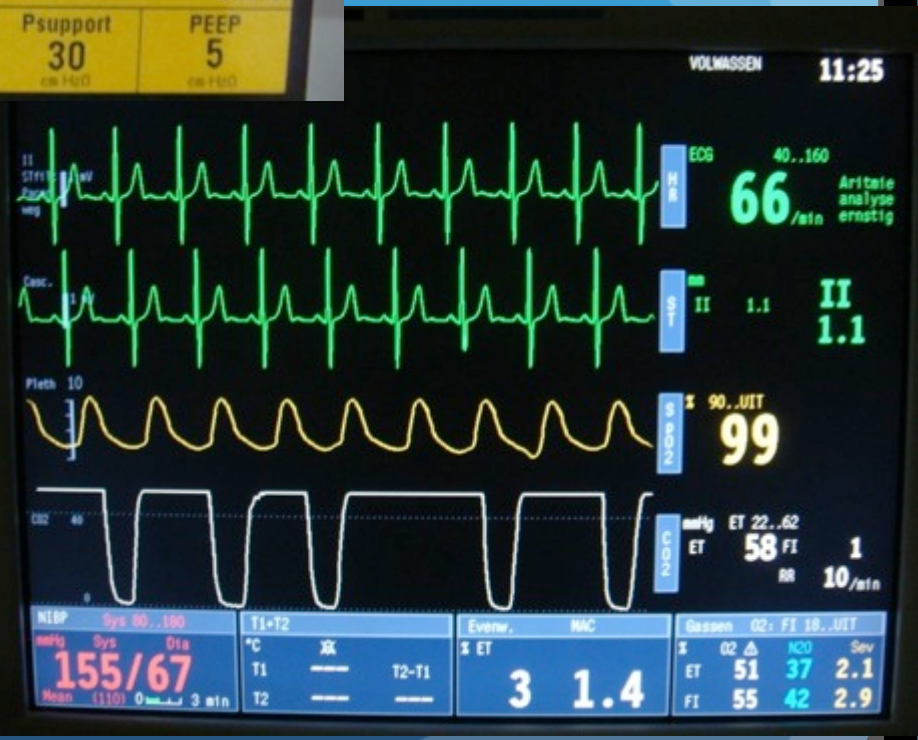




Less ephedrine is needed to elevate SAP due to CO increase

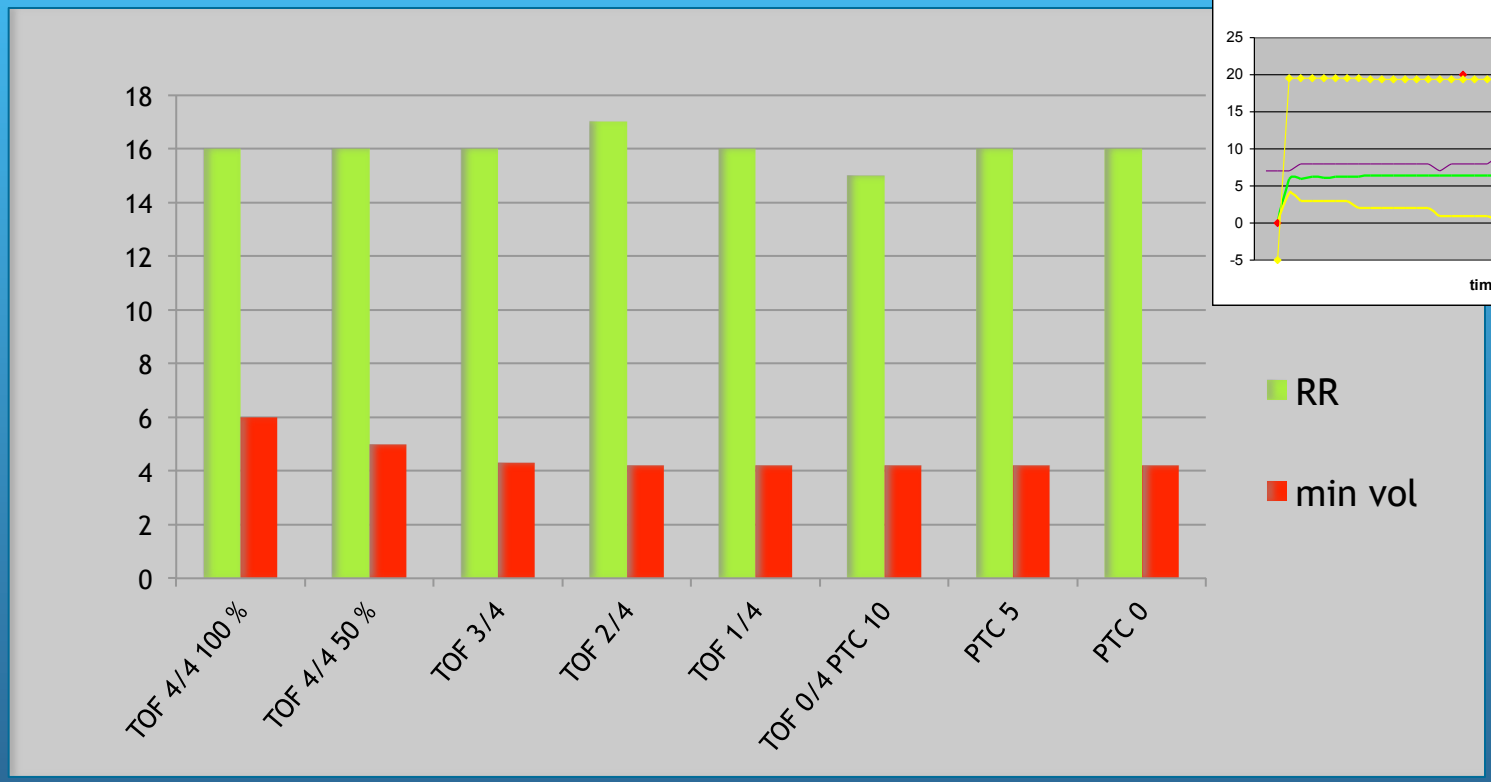
# Effect of et CO2 on blood pressure

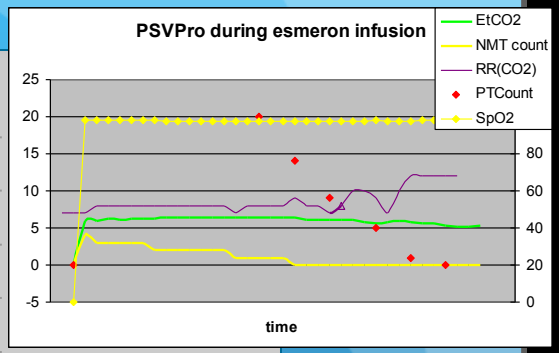


# To what depth of NMB is PSV possible?

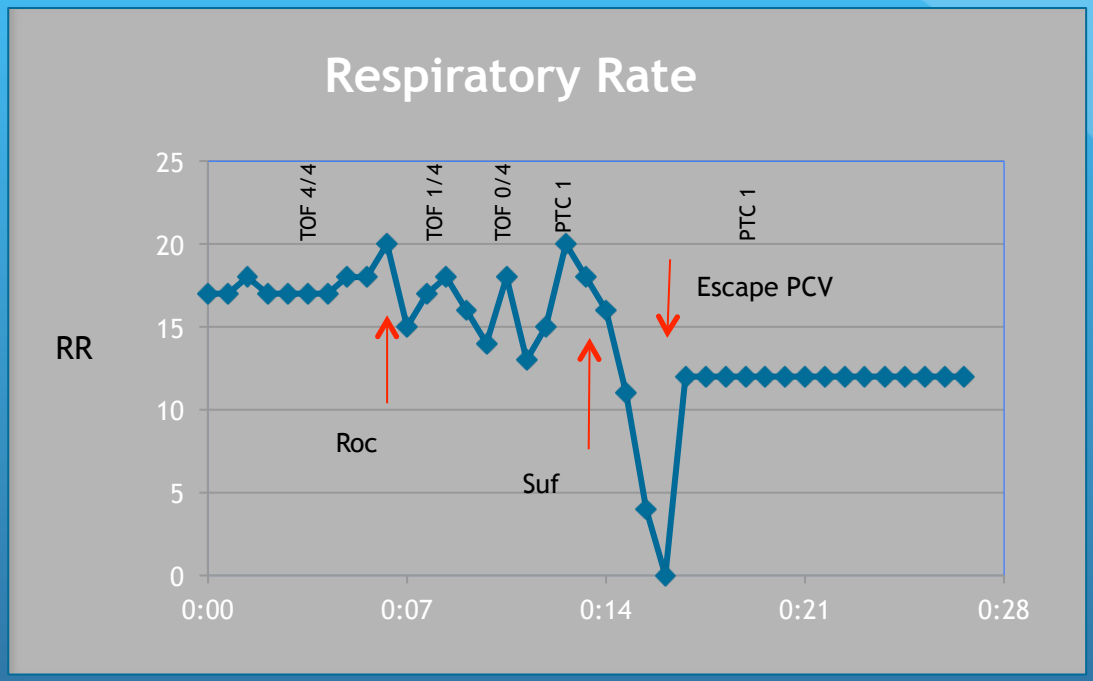



**Profound muscle relaxation does never disturb pressure support ventilation.**

Mulier JP 2009 PGA

# High dose Morphine blocks respiratory center making PSV impossible.




Casier I, Mulier JP ESA 2010

- Aestiva S/5 with a trigger sensitivity of less than 0.6 L/min. Backup ventilation mode was set to start after 30 second of no ventilation.
- Rocuronium infusion was given at 500mg/h till TOF and PTC were 0.
- Then Rocuronium infusion was stopped en Sufentanil 25µg was given.

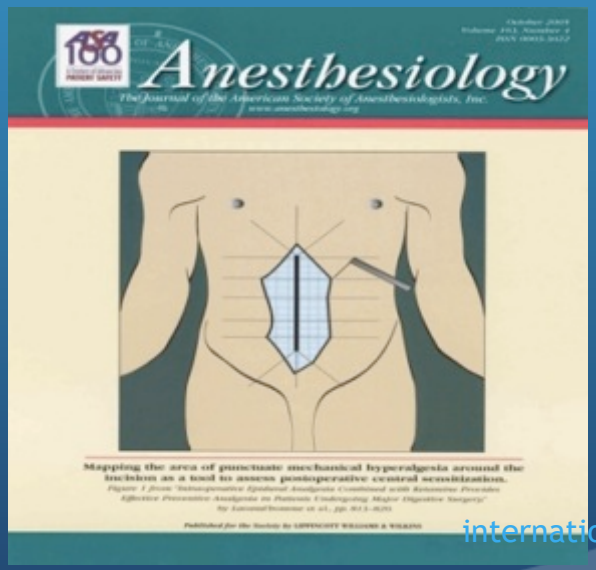
# Opioid free anesthesia (OFA) improves the comfort and reduces the post operative pain

# *Chronic Postoperative persistent Pain….*

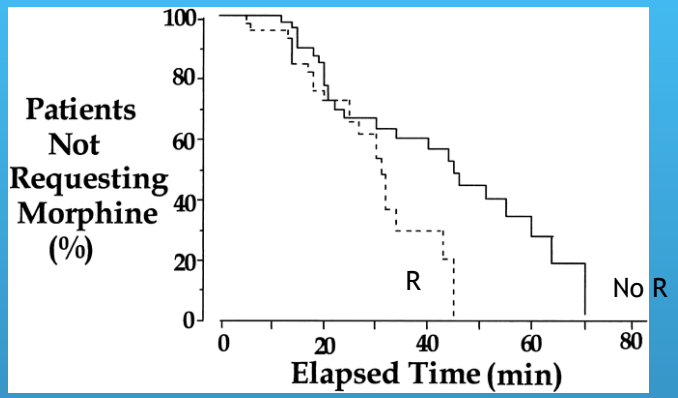
## 11.5 to 47 %

*of the patients undergoing surgery !!*

*Perkins & Kehlet, Anesthesiology 2000*



# *Hyperalgesia to opioids….*




**Intraoperative Remifentanil Increases Postoperative Pain and Morphine Requirements**
(Guignard, Chauvin: Anesthesiology 2002)

**Table 5. Independent Predictive Factors of Severe Postoperative Pain in the Postanesthesia Care Unit**

| | Odds ratio | 95% Confidence interval | *P* |
|---|---|---|---|
| High sufentanil dose[a] | 2.68 | [1.68–4.29] | <0.001 |
| General anesthesia (vs regional) | 3.96 | [1.14–13.81] | 0.03 |
| Preoperative analgesics | 1.91 | [1.15–3.18] | 0.01 |

[a] High dose sufentanil = dose >0.6 μg/kg.

**Independent Predictive Factors of Severe Postoperative Pain in the Postanesthesia Care Unit**

***The dose of intraoperative opioid !!***

(Aubrun, F. et al. Anesth Analg 2008;106:1535)

Intensity of post op pain is proportional to the dose of opioids given during anaesthesia.

# Obesity and morphine

- Obesity is a chronic pro-inflammatory disease.
  - It exposes to chronic post surgical pain.
- Opioids are naturally hyperalgesic by direct interaction with the NMDA system.
  - Intense agonism of the u-excitatory receptors lead to overexpression of the NMDA nr2b receptors in the forebrain.
    - This is associated with increased inflammatory and chronic pain.
- Immune suppression should be avoided in bariatric surgery
- OSAS: use less opioids to prevent post op hypoventilation

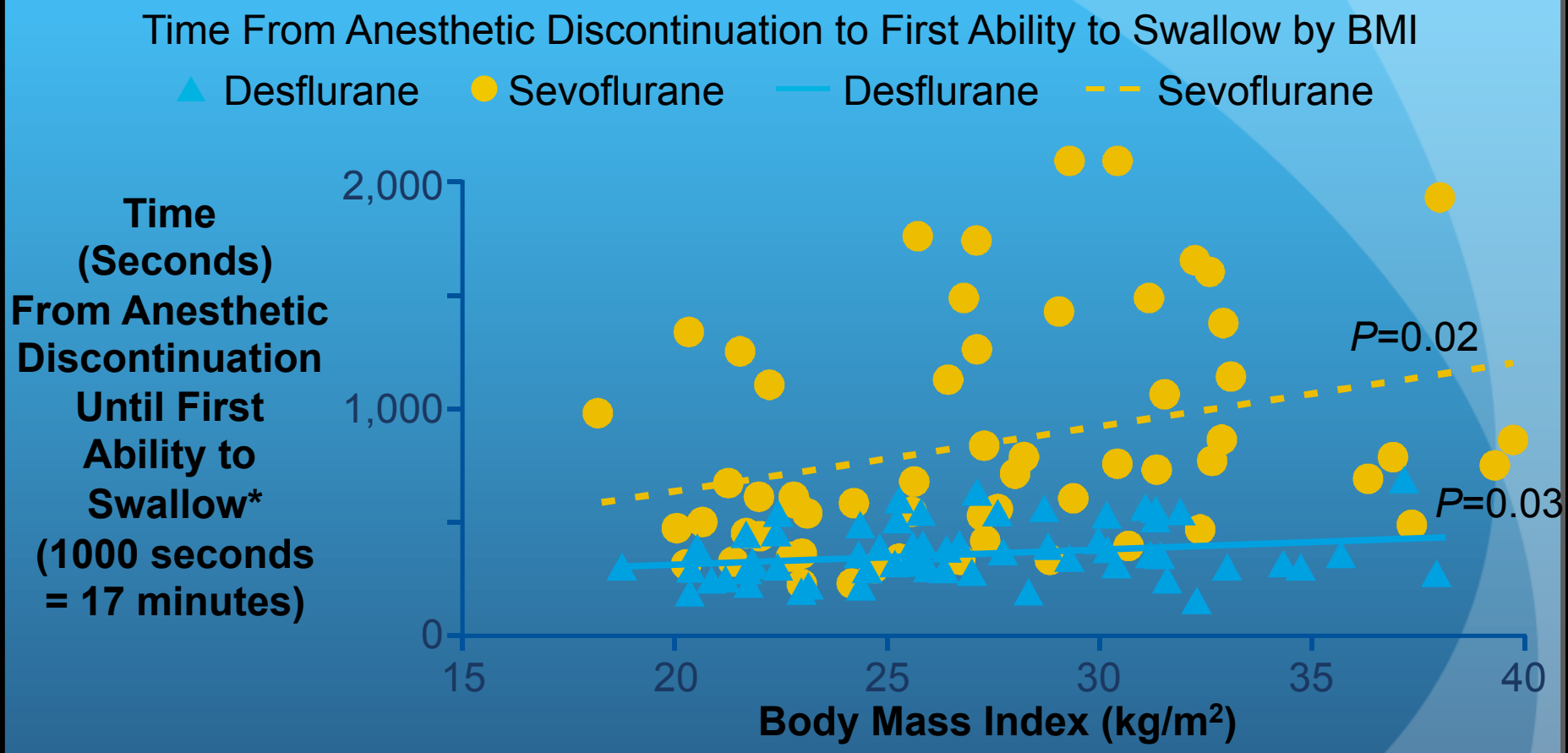
Avoid opioids in obese patients.

# How I avoid opioids per operative (lap RNY)

- No Premedication Epidural if possible, but not done in laparoscopic gastric bypass
- Induction for intubation
  - Clonidine 150 - 300 ug po avoid sedative doses
  - Ketamine 10 – 25 ug iv only painkiller no sedation post op
  - Seloken 2 - 5 mg iv according to heart rate
  - Propofol (dexmetodine? when availble)
  - Xylocaine 1 mg/kg IBW: 70 mg iv intubation and extubation stress
  - Rocuronium 0,6 - 1,2 mg/kg
- Maintenance
  - Desflurane 1 to 2 MAC no TIVA no remifentanyl
  - Esmolol according to heart rate & blood pressure
  - Paracetamol 3 - 2 gr loading, 1 gr every 6 hours
  - NSAID's if possible
- Before awakening
  - Pressure support ventilation measuring respiratory rate
  - Low Bolus dose of sufentanil: 5 mg piritramide: 10 mg for post op pain
  - Local wound infiltration, diaphragm spray


Perfusalgan 10 mg/ml

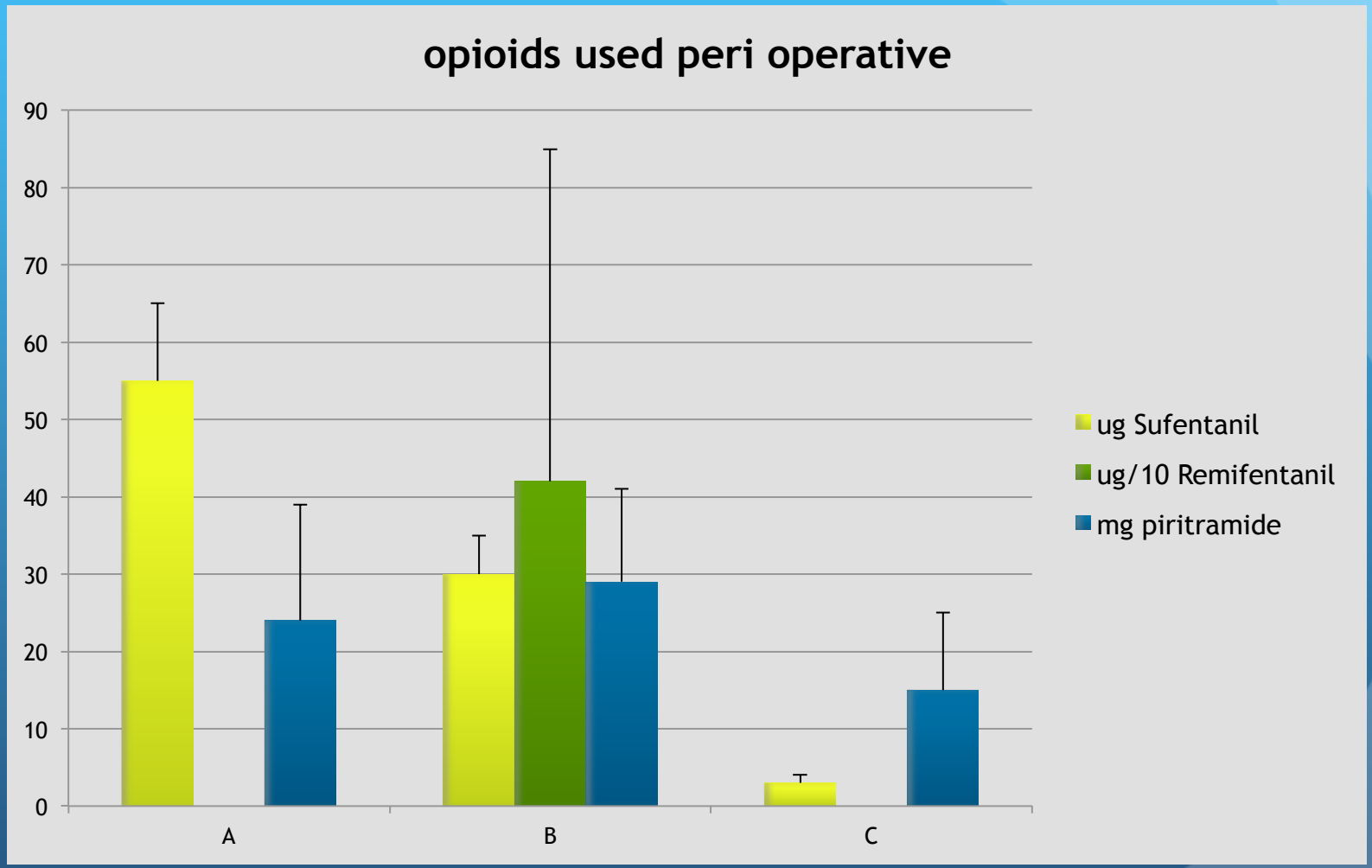
# BMI Affects Recovery of Pharyngeal Function More With Sevoflurane Than With Desflurane




*** Regarding Swallowing: Administering water to patients after anesthetic discontinuation is not a standard of care.**

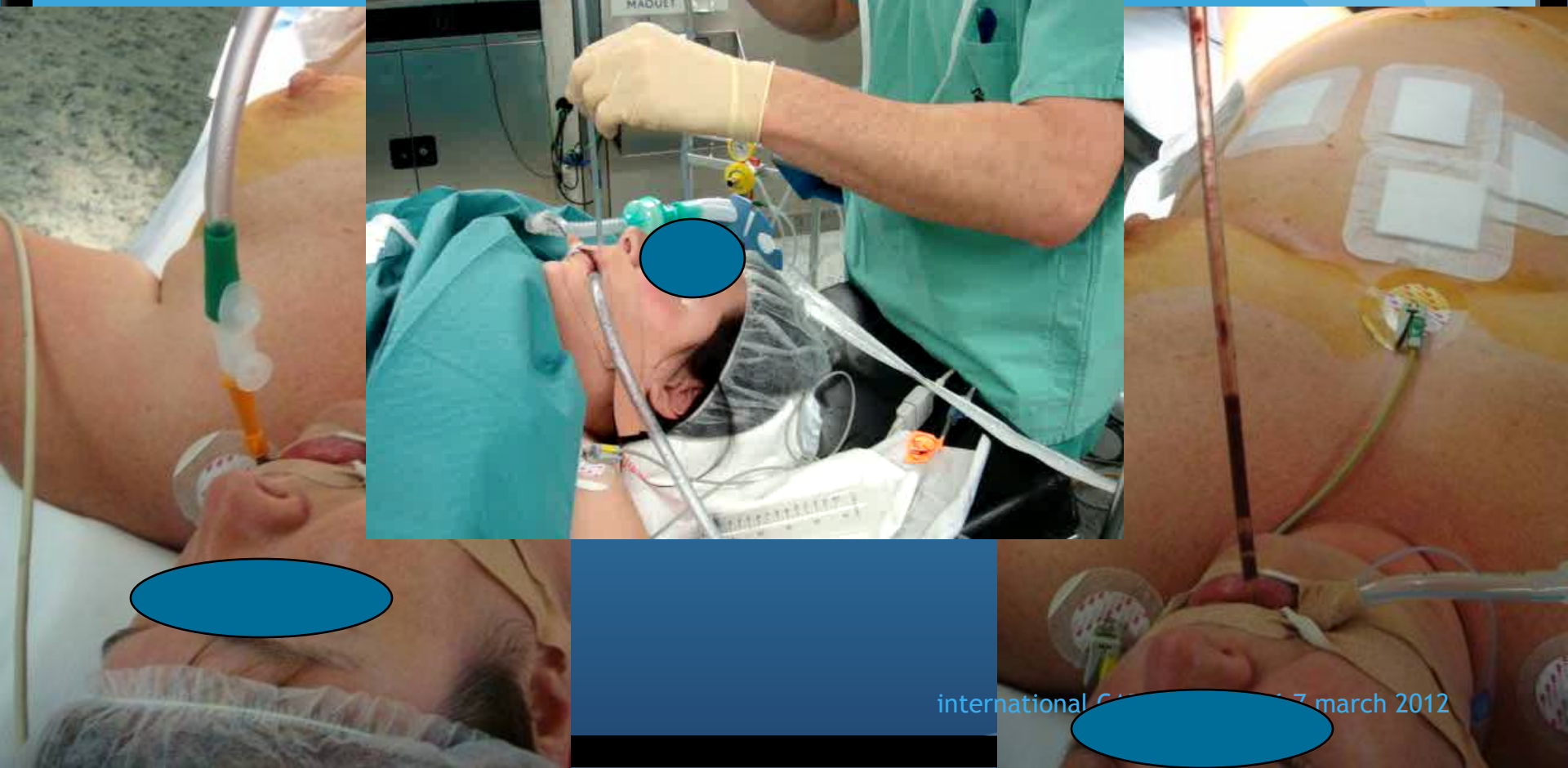
McKay RE et al.
Br J Anaesth. 2010 Feb;104(2):175-182.

# Operating Room and PACA use of opioids



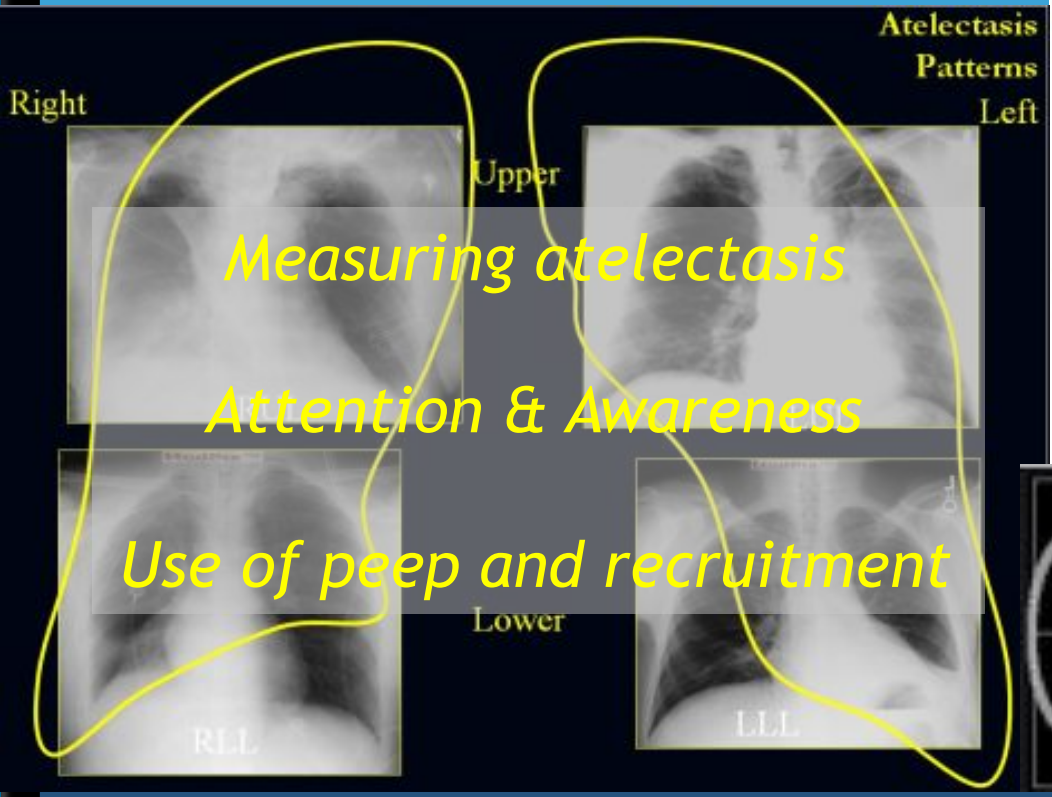
# control of gastric bleeding by deep aspiration

- Treat if new red blood is aspirated
- Empty gastric pouch to prevent post extubation aspiration




# Low saturation

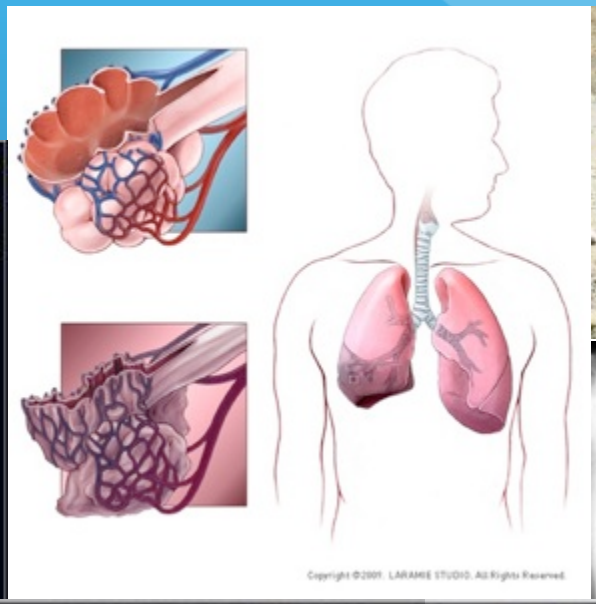
- Old problem still needs attention
  - Atelectasis: peep & recruitment

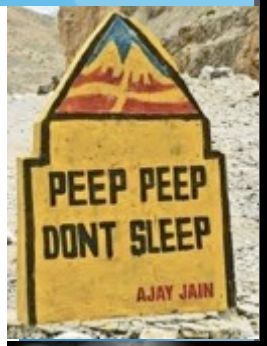


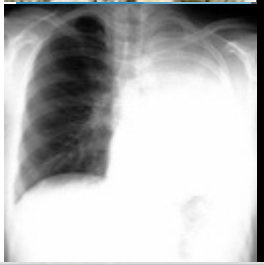

*Measuring atelectasis*

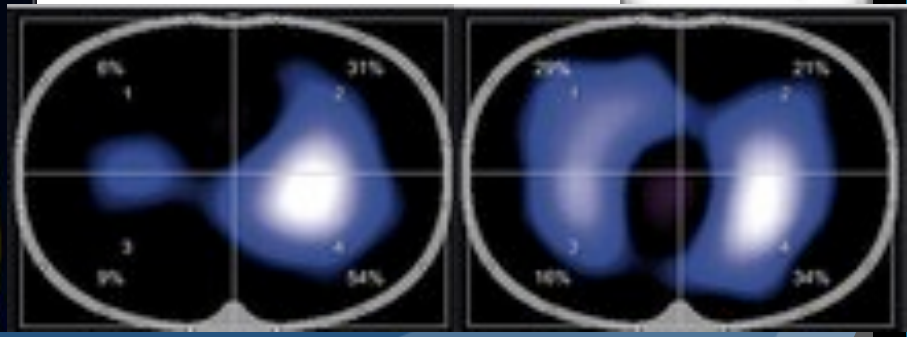
*Attention & Awareness*

*Use of peep and recruitment*



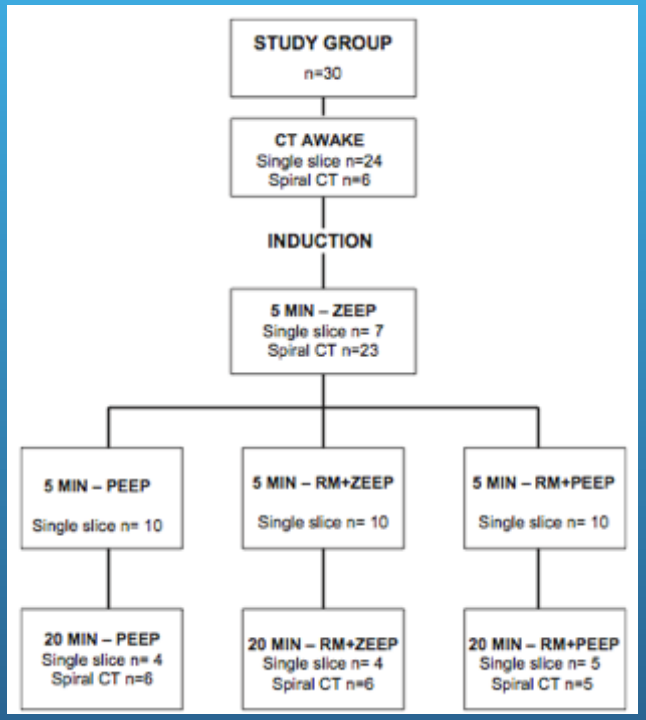


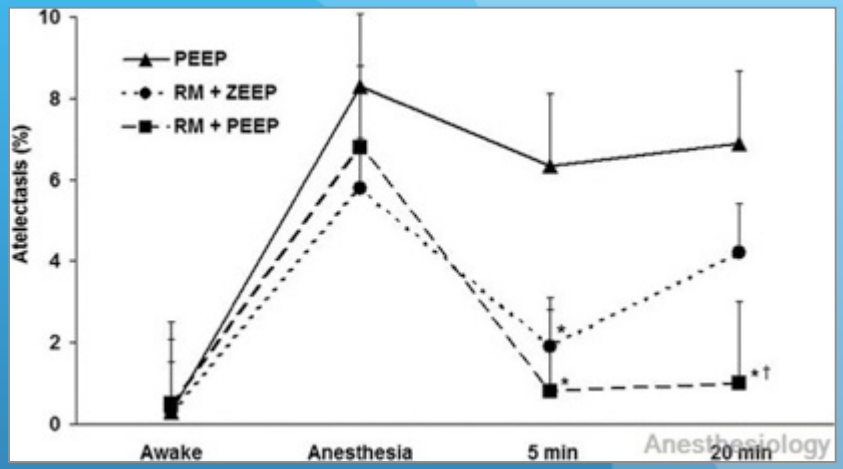



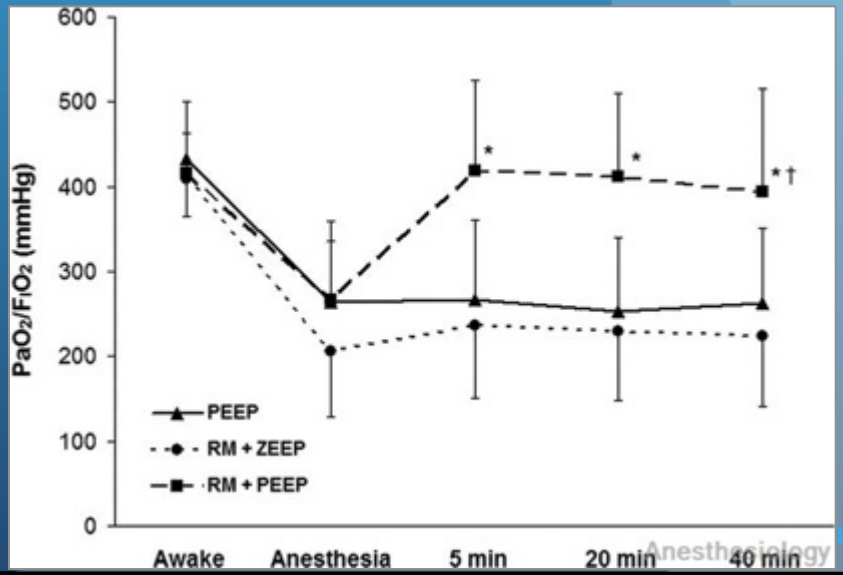


# Prevention of Atelectasis in Morbidly Obese Patients during General Anesthesia and Paralysis

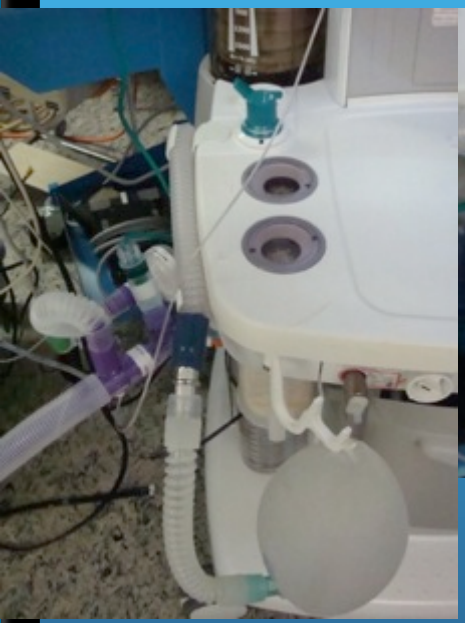
## Reinius et al. Anesthesiology 2009

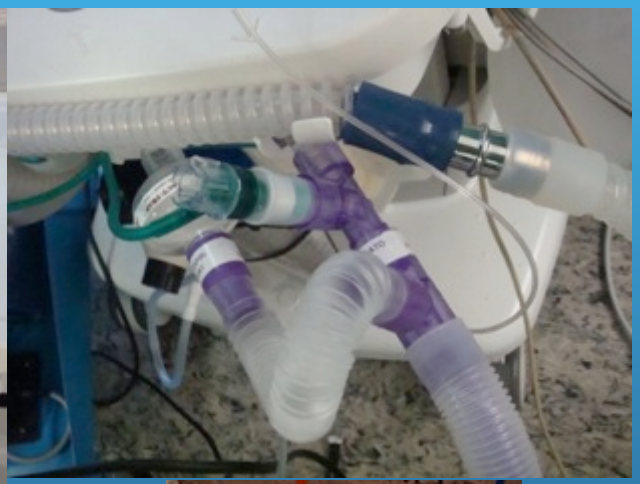


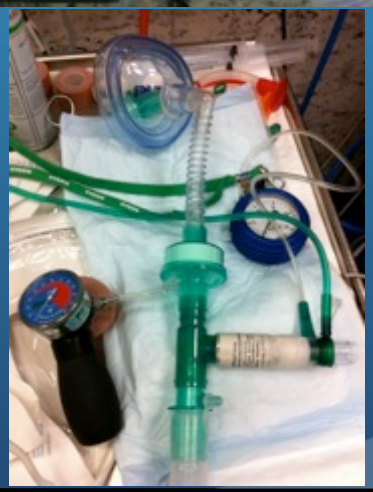



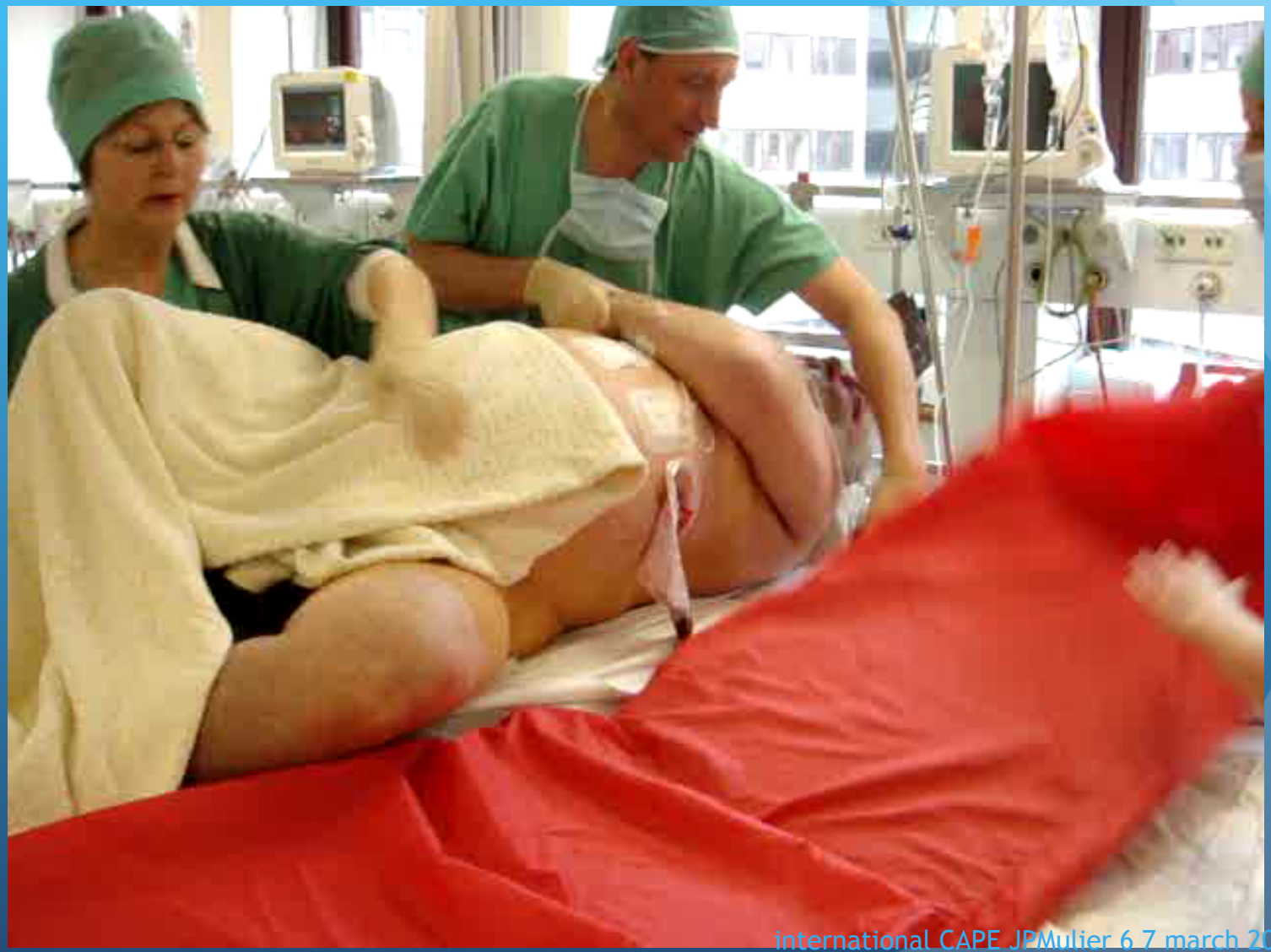
# CPAP adapted ventilator used to breath spontaneous or to assist manual with facemask





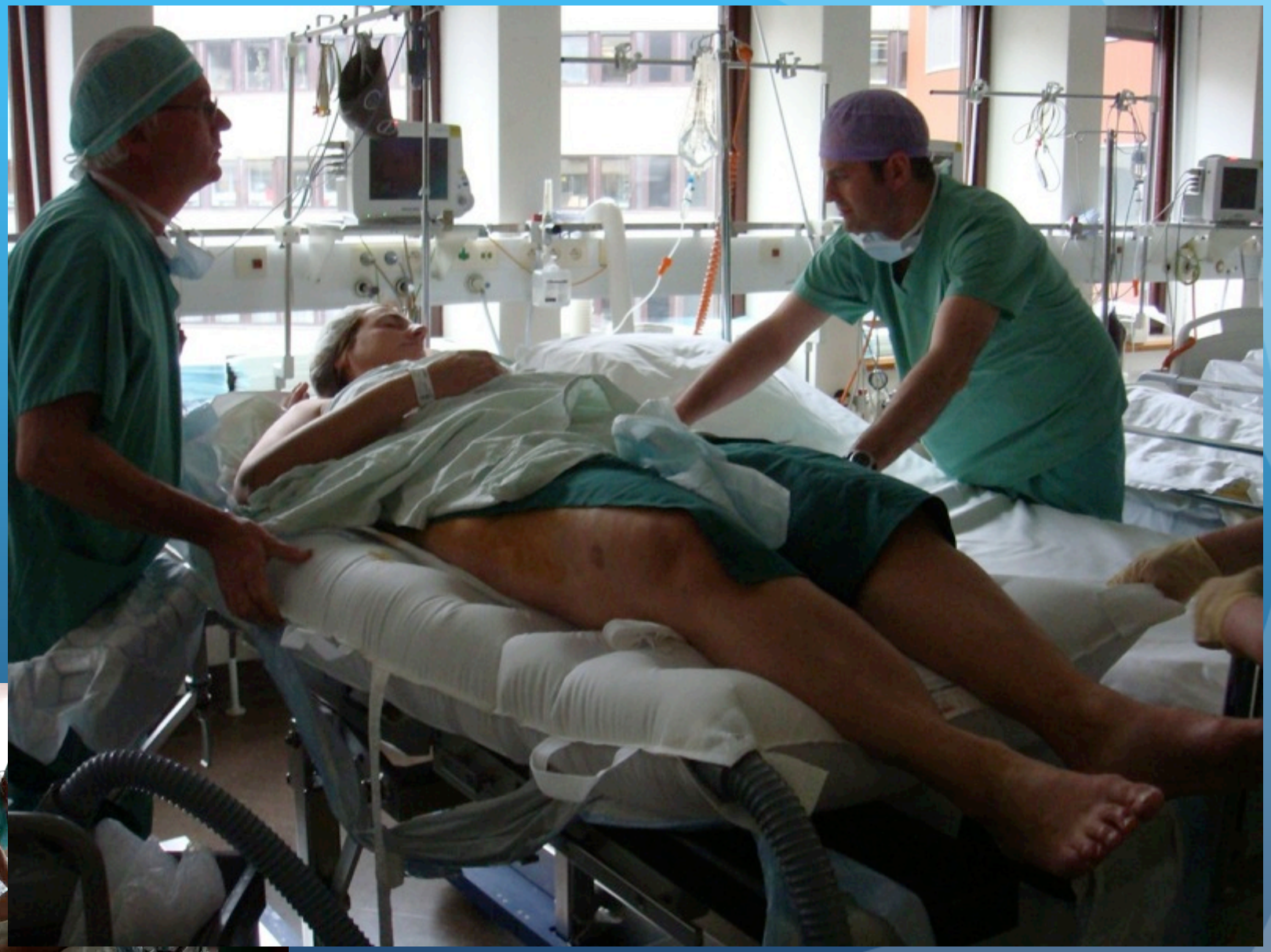



# Old method: 4 pers

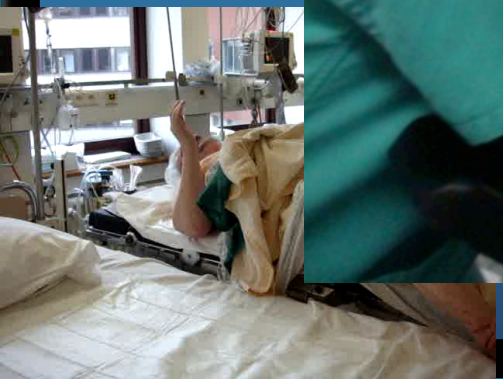


# Floating hoover: 2 pers





# Move themselves in bed after Sugammadex?



# ERAS (enhanced recovery after surgery)

- Deep NMB till the end
  - Sugammadex improves awakening by muscle spindles activation
- Large volume leak test
- Opioid free anesthesia - high dose paracetamol - low dose morphine post op
  - Prevent post op pain
  - No sedation  low dose ketalar, droperidol, no benzodiazepines
- Permissive hypercapnia
  - Improve peripheral circulation and hypertension
- PEEP - CPAP - PEEP  lung recruitment  PSV during NMB and lap
  - Prevent post op atelectasis
  - Accellerate awakening
- Taperguard Cuff – gastric aspiration – RSI
  - Prevent peri op aspiration
- Leg elevation per op
  - tromboprophylaxis

# Conclusion C: ERAS and sugammadex in morbid obese patients

ERAS improves outcome quality and reduces turnover time

1. Hypercapnic PSV is possible during deep NMB and
   1. Improves oxygenation.
   2. Facilitates weaning to spontaneous breathing
   3. Allows low morphine dosage without respiratory depression
   4. Increases cardiac output and blood pressure preventing postoperative bleeding and wound infections.
2. Desflurane elimination is fast and predictable with early alertness in morbid obese patients compared to propofol and sevoflurane.
3. Atelectasis and respiratory failure are prevented with
   1. Peep and Lung Recruitment during ventilation
   2. Predicatable and fast decurarisation with sugammadex to 90% TOF
   3. CPAP during extubation
   4. Early mobilisation in bed and deep breathing maneuvers

Sugammadex makes ERAS possible in morbid obese patients.