



1150

1850

1947

1977

2010

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

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

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

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

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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.

Mulier 8 march 2012

# 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!

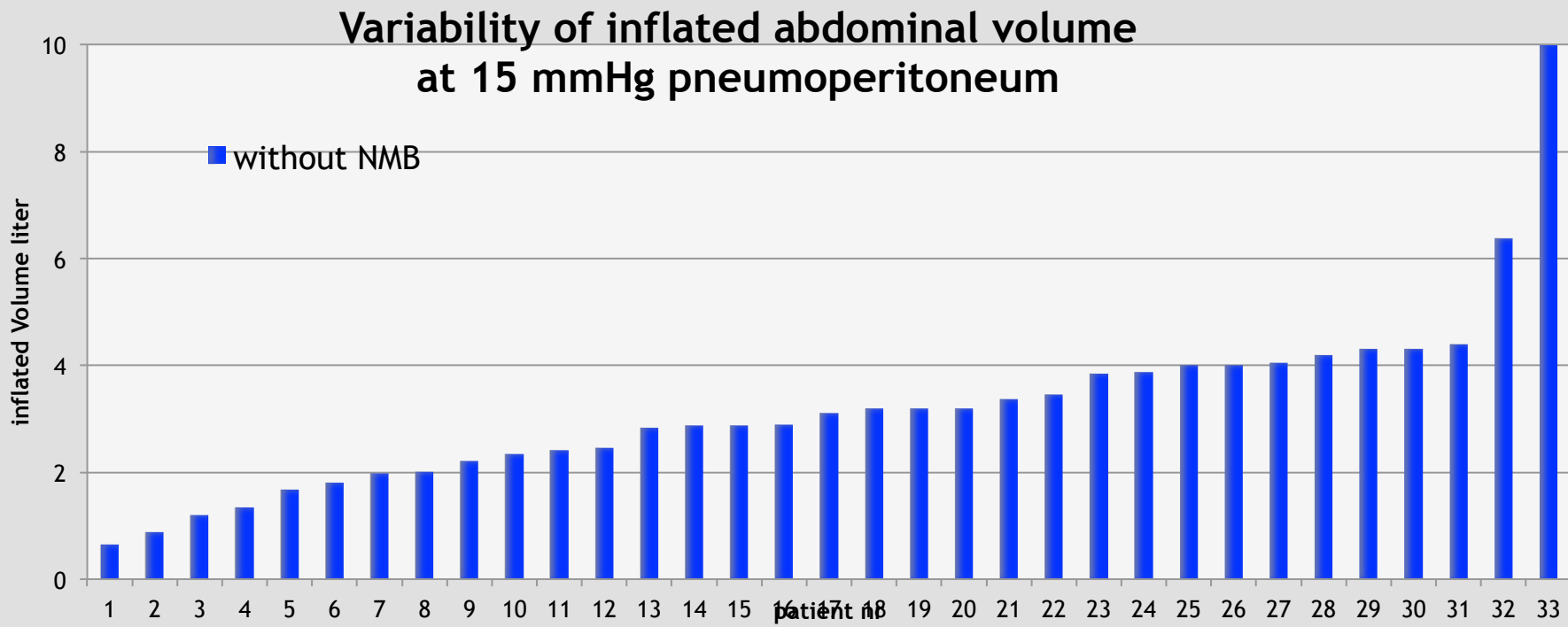
- The effects of NMB on peak airway pressure and abdominal elastance during pneumoperitoneum.
  - Chassard D Anesth Analg 1996; 82: 525
  - *Pigs have a non linear behaviour different from humans*
  - *Elastance is not changing either in humans*
- Gynecologic laparoscopy with or without curare?
  - Chassard 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.

**Mulier Jan Paul,**

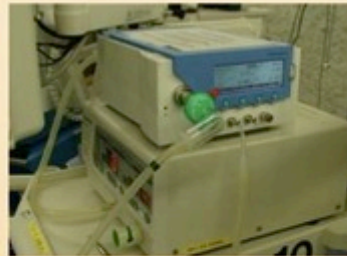
Dep of Anesthesiology, AZ-st-Jan AV, Brugge  
and Katholieke Universiteit Leuven, Louvain, Belgium

Contact Email: jan.mulier@azbrugge.be  
More info: www.publicationslist.com/jan.mulier

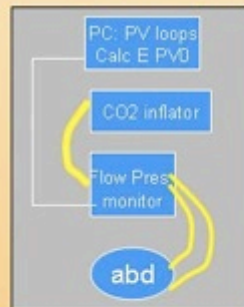
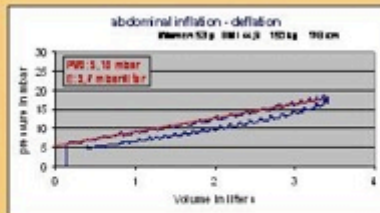
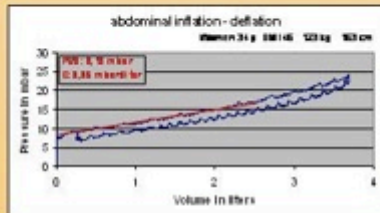
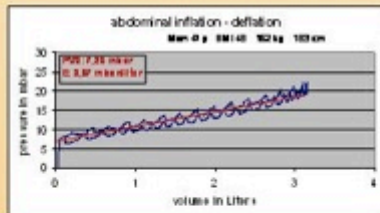
**Introduction and goal of the study.**

- > 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 automatically 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

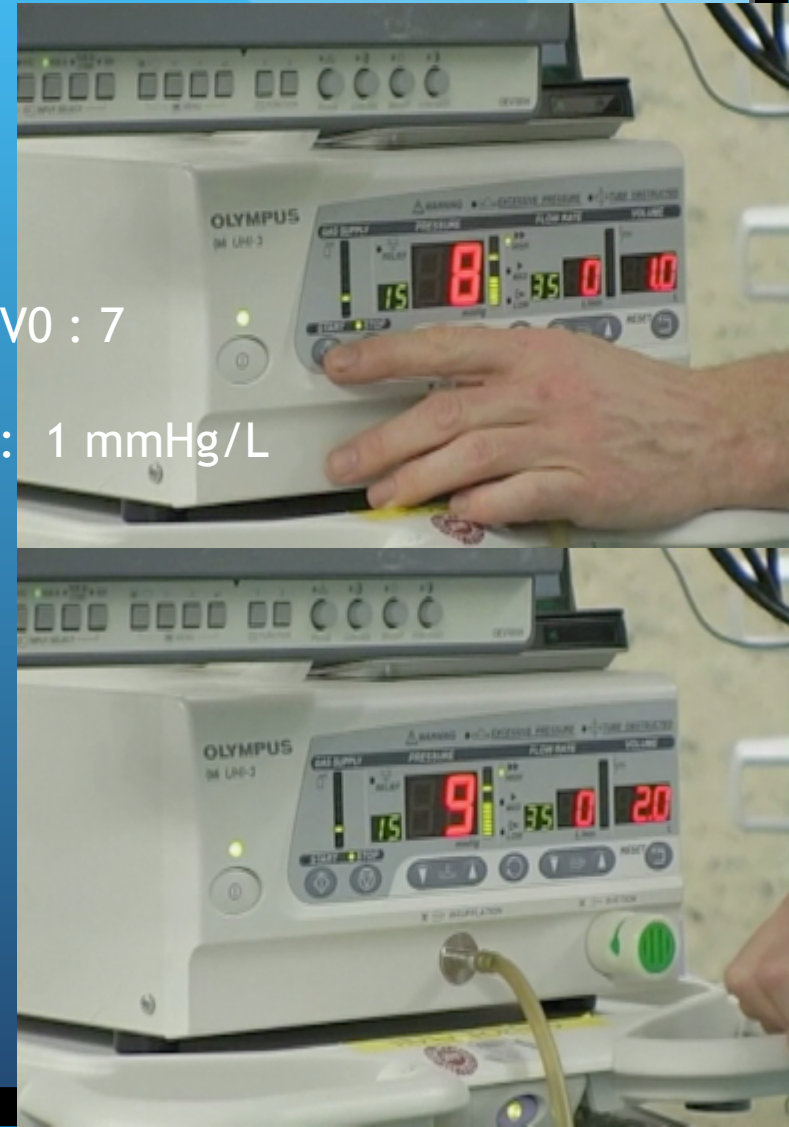
**References**

1. Obes Surgery 2007; 5
2. Anesth Analg. 2006;103:677-81.
3. Acta Clinica Belgica 2007; 62:SP8

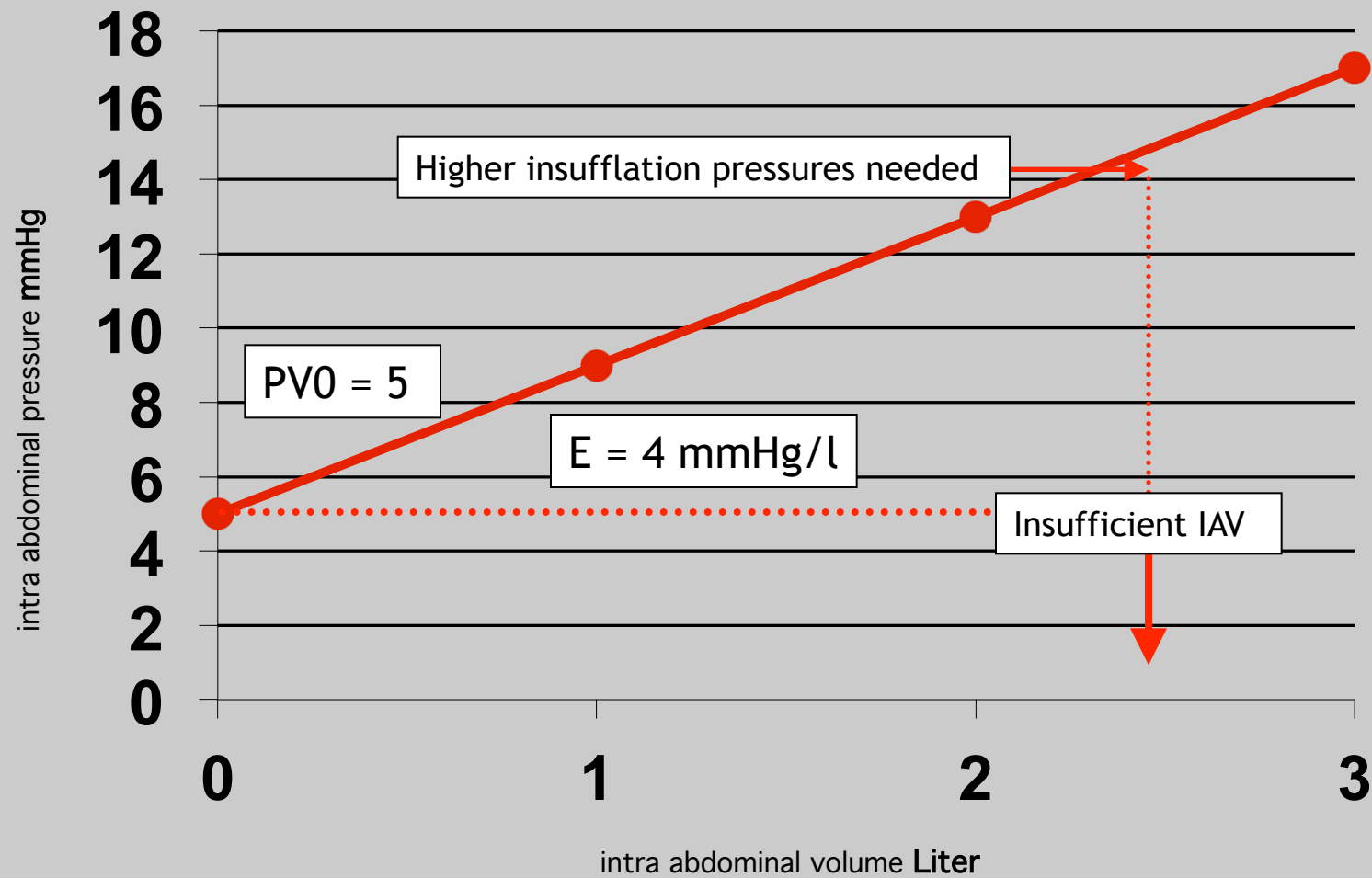
Pressure volume loops  
or  
Simplified 3 points measurement  
or  
Look to max vol at 15

PV0 : 7

E: 1 mmHg/L



# On the abdominal pressure volume relation



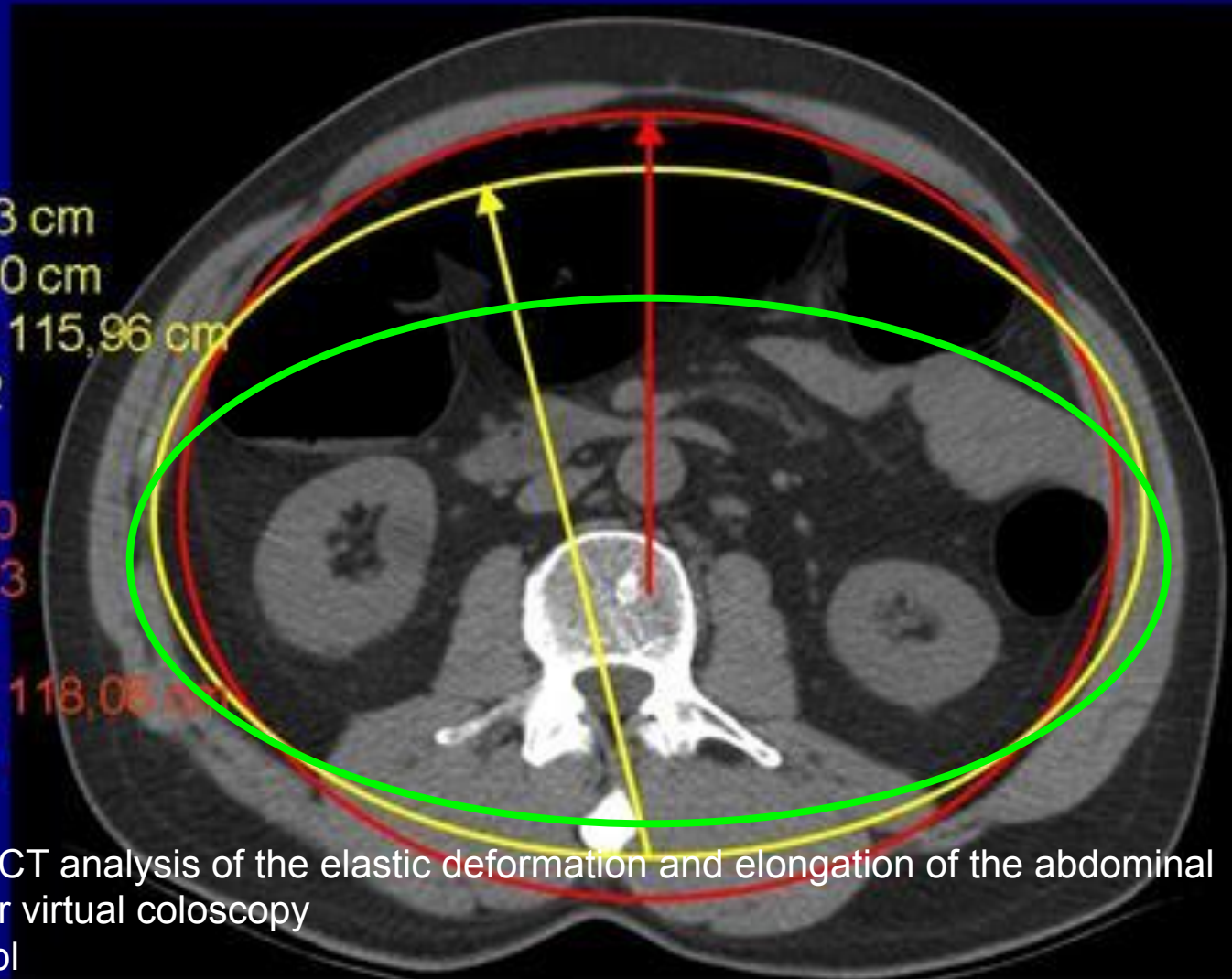
# Fitting of cross section abdomen when inflated at 15 (yellow) versus 25 (red) mmHg

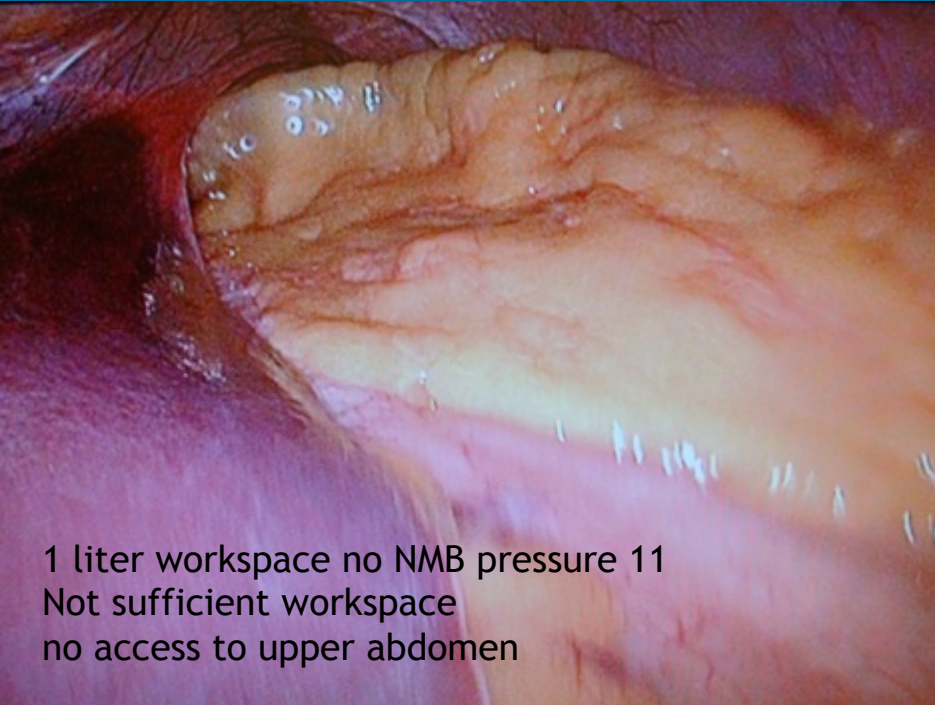
- **Yellow:**

- Long axis: 43,23 cm
- Short axis: 30,00 cm
- Circumference: 115,96 cm
- Area: 1018 cm<sup>2</sup>

- **Red:**

- Long axis: 40,80 cm
- Short axis: 34,23 cm
- Circumference: 118,05 cm
- Area: 1097 cm<sup>2</sup>





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



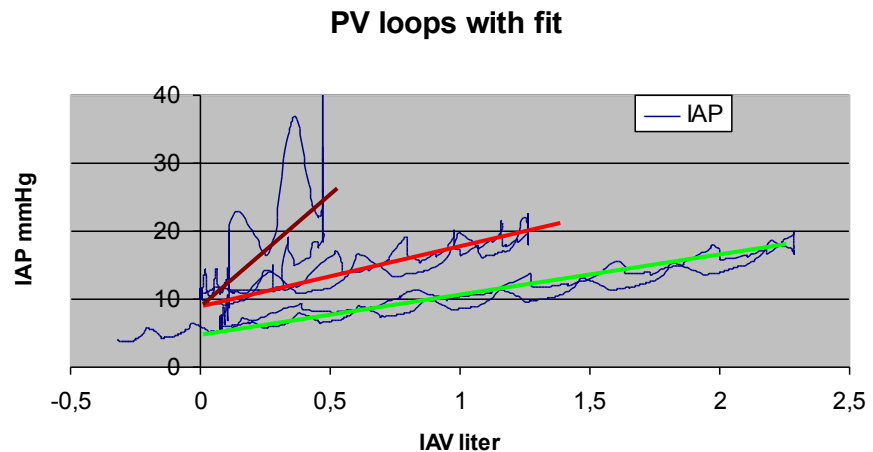
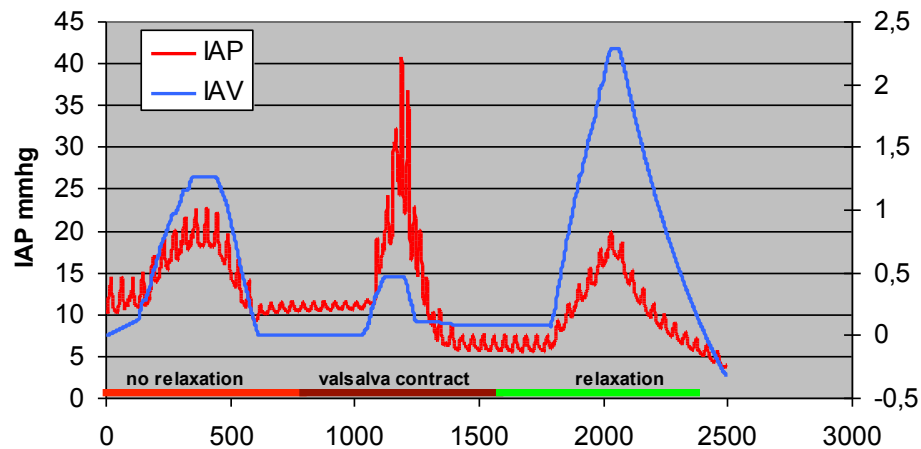
3 liter workspace no NMB pressure 15  
Sufficient workspace for upper abdomen



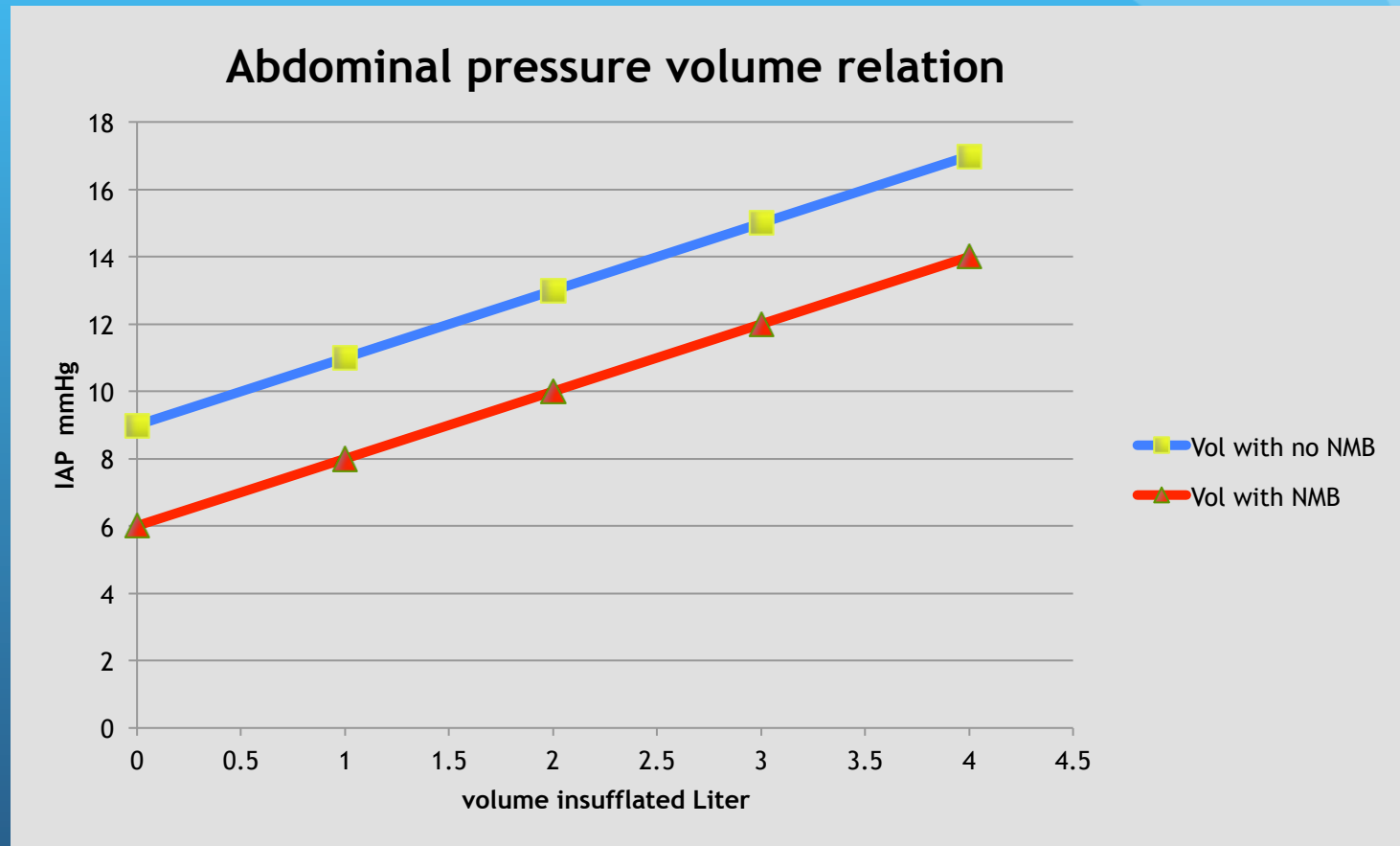
4 liter workspace with NMB pressure 14  
Sufficient workspace and easy access.

# Difference between active contraction and relaxation <sup>13</sup>

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



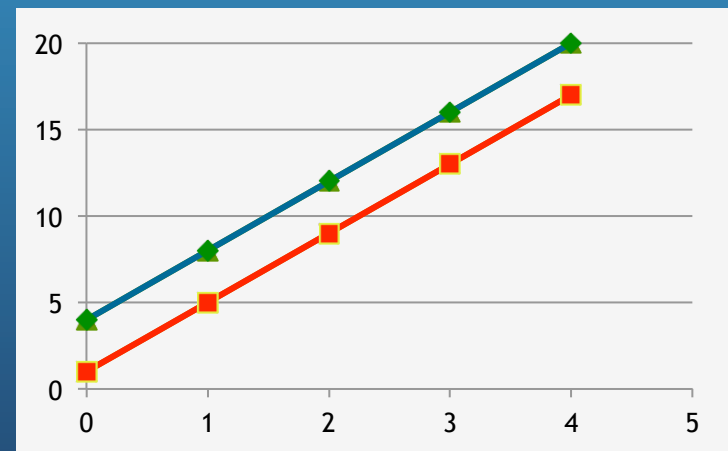
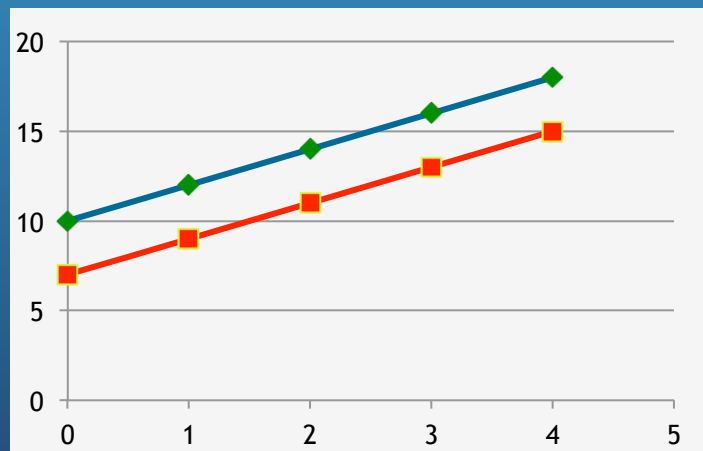
# Pressure volume relation without vs with NMB



# How improving workspace?

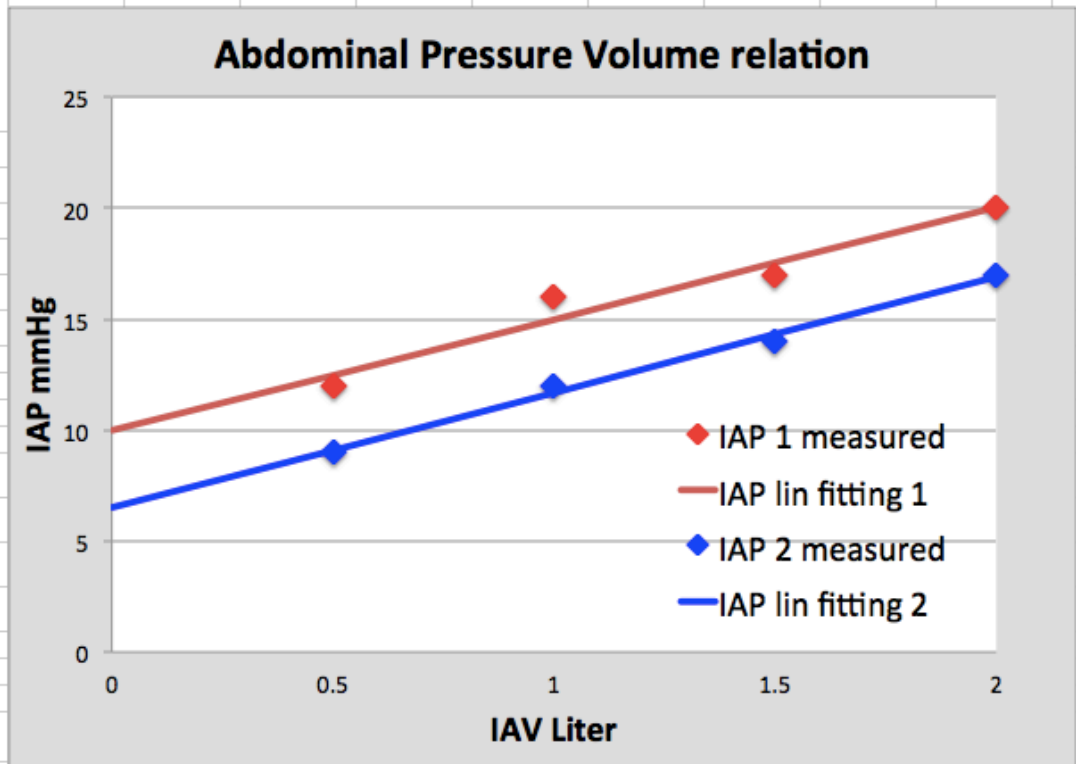
- If high PV0 easy to improve
  - NMB most effective, trendelenburg, IAP increase
- If low C difficult to improve
  - Flexing legs, higher IAP and NMB are less effective

NMB helps in both situations!



# 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	
<b>PVO</b>	<b>10 mmHG</b>		<b>PVO</b>	<b>6,5 mmHG</b>	
<b>E</b>	<b>5 mmMHg/L</b>		<b>E</b>	<b>5,2 mmMHg/L</b>	
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 safe predictor of recovery.
  - Moerer O. Anesthesiol Intensivmed Notfallmed Schmerzther. 2005; 40: 217
- The diaphragm is more resistant than the adductor pollicis to rocuronium and has a faster recovery of the twitch height.
  - Cantineau JP Anesthesiology. 1994; 81: 585



# The Benefits of Deep Neuromuscular Blockade: Surgical Procedure

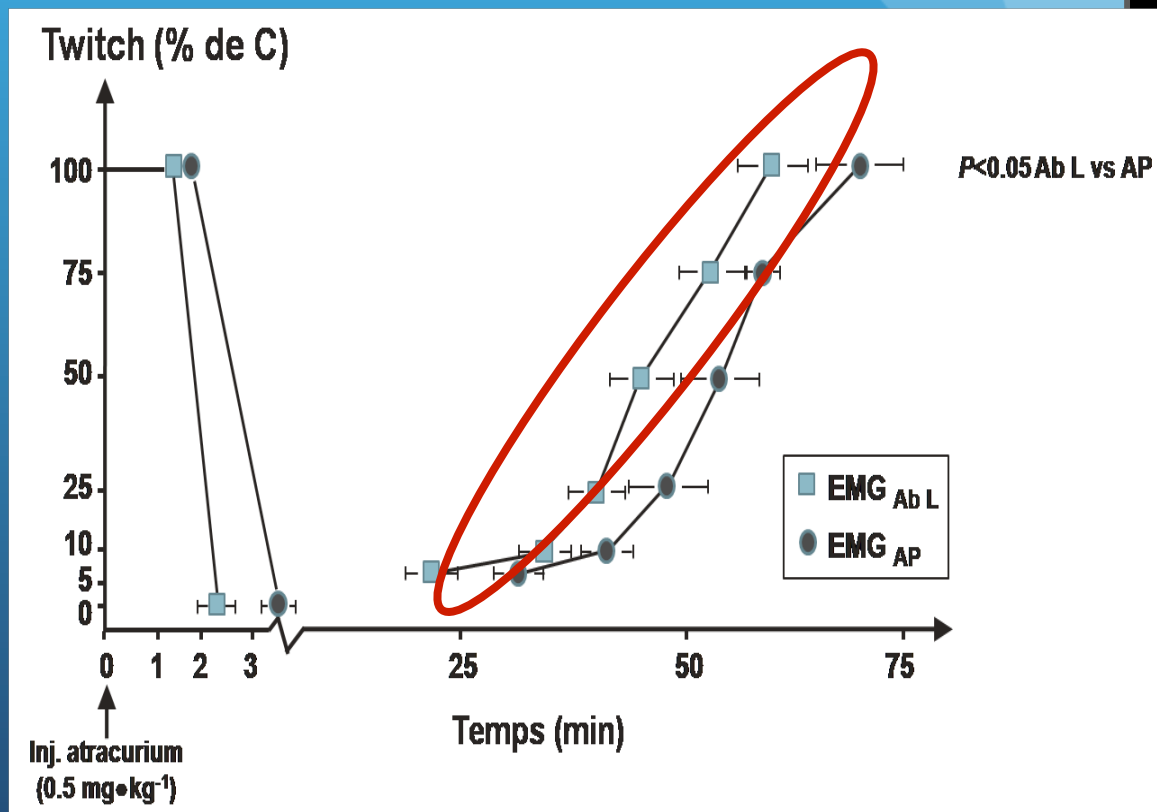
## Sensibilité à l'atracurium des muscles abdominaux latéraux\*

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

### Sensibility to atracurium of the lateral abdominal muscles

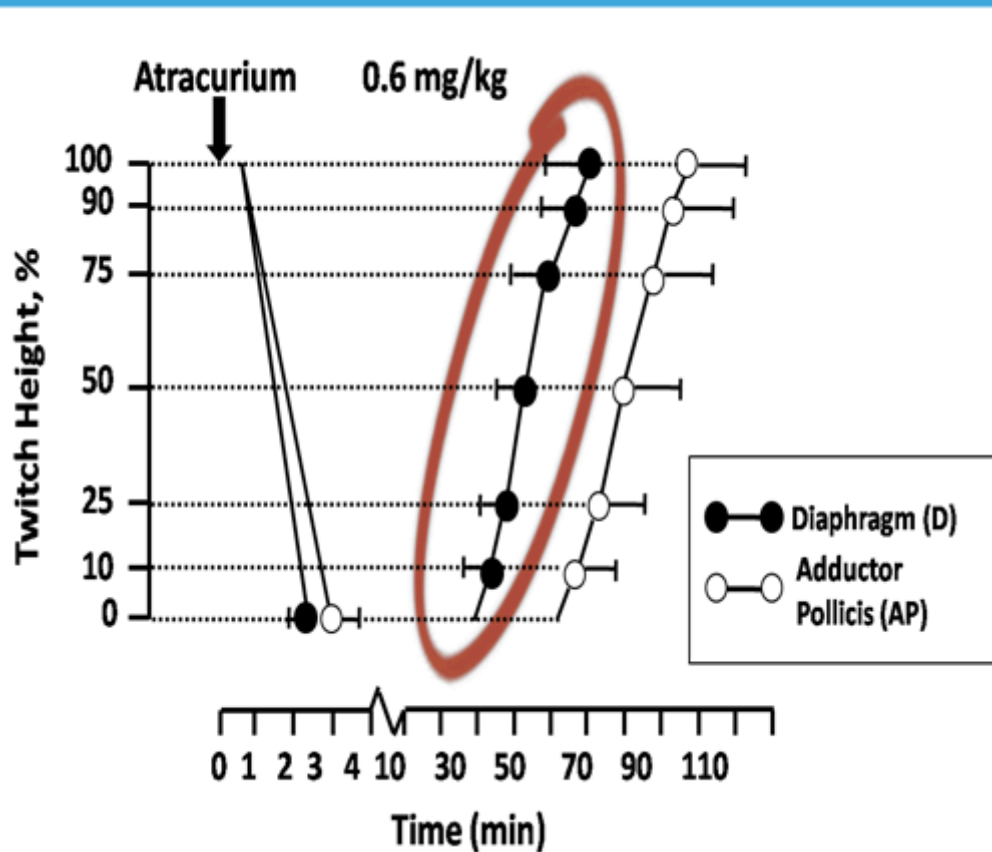
**Objective:** To study the effect of atracurium on the electromyographic activity of the lateral abdominal muscles and adductor pollicis in anaesthetized subjects.

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



# The Benefits of Deep Neuromuscular Blockade: Surgical Procedure

## AP and Diaphragm Neuromuscular Block

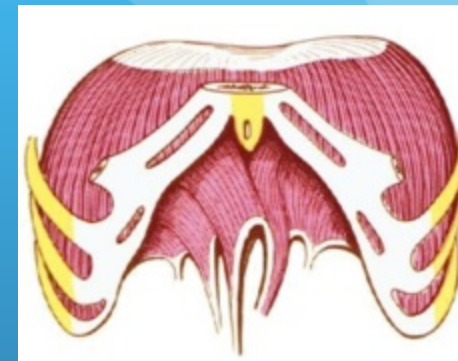
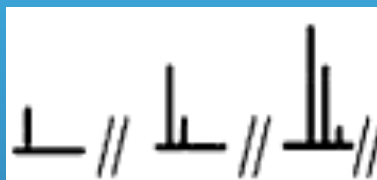


Diaphragm blockade has a faster onset and recovery than adductor pollicis

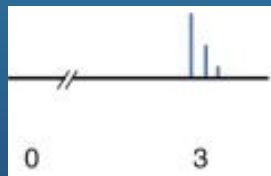
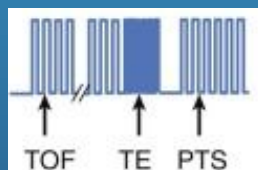
Deep block in abductor pollicis means moderate block in abdominal muscles and diaphragm



Shadow block



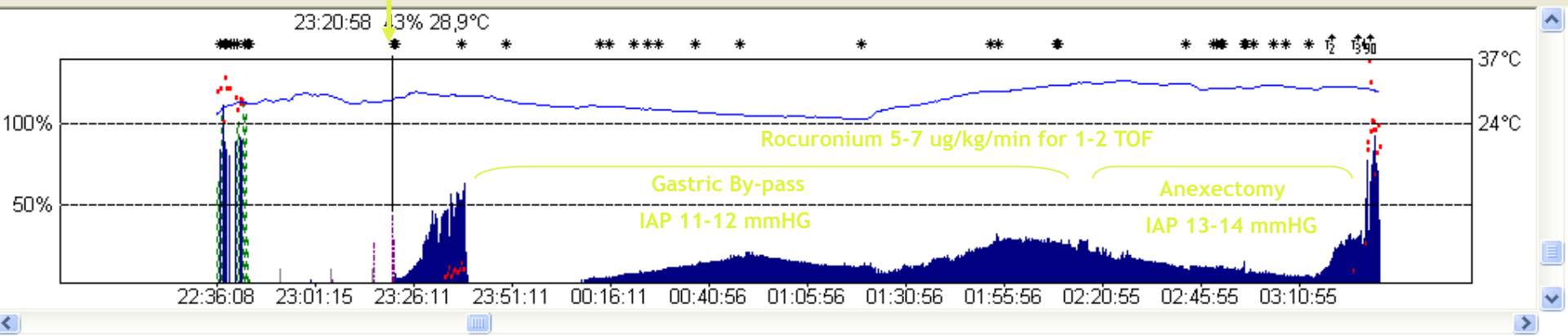
Deep block



10 PTCs

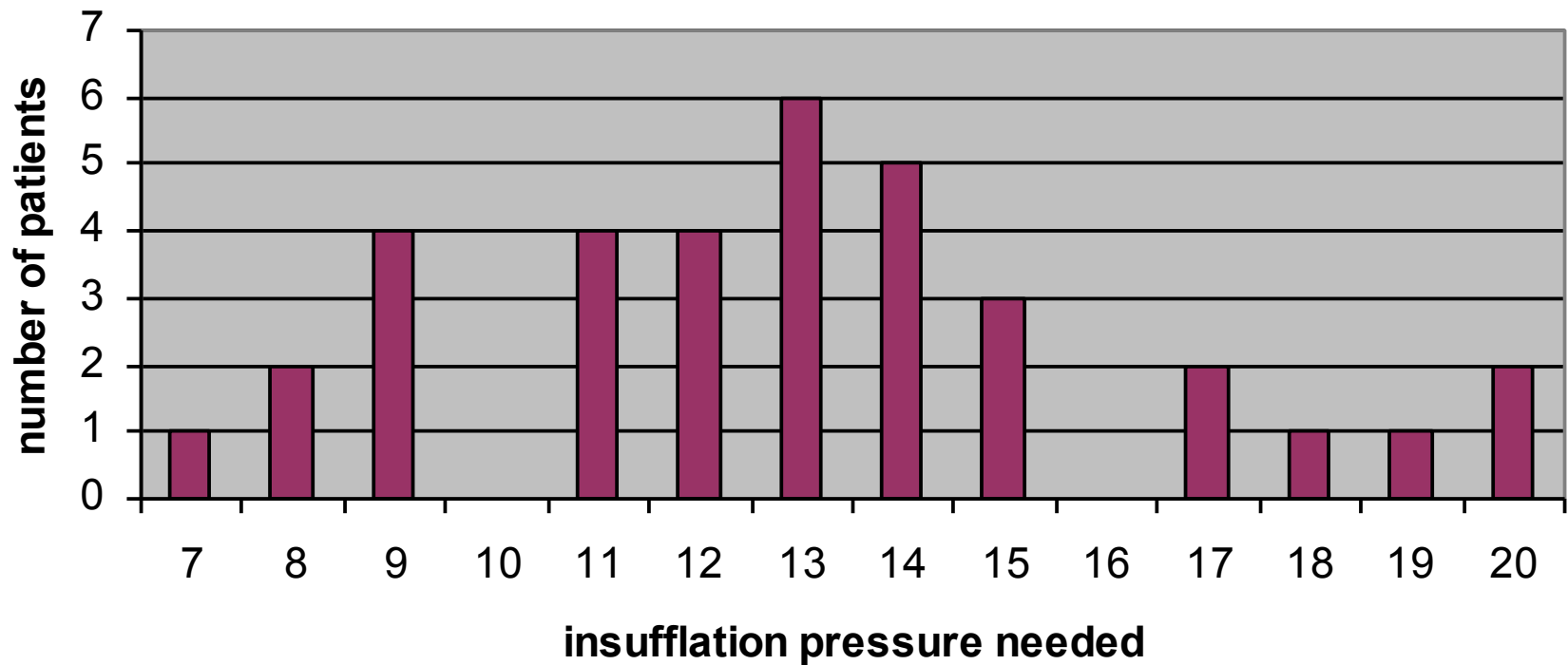
Time	?!* Mode	Tw1	Tw2	Tw3	Tw4	TOF	CNT	Temp	Stim	T	Sens.	CAL [Curr.]	TOF alarm	Comments
		%	%	%	%	%		°C	mA	µs		- [mA]		
23:20:45	PTC pre pulse 10	0						28,7	60,00	200	151	2 [<20]		
23:20:46	PTC pre pulse 11	0						28,7	60,00	200	151	2 [<20]		
23:20:47	PTC pre pulse 12	0						28,7	60,00	200	151	2 [<20]		
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**  
 0.5 L  
 1.5 L  
 2.5 L  
 3.5 L  
**Pressure**  
 7 mmHg  
 10 mmHg  
 12 mmHg  
 15 mmHg  
**PV0** 5-6 mmHg  
**E** 2-3 mmHg/L



We can choose the lowest IAP possible  
by using max NMB

### Pressure needed for 3L insufflation



# 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 NMBA limit increase in insufflation pressure?

# Determinants of E and PV0

	PV0	P <sub>VO</sub> 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

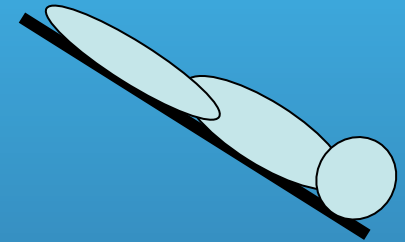
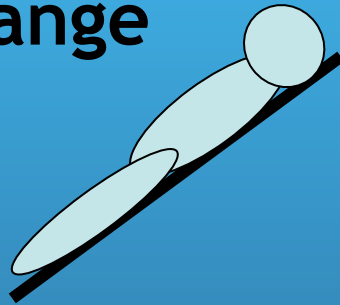
Mulier JP 2007

\* Sig p<0.05

Mulier 8 march 2012

# Effect of table position on APVR

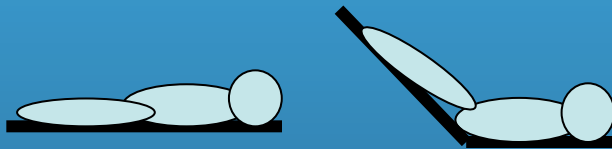
- PV0 decreases
- E no change



<b>PV0</b>	5,037	>	4,122	>	3,835
<b>E</b>	3,459	=	3,368	>	3,217

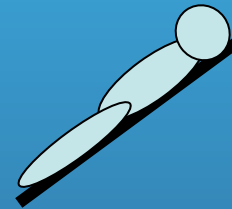
# Effect of leg flexion on APVR

- PV0 no change
- E decreases



PV0      4,320      =      4,76571

E          3,459      >      2,66067



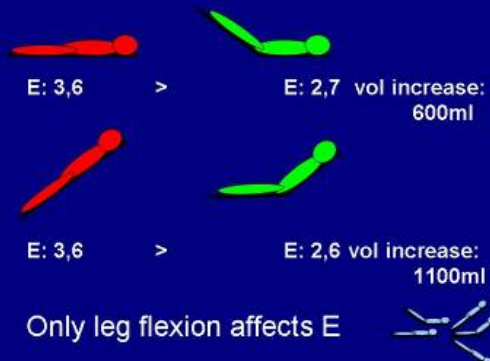
5,037      =      4,91096

3,368      >      2,577

# How to change E : hip flexion

Mulier JP Obes Surg 2009

Effect of position on E in mmHg/L



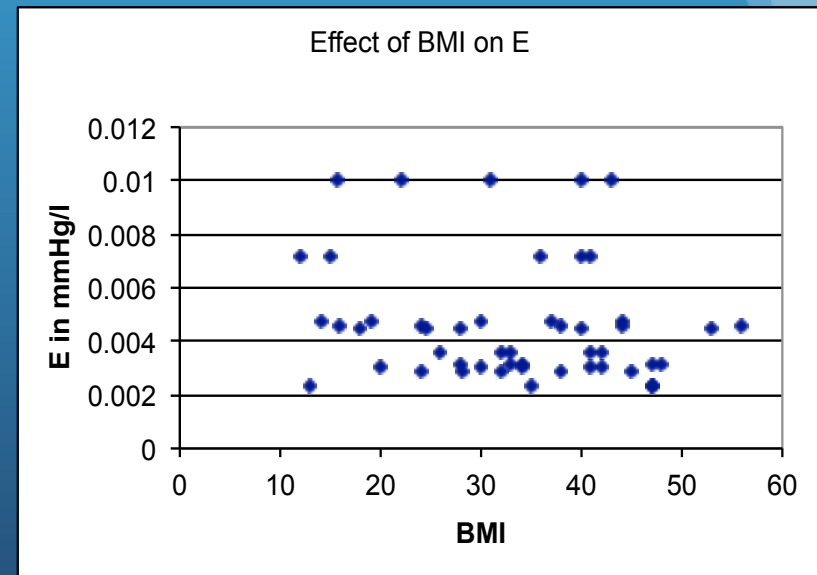
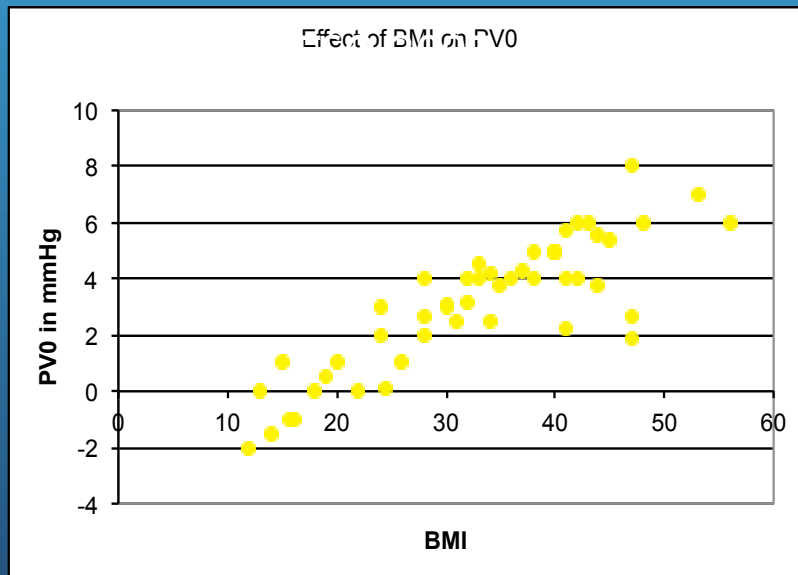
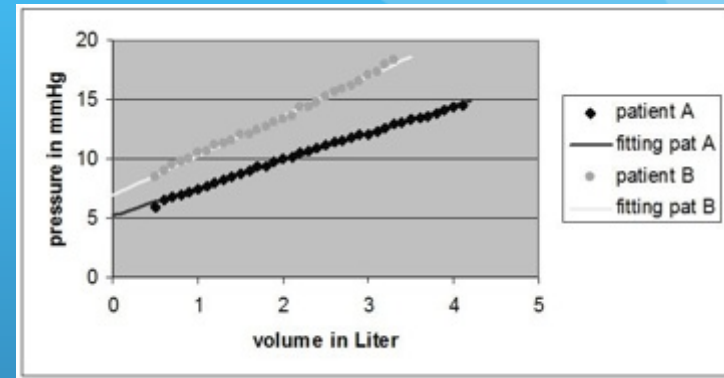
# Avoid too much leg flexion if “Double bubble abdomen”

- 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 IS PUB 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

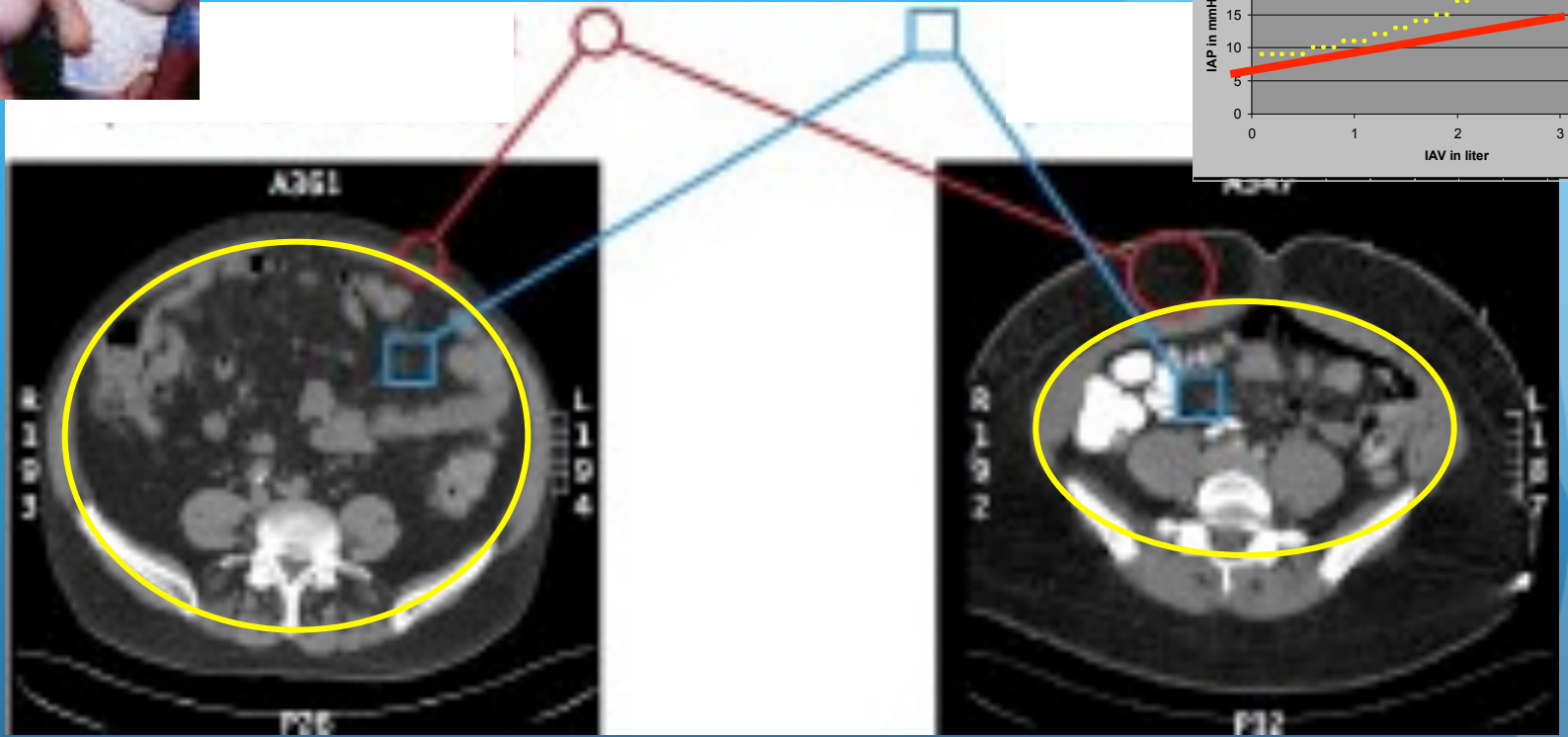
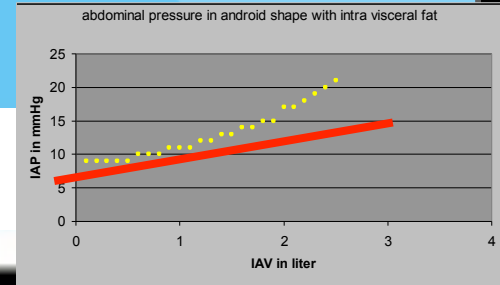
- Extra abdominal fat
- abdominal fat

intra



# Two types of android obesity

Subcutaneous Fat    Visceral fat



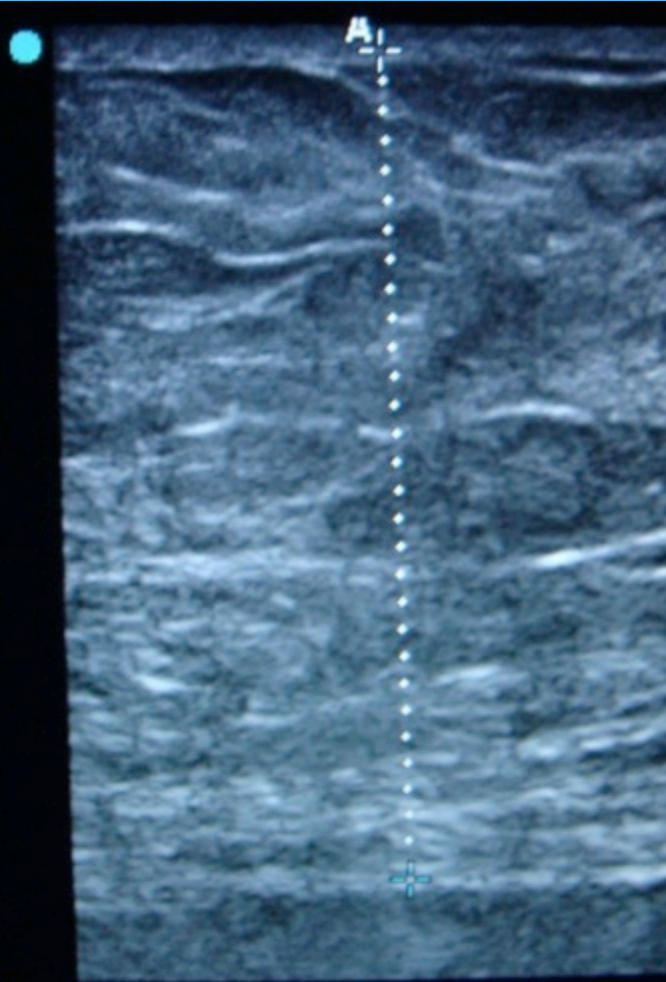
## Intra visceral adiposity

Subcutaneous fat is scant and  
intra abdominal fat is thick and

## Extra visceral adiposity

Subcutaneous fat is thick and  
intra abdominal fat is scant.

# Thickness of external fat



A 5.09cm



# 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.



# Other techniques used to improve surgical workspace 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 Defloor · Els Van Dessel · Faki Akis · Nathalie Moreels · Sebastiaan Lambert · Jan Muller · Ravindra Date · Michiel Vandanaotte · Tom Feryn · Luc Proot

Received: 17 February 2009 / Accepted: 26 July 2009  
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# 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**



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2010

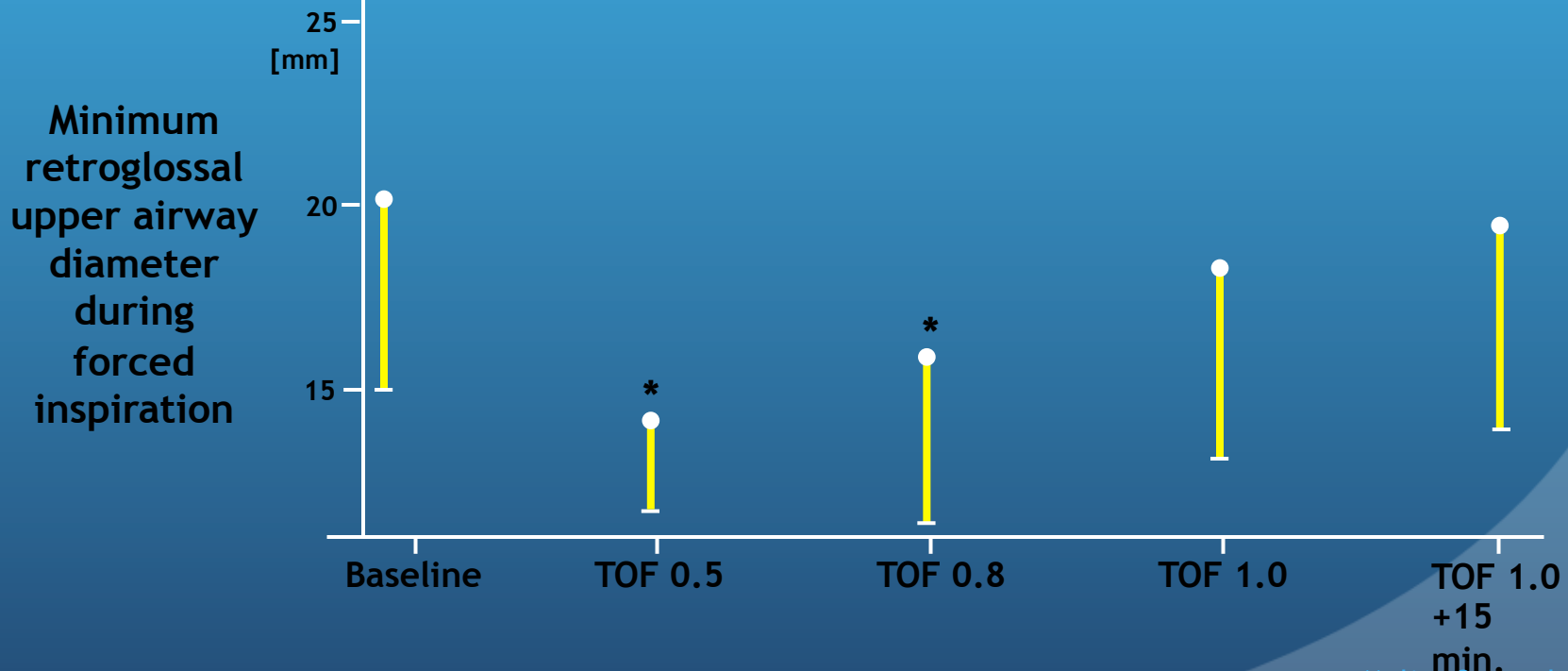
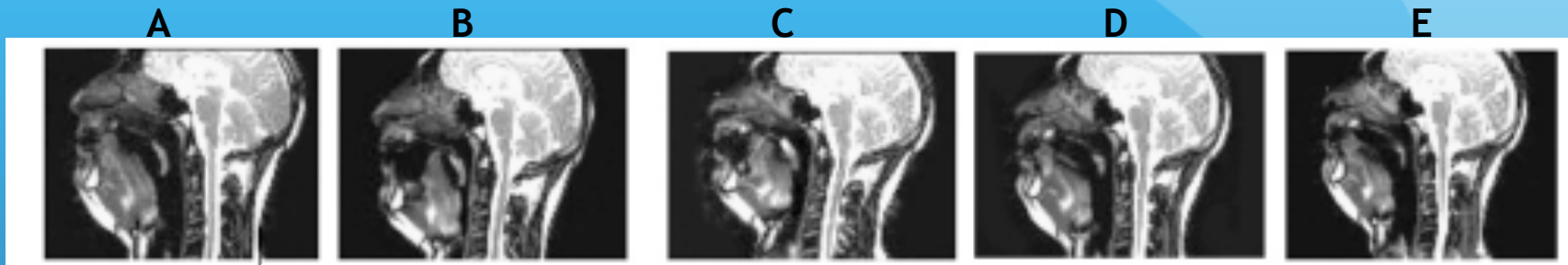
A. Use of Deep Muscle Relaxation in Laparoscopic Bariatric Surgery:

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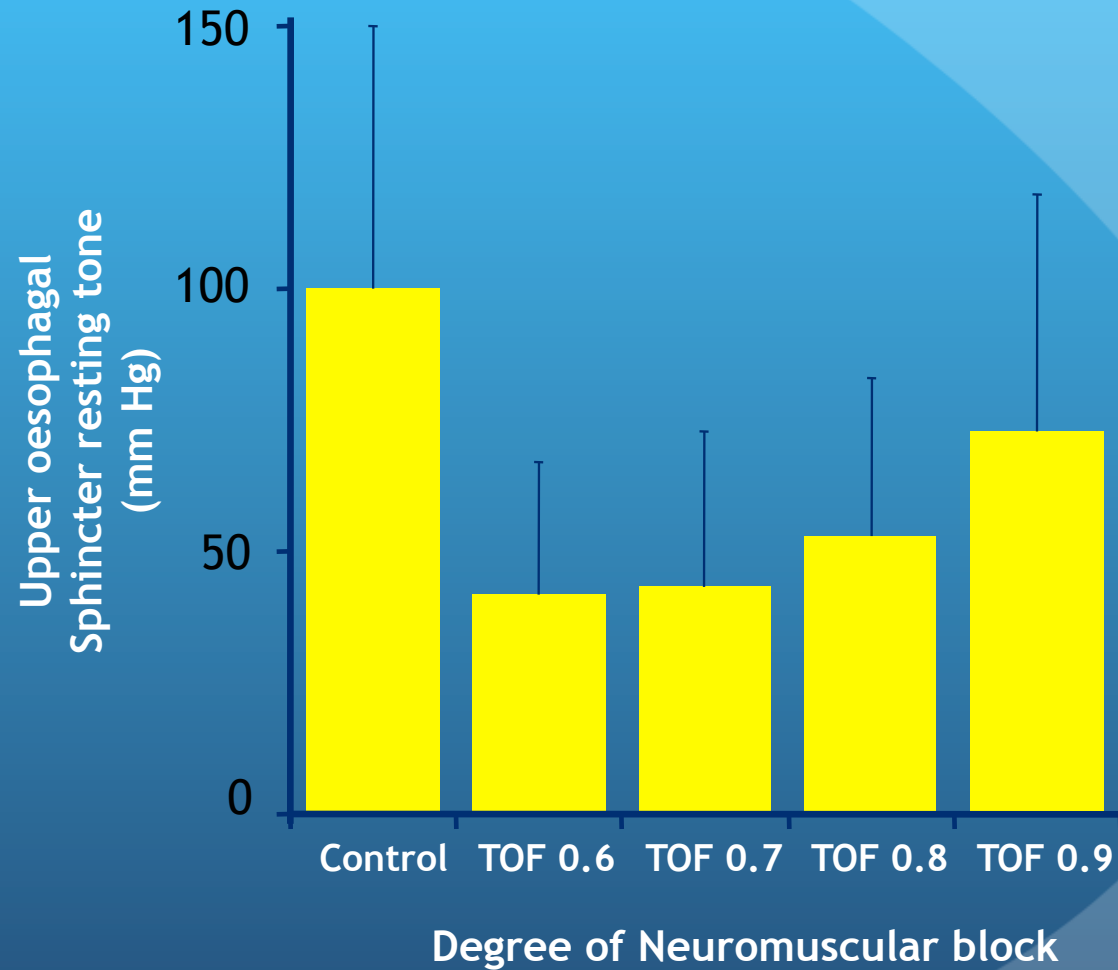
# Importance of Achieving TOF $\geq 0.9$



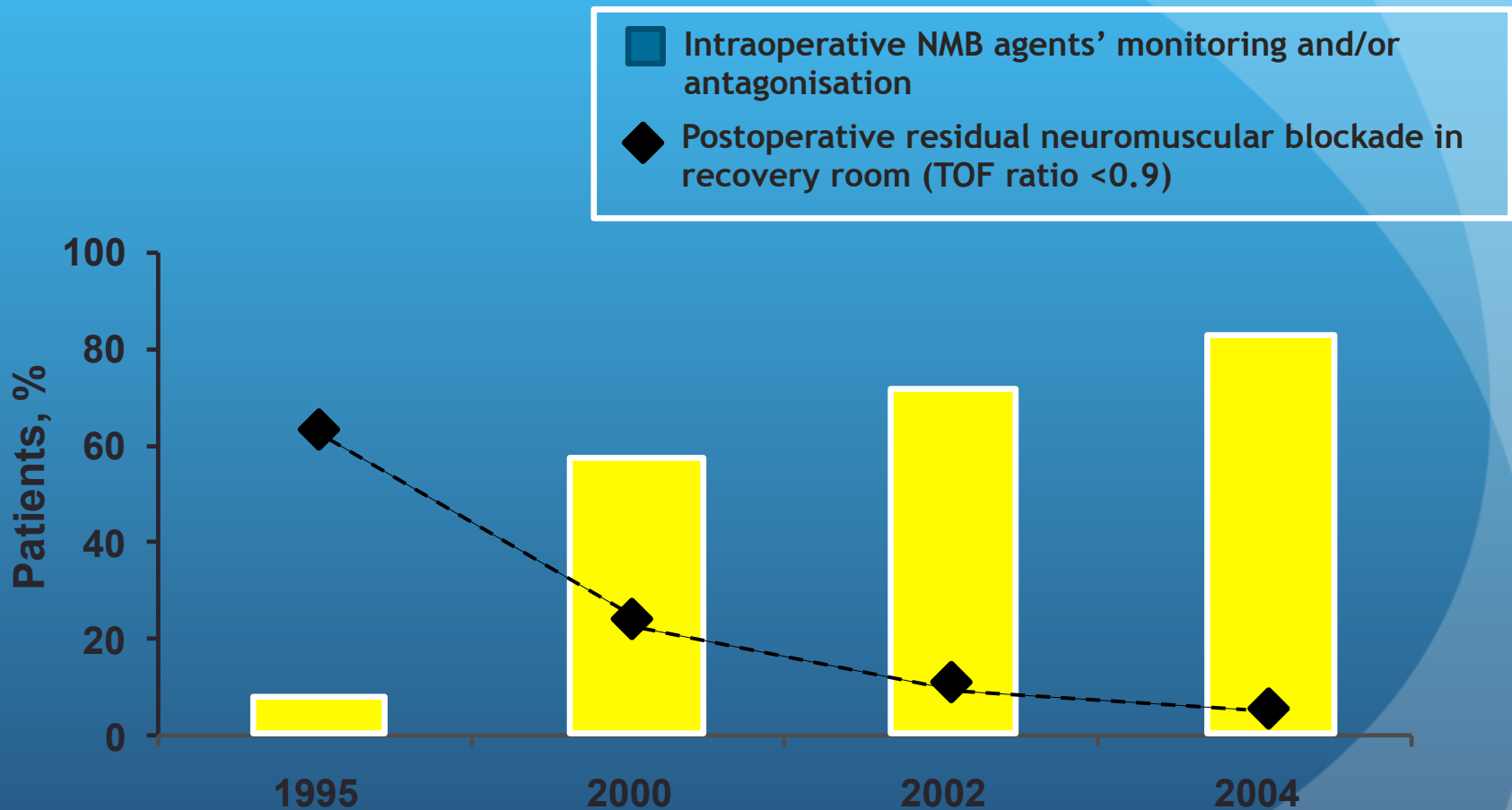
Mulier 8 march 2012

# Pharynx Dysfunction Increases the Aspiration Risk

Human volunteers  
Partially paralyzed



# The Clinical Benefits of Routine Monitoring and Reversal<sup>1</sup>

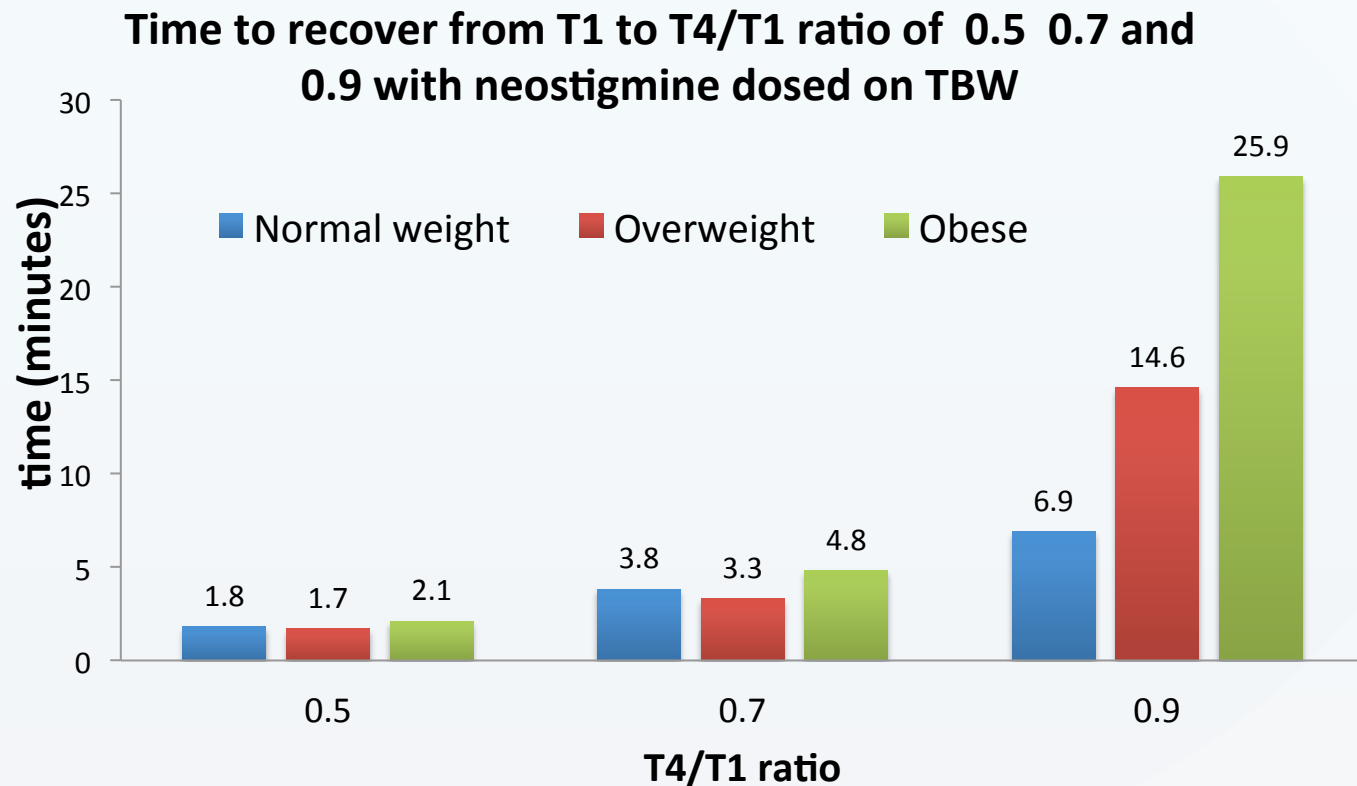


NMB=neuromuscular blockade; TOF=train of four.

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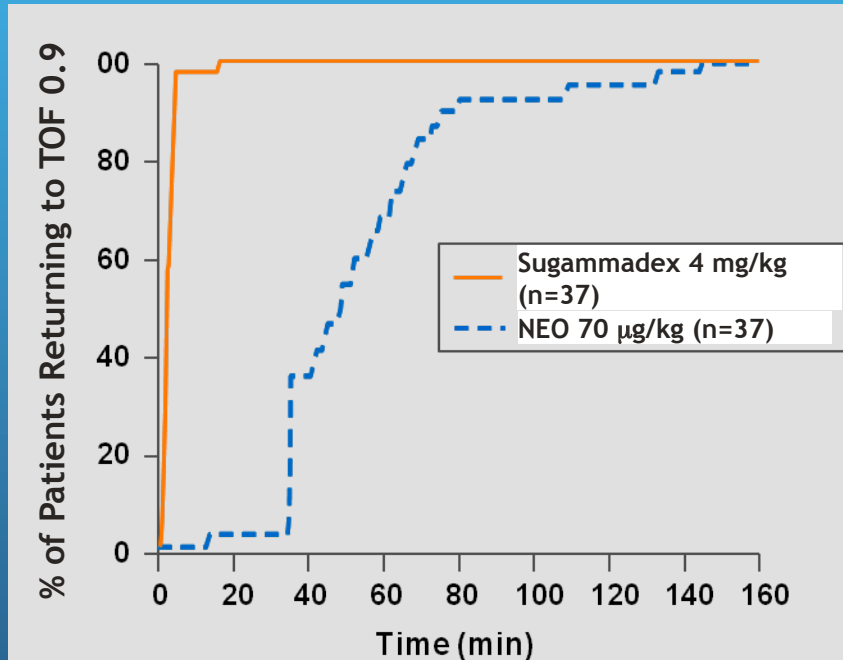
# Neostigmine is Less Effective in Obese Patients

- Obese patients are more difficult to reverse with neostigmine.

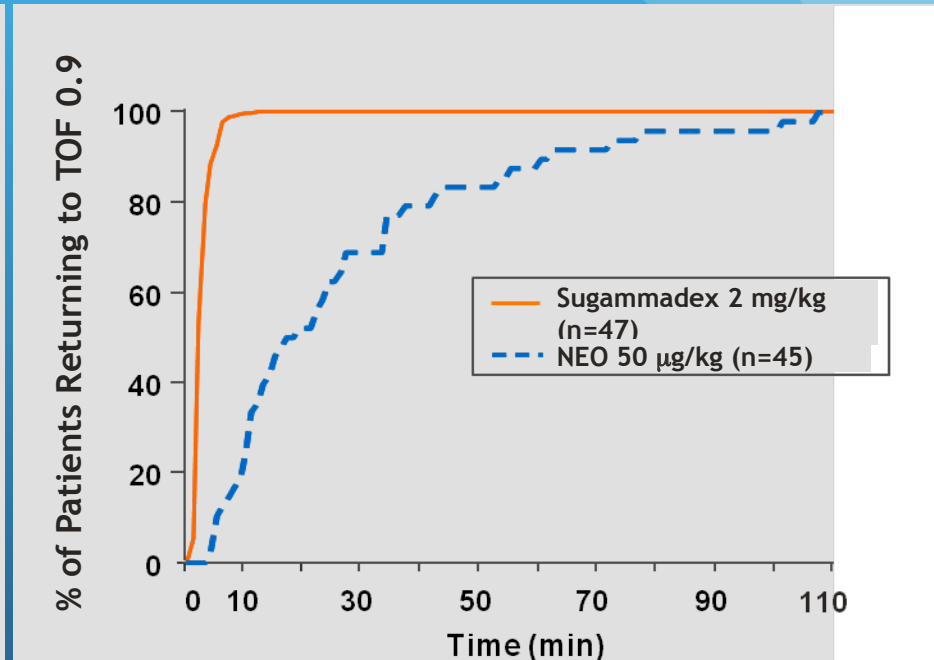


# Predictability and Consistency of Sugammadex Reversal in Moderate and Deep NMB

Reversal from 1 to 2 PTCs following rocuronium<sup>1</sup> 0.6 mg/kg

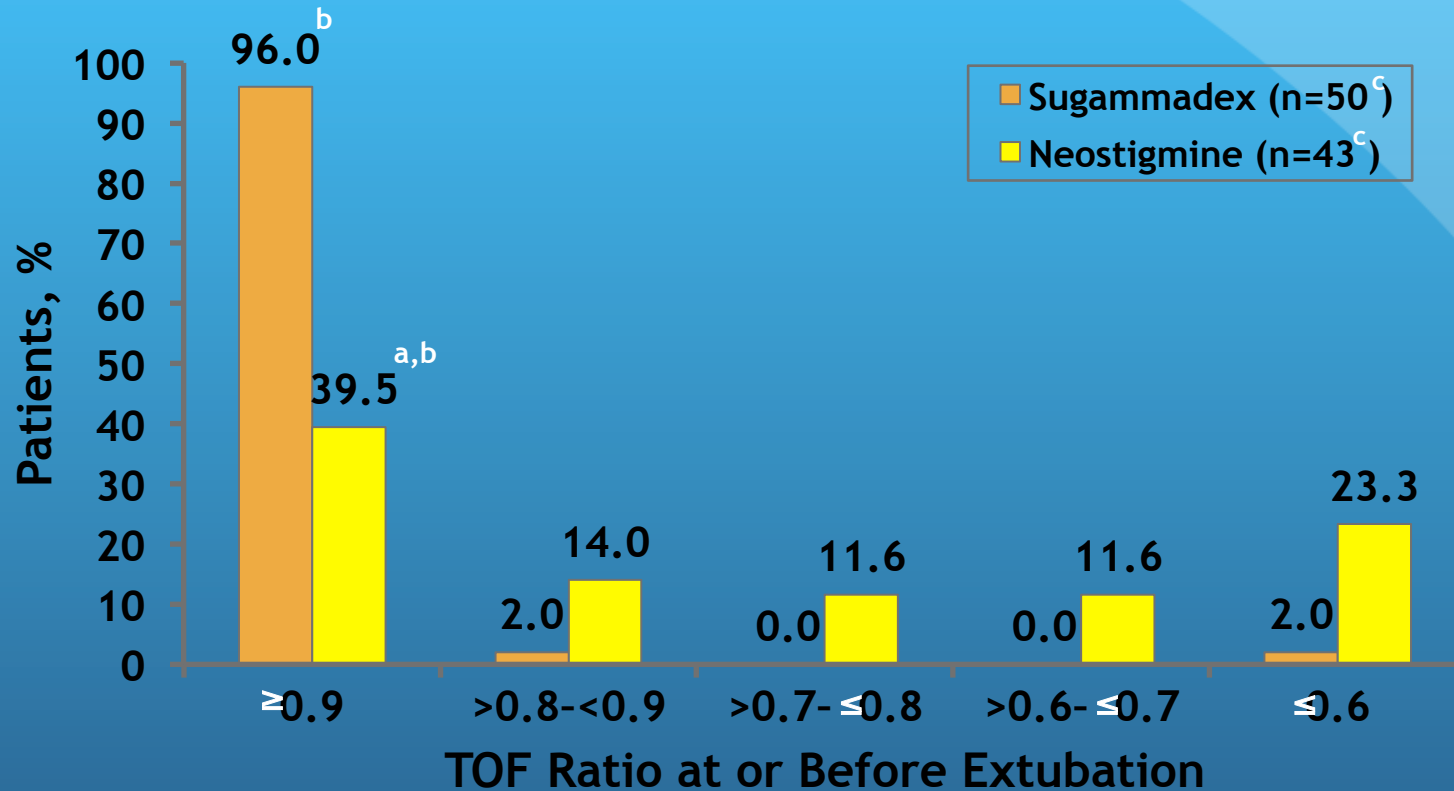


Reversal from T2 following rocuronium<sup>2</sup> 0.6 mg/kg



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

# Sugammadex Increases Likelihood that Extubation Occurs at TOF $\geq 0.9$ <sup>1</sup>



<sup>a</sup>  $P < 0.0001$  for sugammadex vs neostigmine (Fisher's exact test).

<sup>b</sup> 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  $\geq 0.9$ .

<sup>c</sup> 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.

Muller 8 march 2012

# EFFECTS OF CISATRACURIUM ON MORBIDLY OBESE WOMEN

Leykin Y et al. Anesthesia & Analgesia 2004;99:1090-4

*Cisatracurium 0.2 mg/kg: onset RBW duration RBW - IBW*

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

## The Effects of Cisatracurium on Morbidly Obese Women

Yigal Leykin, MD, MSc\*, Tommaso Pellis, MD, Mariella Lucca, MD\*,  
Giacomina Lomangino, MD, Bernardo Marzaro, MD, and Antonino Gullo, MD†

\*Departments of Anesthesia, Pain, Perioperative Medicine and Intensive Care, and †Surgery, Santa Maria degli Angeli Hospital, Pordenone, Italy; and the ‡Department of Perioperative Medicine, Intensive Care and Emergency, Trieste University Medical School, Trieste, Italy

Group	BMI	Weight (kg)	Onset (sec)	Duration 25% (min)
RBW (n=10)	42.2 ± 4.2	114 ± 12	132 (110-153)	74.6 (61-88)
IBW (n=10)	43.5 ± 4.0	116 ± 15	182 (150-237)	45.0 (34-56)
NBW (n=10)	22.1 ± 1.3	59 ± 3	135 (70-237)	59.1 (38-78)

$p < 0.05$  vs Real Body Weight

$p < 0.05$  vs Ideal Body Weight

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# EFFECTS OF ROCURONIUM ON MORBIDLY OBESE PATIENTS

Leykin Y et al. Anesthesia & Analgesia 2004;99:1086-9

Rocuronium 0.6 mg/kg: onset and duration according to IBW

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

## The Pharmacodynamic Effects of Rocuronium When Dosed According to Real Body Weight or Ideal Body Weight in Morbidly Obese Patients

Yigal Leykin, MD, MSc<sup>1</sup>, Tommaso Pellis, MD<sup>2</sup>, Mariella Lucca, MD<sup>3</sup>,  
Giacomina Lomangino, MD<sup>3</sup>, Bernardo Marzano, MD<sup>3</sup>, and Antonino Gullo, MD<sup>3</sup>

<sup>1</sup>Department of Anesthesia, Pain, Perioperative Medicine and Intensive Care, Santa Maria degli Angeli Hospital, Pordenone, Italy; <sup>2</sup>Department of Perioperative Medicine, Intensive Care and Emergency, Trieste University Medical School, Trieste, Italy; and <sup>3</sup>Department of Surgery, Santa Maria degli Angeli Hospital, Pordenone, Italy

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)

$p < 0.05$  vs Real Body Weight

$p < 0.05$  vs Ideal Body Weight

## France 2 year incidence: 2001 - 2002

- 712 cases of Anaphylaxis and anaphylactoid reactions during anesthesia
- 55 % NMB
- Succinyl choline 38 % Rocuronium 26 % other NMB 46%
- Cross reactivity in 63%
- Anaphylactic and anaphylactoid reactions occurring during anaesthesia in France. Seventh epidemiologic survey (January 2001-December 2002)  
[Ann Fr Anesth Reanim.](#) 2004; 23:1133-43.

# Risk for allergic reactions?

- All NMB have anafylaxis ( IGE) and anafylactoid reactions (non IgE)
  - No difference in clinical effect
  - Most frequent benign with only cutaneous reactions and histamine release (tryptase measurement)
- Atracurium                      strong histamine release
- Cisatracurium                less histamine release? and assumed to have less reactions than atracurium?
- Vecuronium                    not used anymore
- Pancuronium                 not used anymore
- Rocuronium                    most freq used: highest incidence of reactions?

# Difference in allergy to NMB ?

- IgE mediated hypersensitivity
  - Mertes P Hypersensitivity reactions to neuromuscular blocking agents [Curr Pharm Des.](#) 2008;14(27):2809-25.
- Non IgE mediated hypersensitivity
  - Direct hist release interaction with muscarine nicotine receptor
  - Peroni D Muscle relaxants allergy [Int J Immunopathol Pharmacol.](#) 2011 Jul-Sep;24(3 Suppl):S35-46.
- Freq cross reactivity
  - Dewachter P Value of skin tests for the choice of a neuromuscular blocking agent after an anaphylactic reaction [Ann Fr Anesth Reanim.](#) 2005 May;24(5):543-6. Epub 2005 Apr 8.
- Skin test not absolute safe
  - Anaphylaxis to cisatracurium following negative skin testing. [Anaesth Intensive Care.](#) 2005 Dec;33(6):816-9.
- No difference between atracurium and cis atracurium in skin test
  - Fischer M Cisatracurium and atracurium as antigens [Anaesth Intensive Care.](#) 1999 Aug;27(4):369-70.
- **Anaphylactoid reactions after cisatracurium administration in six patients.**
  - [Anesth Analg.](#) 2001 Nov;93(5):1257-9, table of contents.

# Treatment difference ?

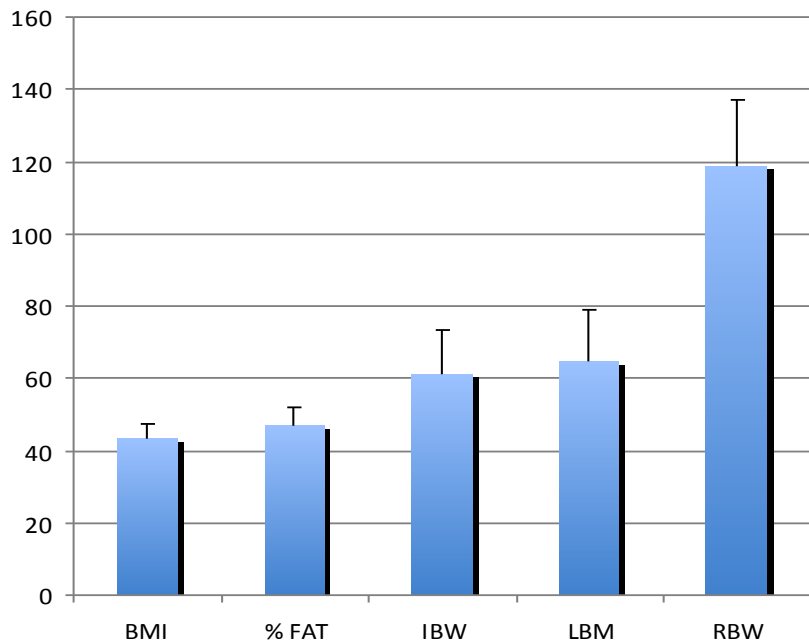
- Reanimation and Stop exposure of agent, ...
  - How?
- Sugammadex in the management of rocuronium-induced anaphylaxis
  - [Mc Donnell N Br J Anaesth.](#) 2011 Feb;106(2):199-201. Epub 2010 Dec 10.
- A further case of rocuronium-induced anaphylaxis treated with sugammadex
  - [Funnell A Br J Anaesth.](#) 2011 Aug;107(2):275-6.
- Theoretical not possible but reality ....?
  - Allergenic groups outside complex.

# Comparison of the IBW, using the index of Broca, with LBW, using electrical impedance, for medication dosage in morbidly obese patients.

IFSO 2011 P6 IBW versus LBW for medication dosage  
JPMulier P VanLancker B Dillemans



**obesity indices**

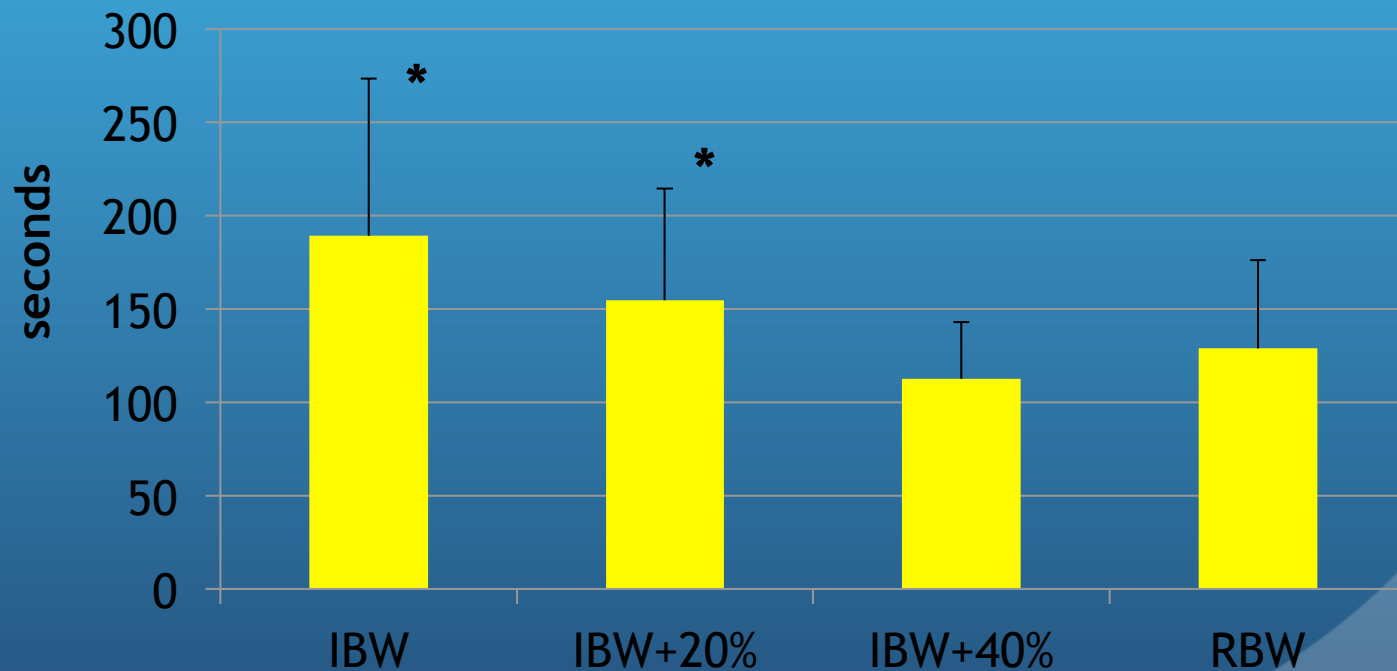


Theoretical LBW should increase in morbidly obese patients. However for patients undergoing bariatric surgery with an average BMI of 40, the difference between IBW and LBW was not significant (only 6.6%).

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

Time (seconds) from TOF 1.2 to 90%

Sugammadex given in 2 mg/kg  
IBW - IBW + 20% - IBW + 40% - RBW



IBW=ideal body weight; RBW: real body weight

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

Mulier 8 march 2012

\* $P < 0.001$  versus RBW

# NMB During Laparoscopic Surgery in Morbidly Obese Patients

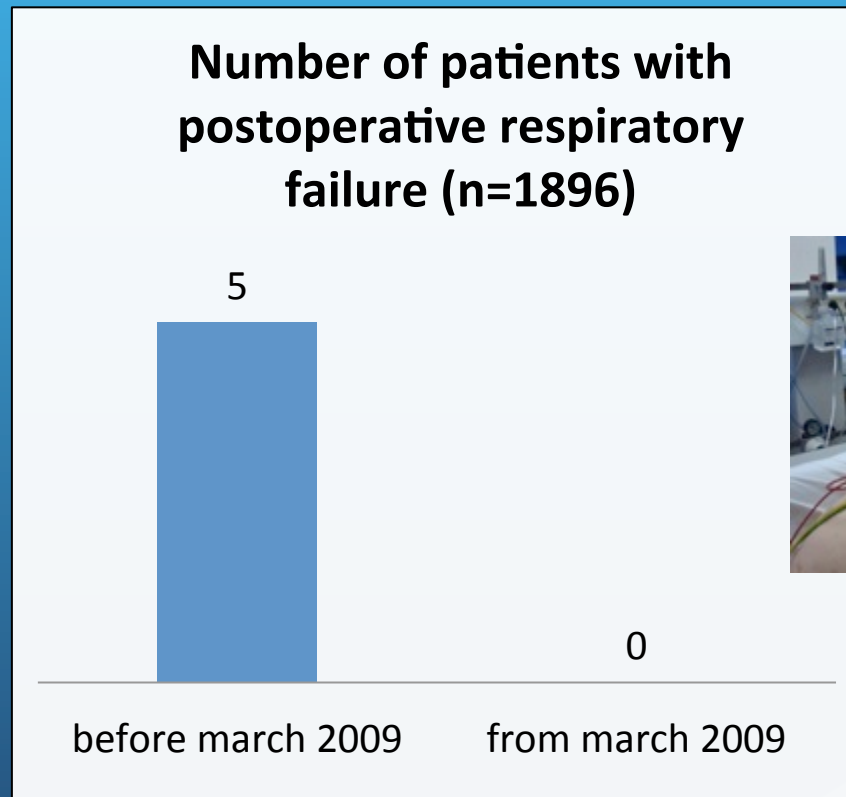
- Deep muscle relaxation may provide and maintain sufficient surgical workspace
- A patient being fully awake and able to take deep breaths postoperatively is important
- Neostigmine has an unpredictable and very long decurarisation time to reach a TOF ratio  $>0.9$
- Sugammadex provides predictable 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.
- 1<sup>st</sup> 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

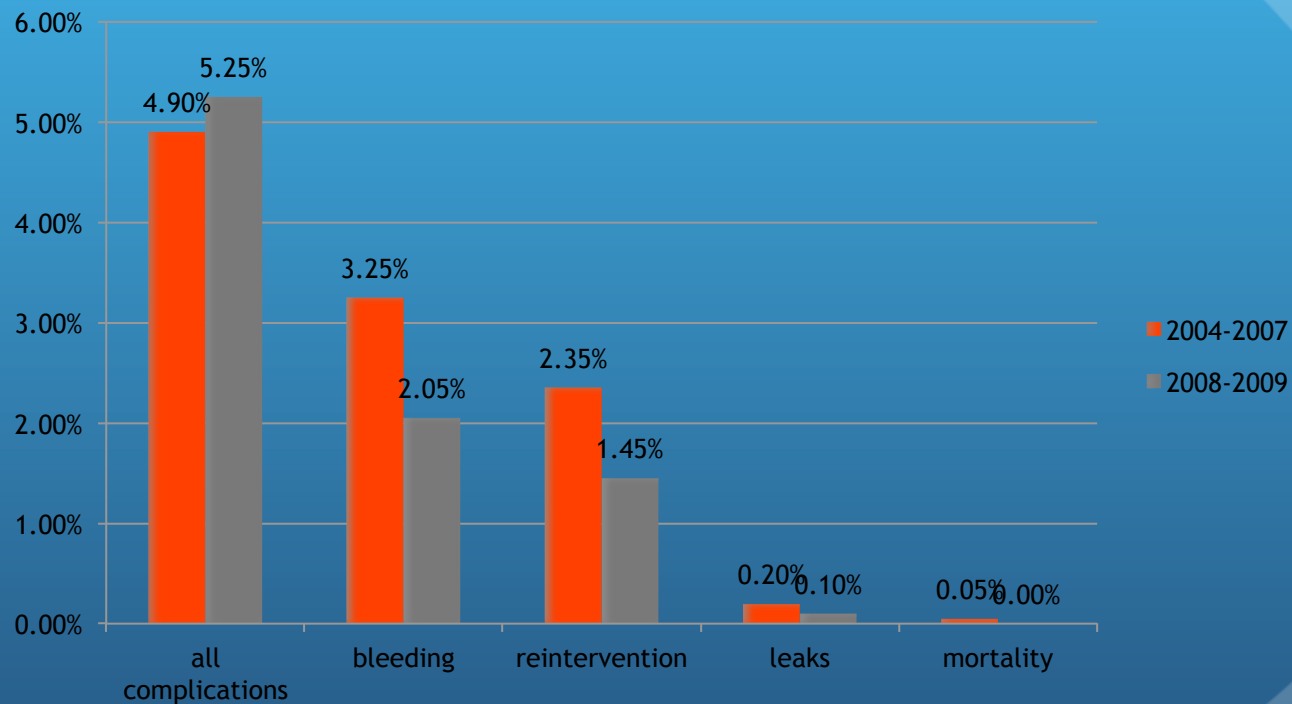
D. Using ERAS (enhanced recovery after surgery) for Laparoscopic Bariatric Surgery: J P Mulier



Sint-Jan Brugge-Oostende, Belgium

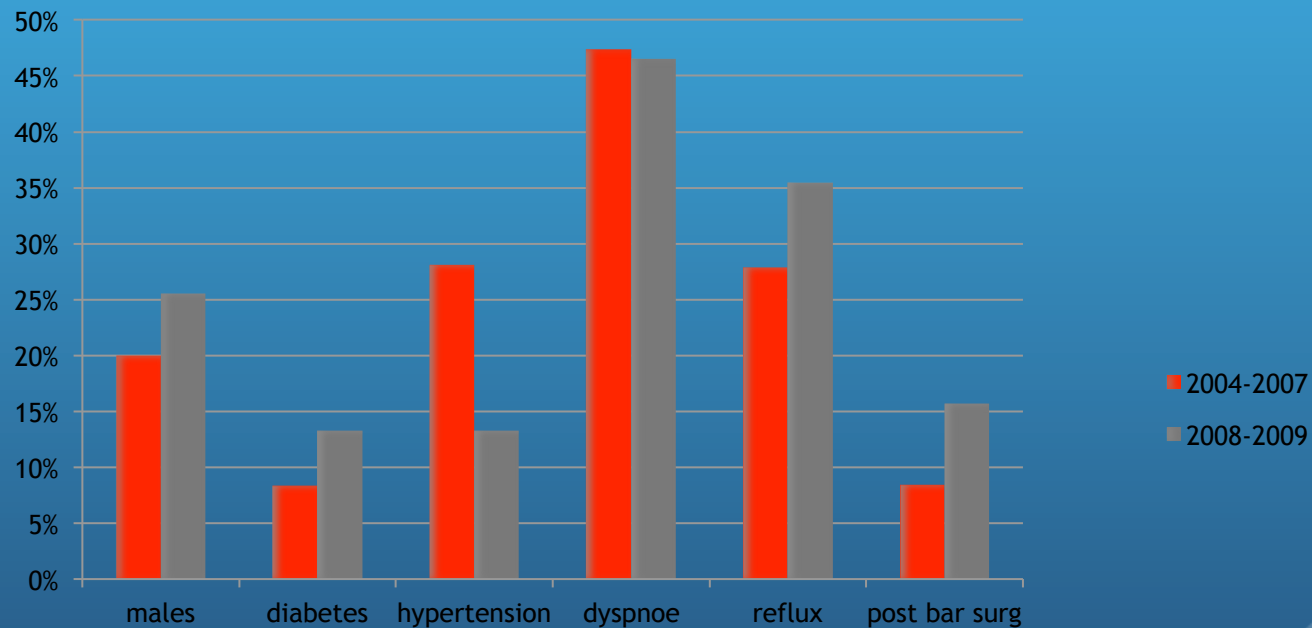
# 4000 consecutive lap RNY

- 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

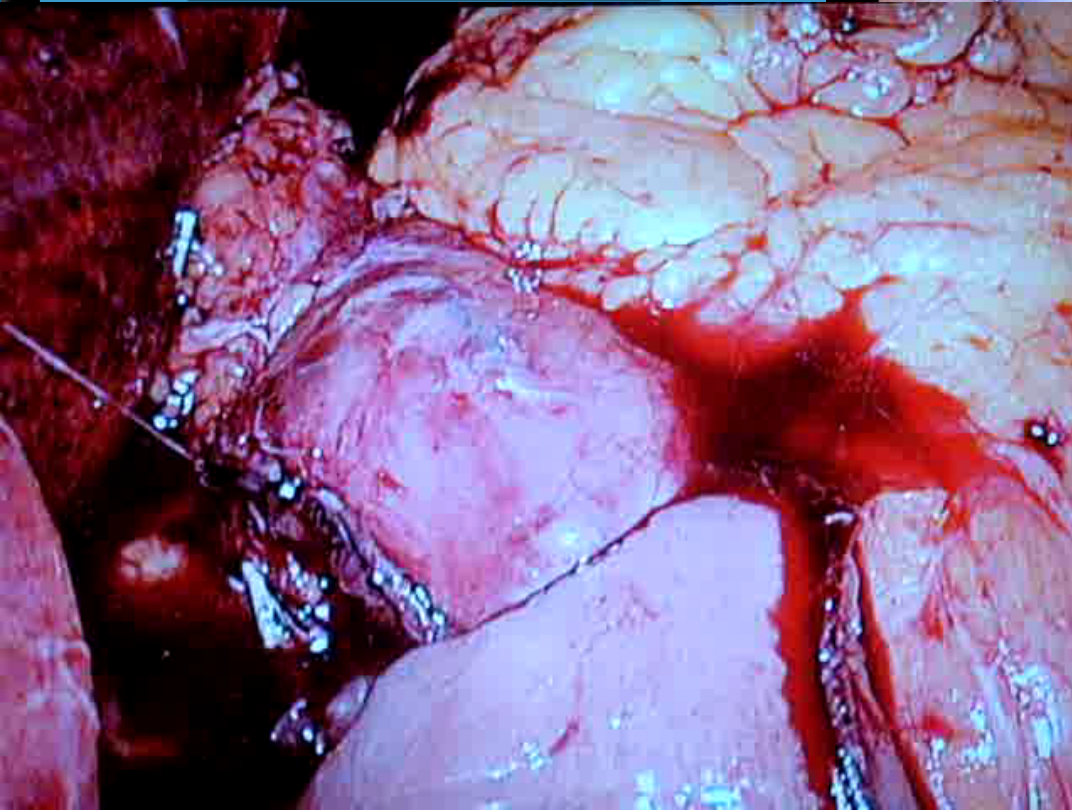
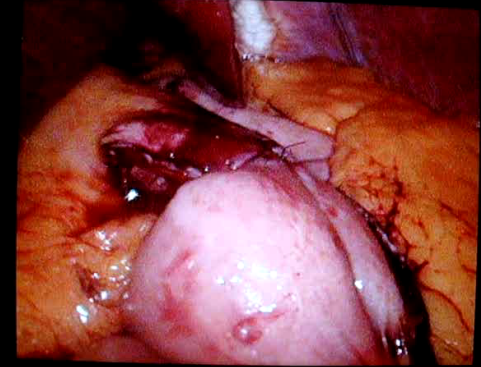
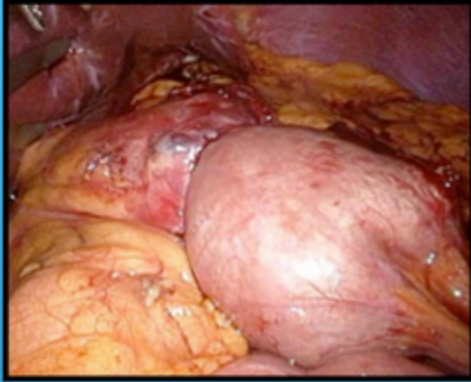
	<b>Dr Dillemans</b>	<b>other</b>
Av. Surgical time	54	61
Av. Non-surgical time	12.5	20.1
Complications rate		
Mortality	0.04%	1.02%
Obstructions	0.38%	1.5%
Bleedings	3.14%	4.38%
Leakage	0.17%	2.7%

- 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

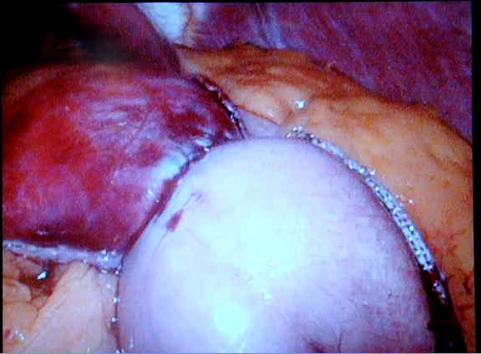
# ERAS (enhanced recovery after surgery)

- Keep NMB till end of surgery if abdomen 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
- tromboprophylaxis

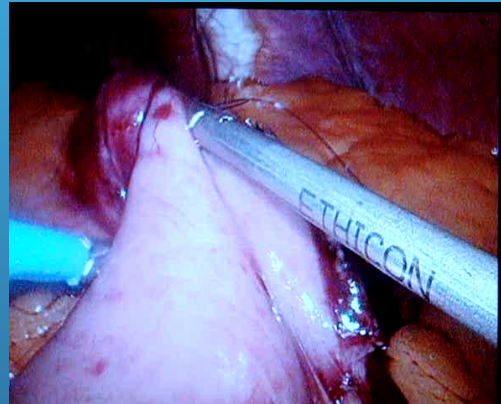
# leak test rapid injection of 150 ml blue water and air



# Positive leak test of the staple line



First leak test is positive



Suture 1



Suture 2

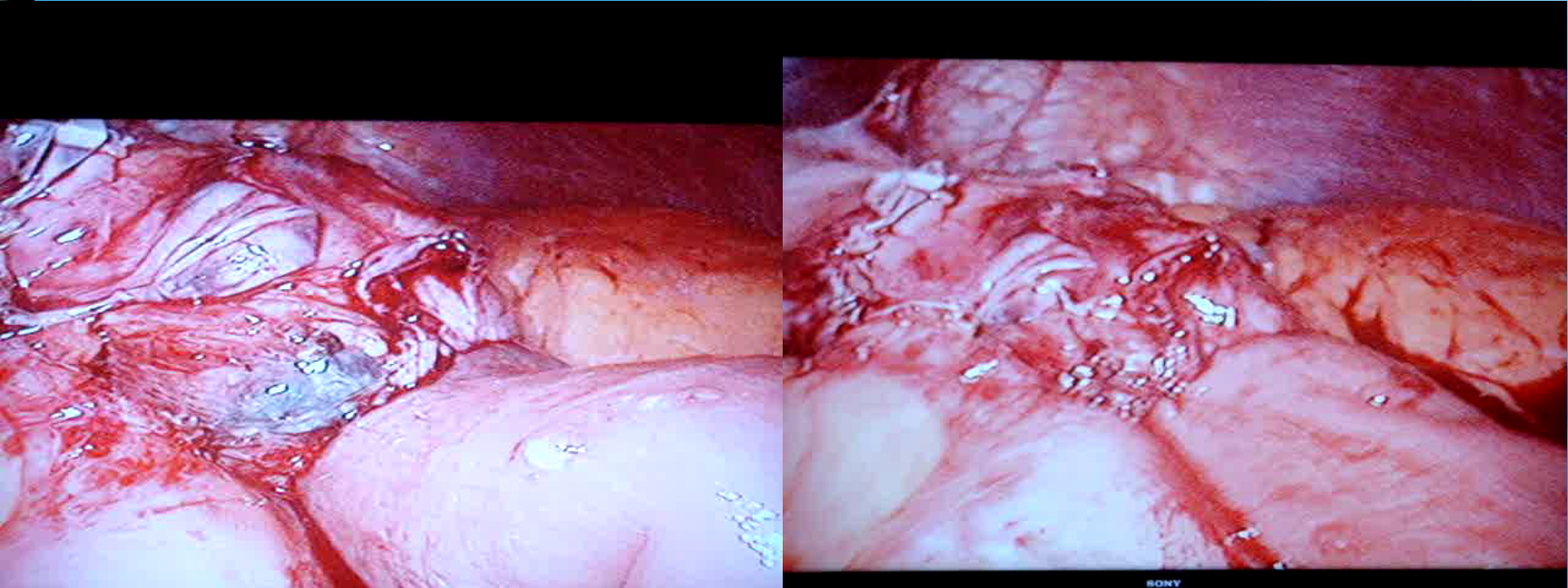
Second leak test is negative



Mulier 8 march 2012

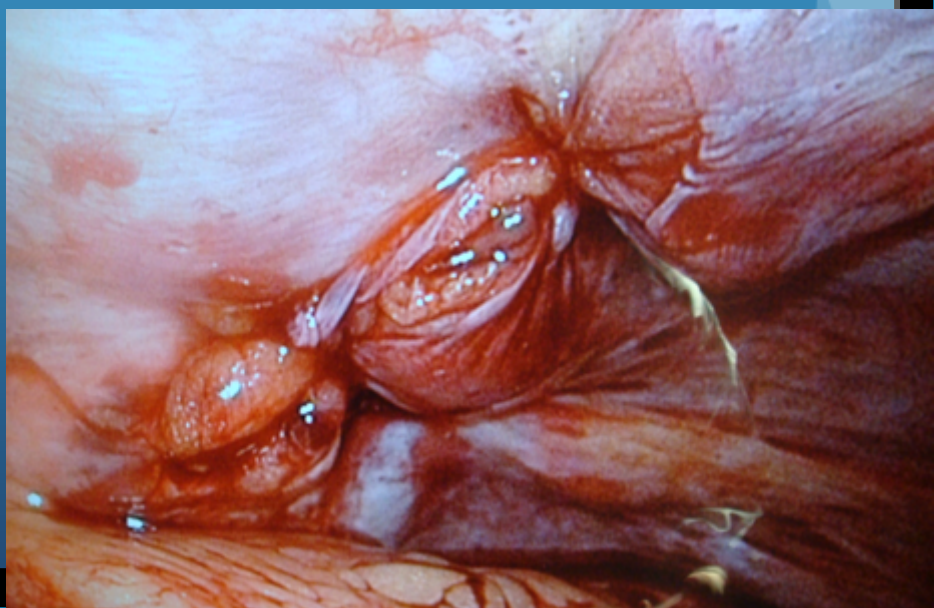
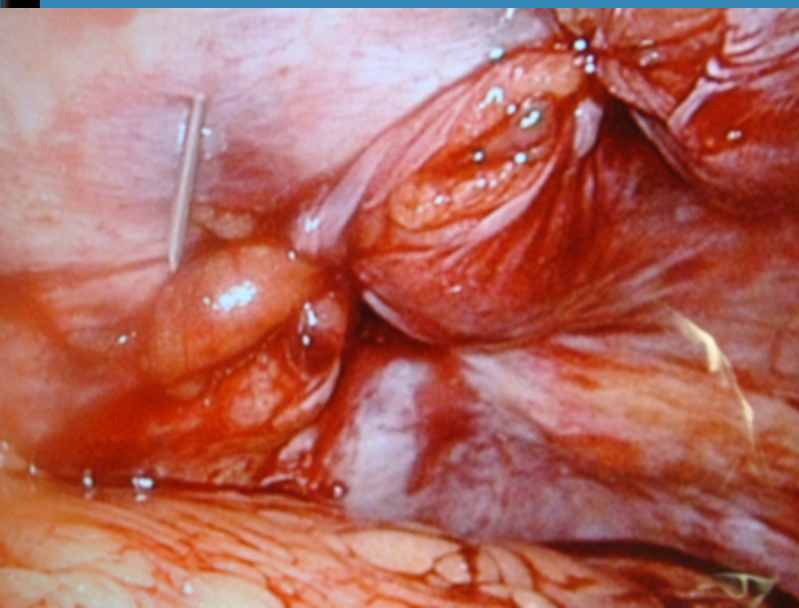
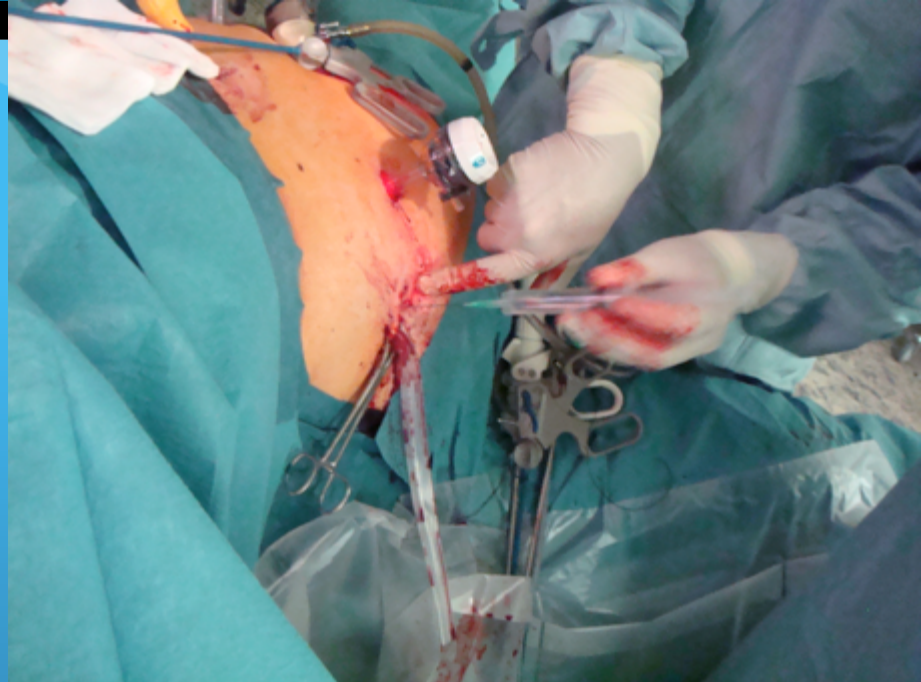
# Positive Leak test submucosal followed by control after suture

65



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

# Local infiltration

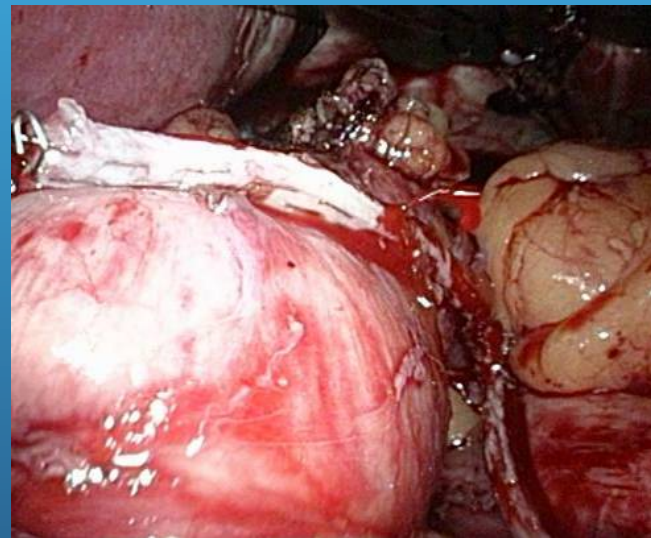


## Use SAP increase to reduce post bleeding

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



**110/57**



**145/78**

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

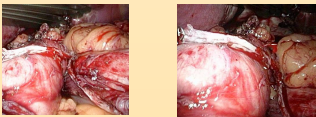
Jan P Mulier, M.D., Ph.D.<sup>1,2</sup>, Mercedes Garcia, M.D.<sup>3</sup>, Tom Bogaert, M.D.<sup>2</sup>, Bruno Dillemans, M.D.<sup>4</sup> and Sebastiaan Vancauwenberge, M.D.<sup>4</sup>.

1. Dep of Anaesthesiology, University hospitals, KULeuven, Leuven, Belgium
2. Dep of Anaesthesiology, Sint JAN Brugge-Oostende, Bruges, Belgium
3. Dep of Anaesthesiology, Hospital de la santa creu I Sant Pau, Barcelona, Spain
4. Dep of General surgery, Sint JAN Brugge-Oostende, Bruges, Belgium

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

### 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.



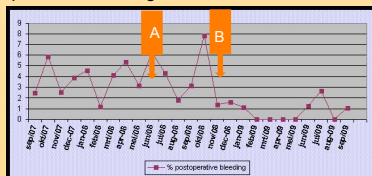
- Blood pressure rose
  - first by vaso active drugs
  - later by adding permissive hypercapnia.
- Detection of bleeding otherwise not treated. (1)

#### The aim of this study:

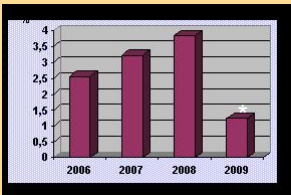
Retrospective analysis of increasing the SAP on the incidence of early postoperative bleeding.

### 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 pCO<sub>2</sub> 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 prevent 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 CO<sub>2</sub> returned to normal
  - Reduction of bic is fast, build up takes hours till 24 H?

Resp depression = sleep apnoe ? or = hyperventilation?

# Hypoventilation and hypercarbia

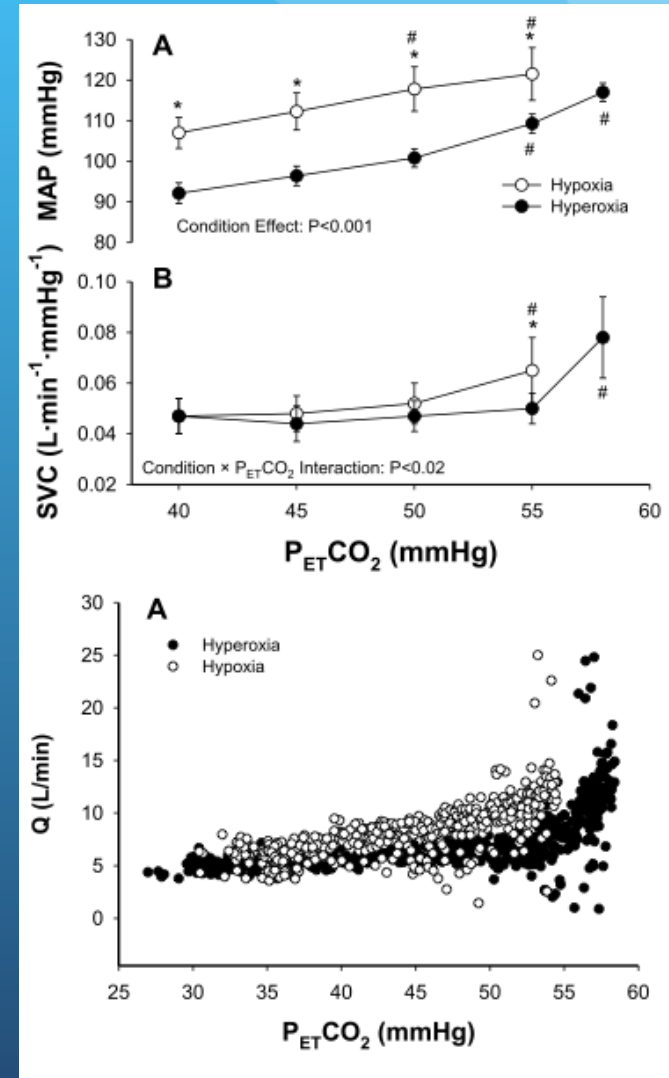
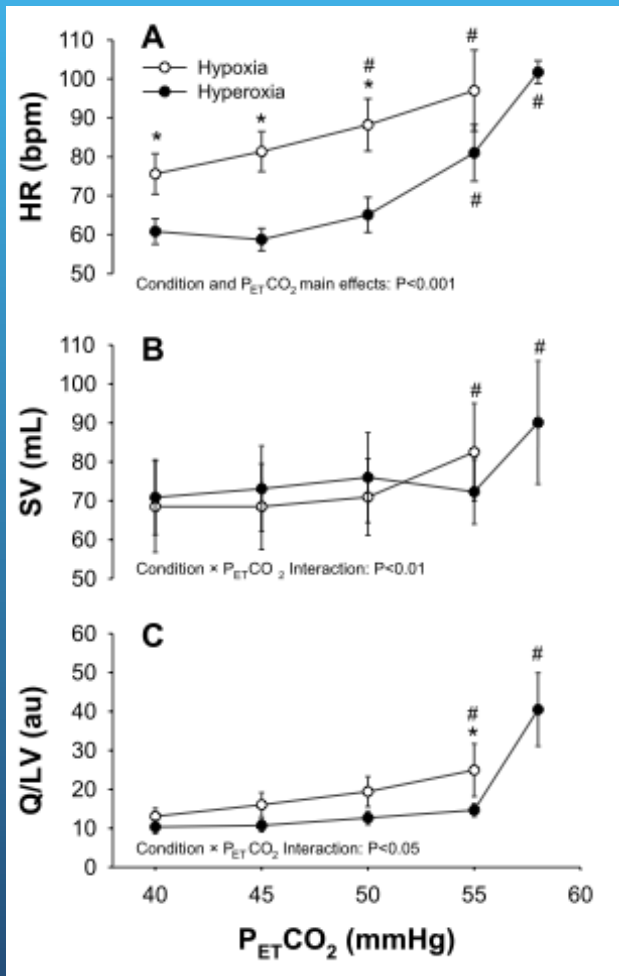
- protection of the lungs
- Hypoxic pulmonary vasoconstriction better VA/Q matching
- Rightward shift of the oxyhemoglobin dissociation curve
- Cardiac output rises
  - which appears to be directly related to both hypercapnic acidosis per se and to hypercapnia-induced sympathetic activation and release 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 O<sub>2</sub> consumption

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

# Hemodynamic effects of Hypercapnia (vs hypoxia)

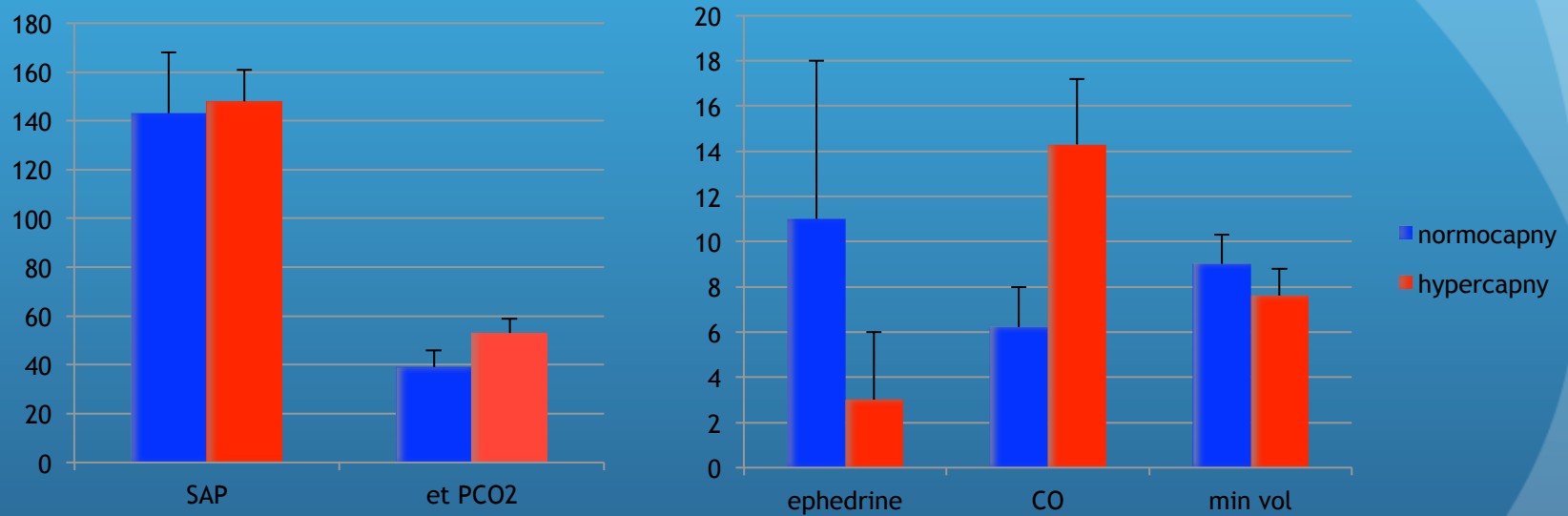
Peripheral chemoreceptor contributions to sympathetic and cardiovascular responses during hypercapnia.

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



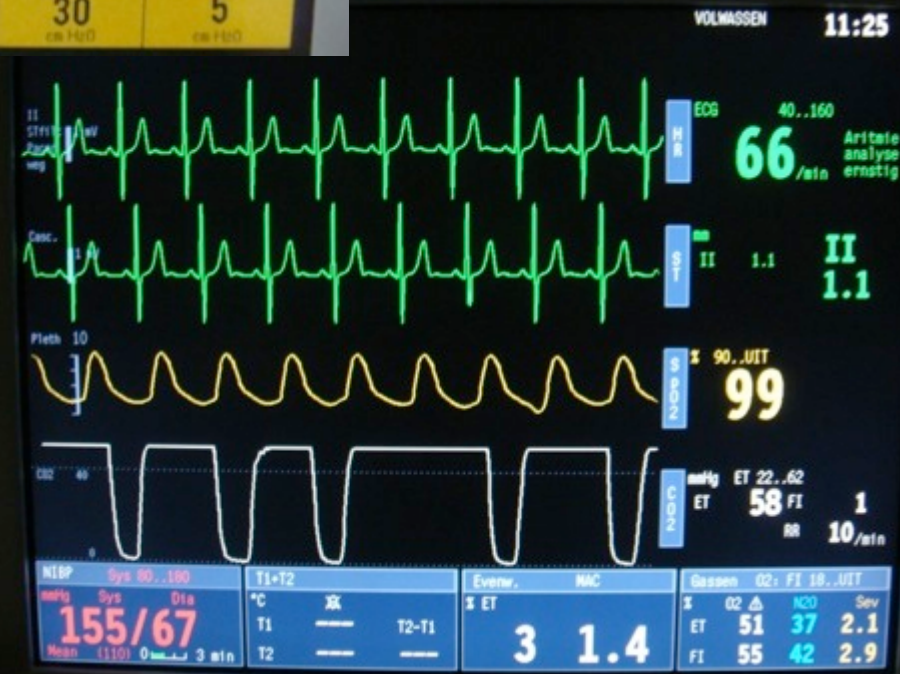
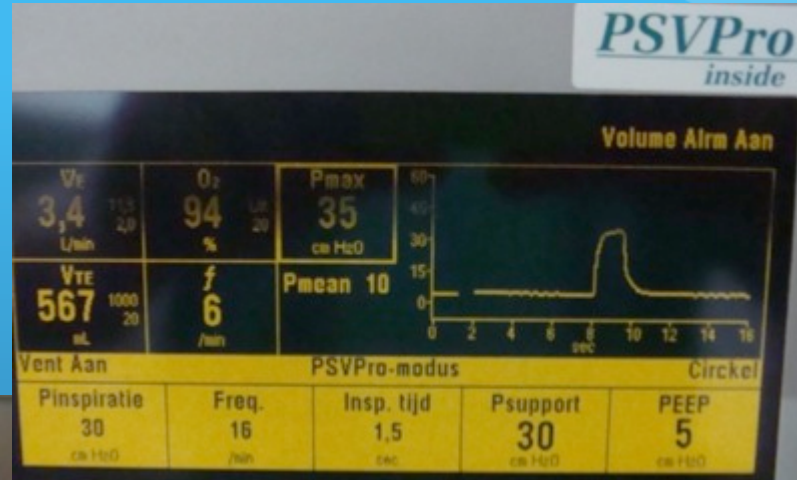
# Permissive Hypercapnia vs Normocapnia under general anesthesia in obese patients

Mulier JP Anesthesiology ESA 2008 A174

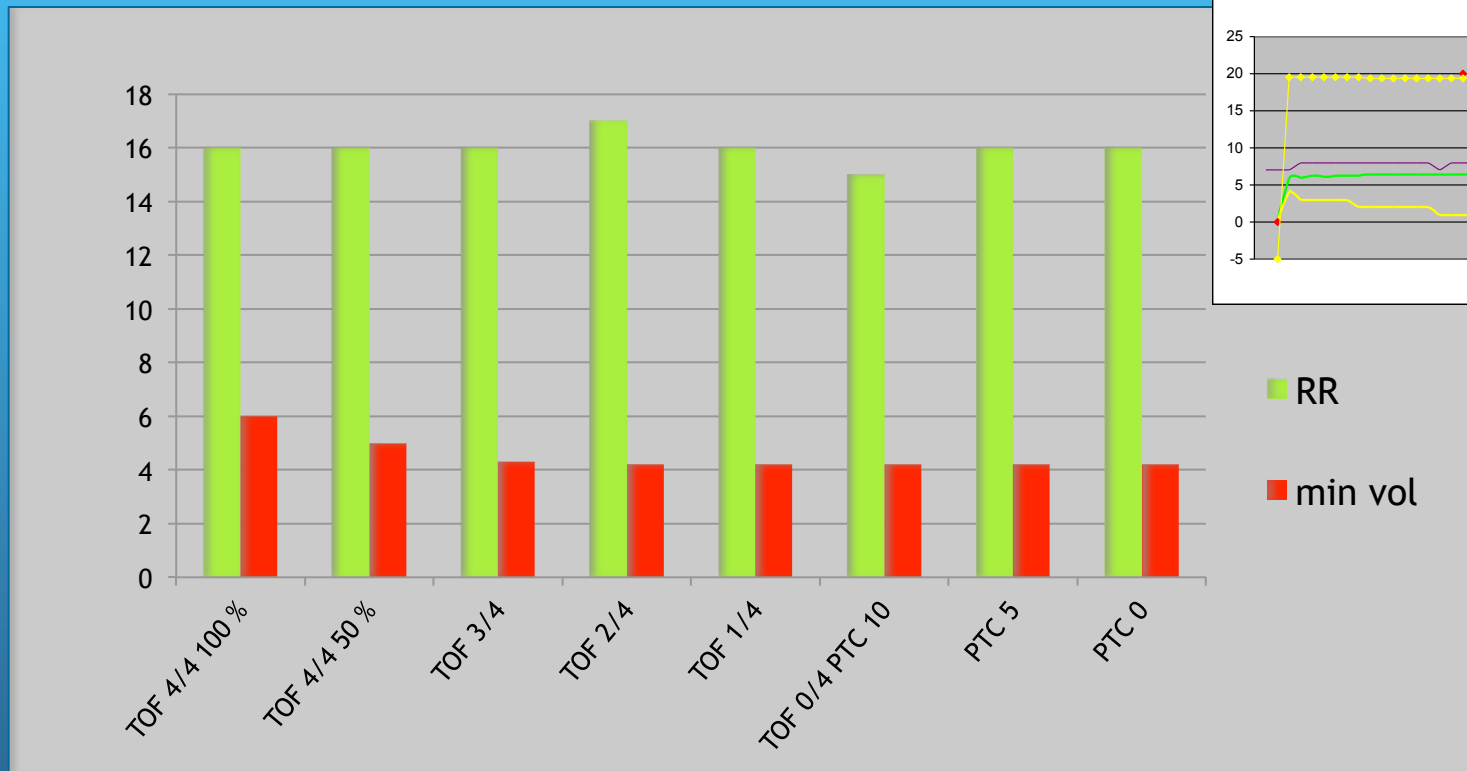


Less ephedrine is needed to elevate SAP due to CO increase

# Effect of et CO2 on blood pressure

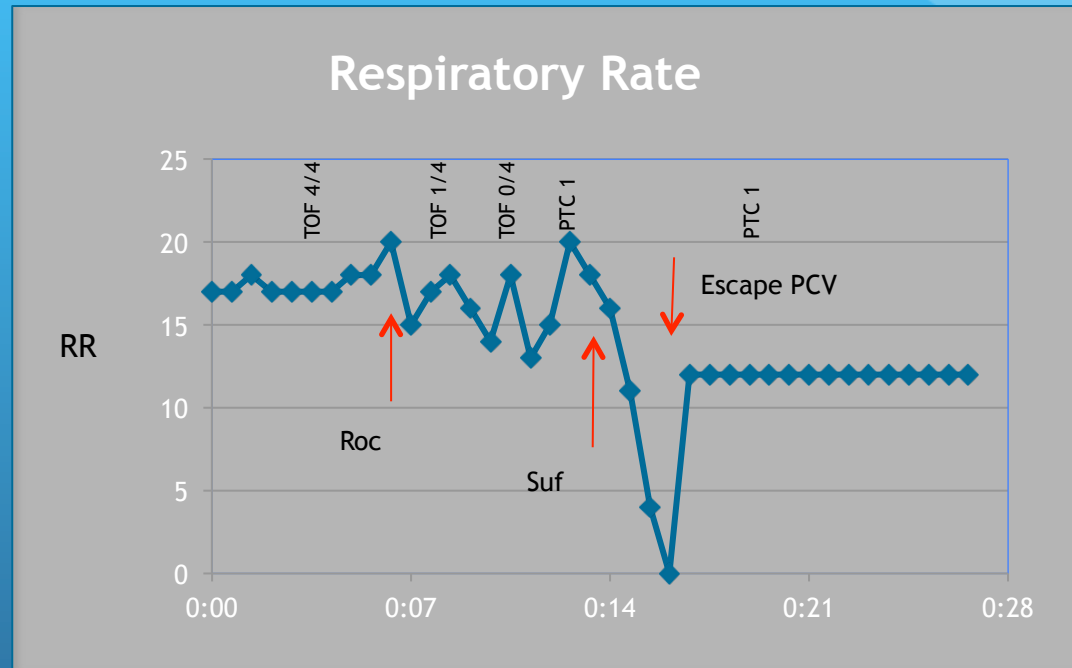


# To what depth of NMB is PSV possible?



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

# 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.



# Low saturation

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

Right Atelectasis Patterns Left

Upper

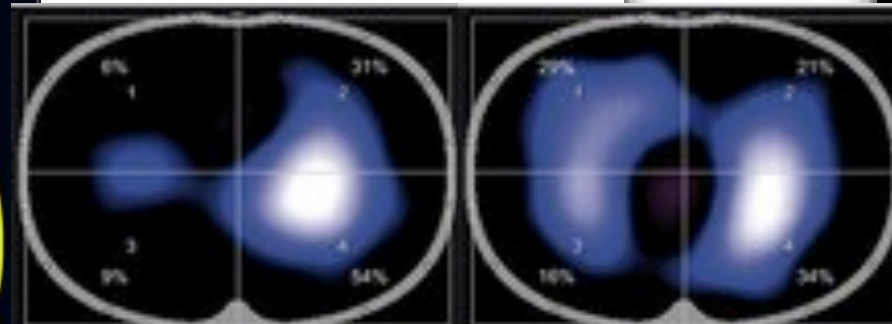
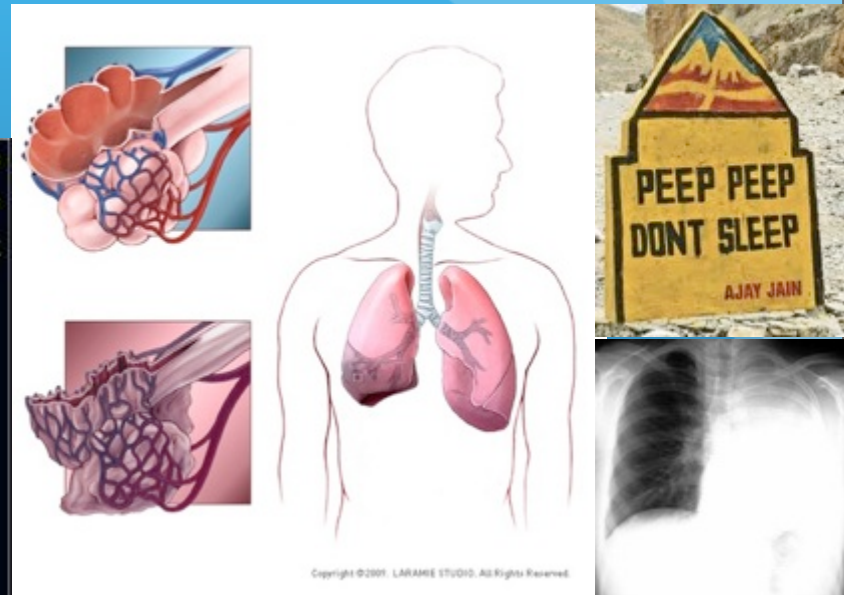
*Measuring atelectasis*

*Attention & Awareness*

*Use of peep and recruitment*

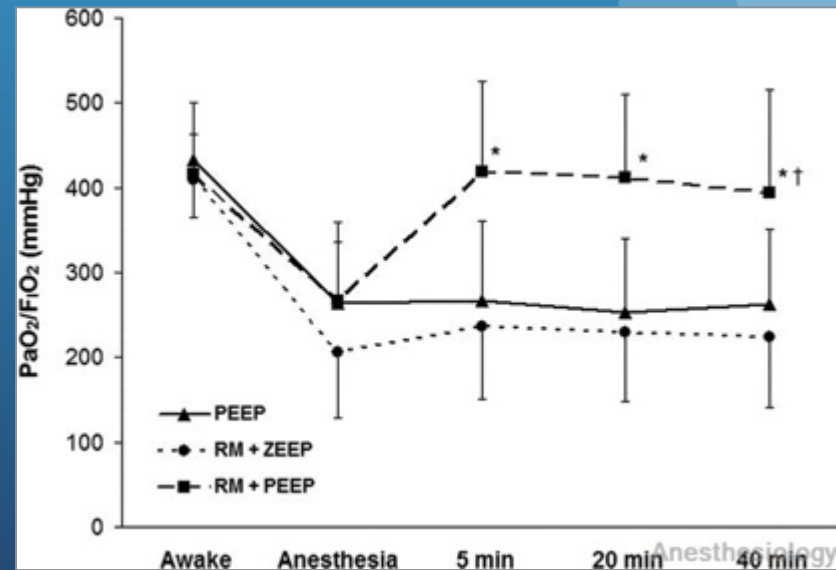
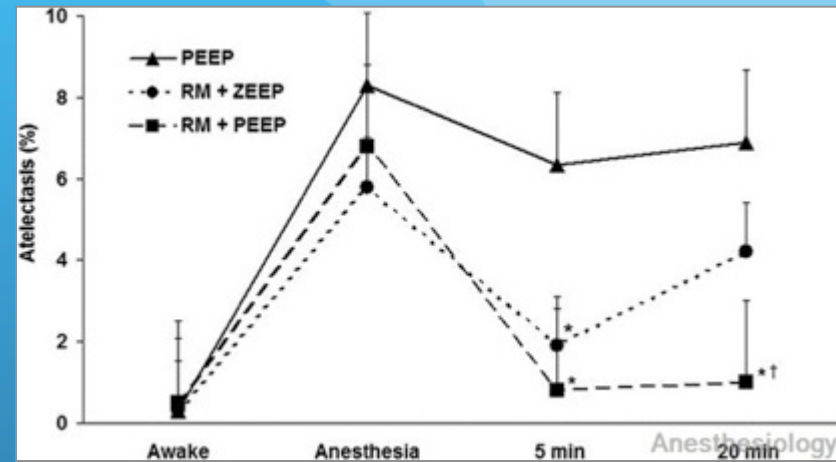
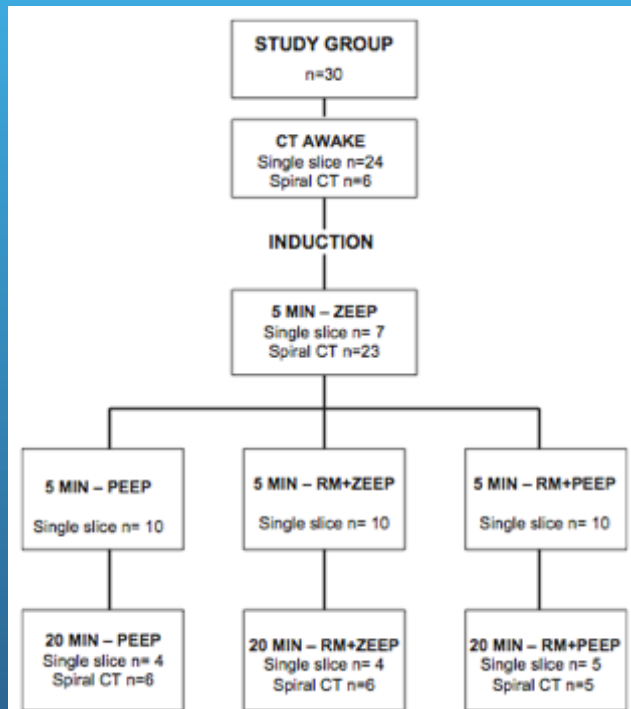
Lower

RLL LLL



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

Reinius et al. Anesthesiology 2009



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

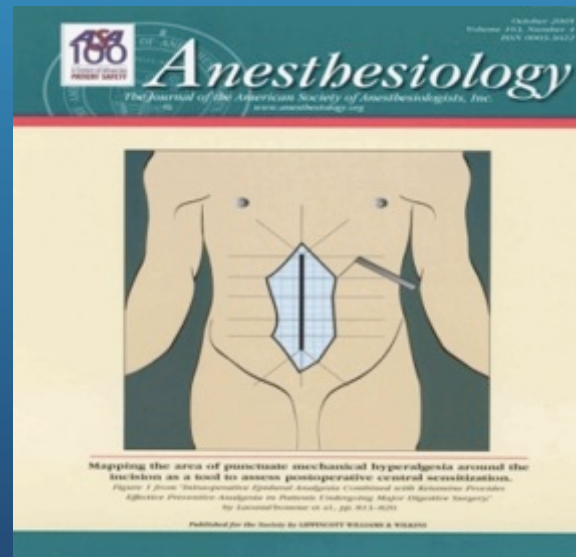


# *Chronic Postoperative persistent Pain....*

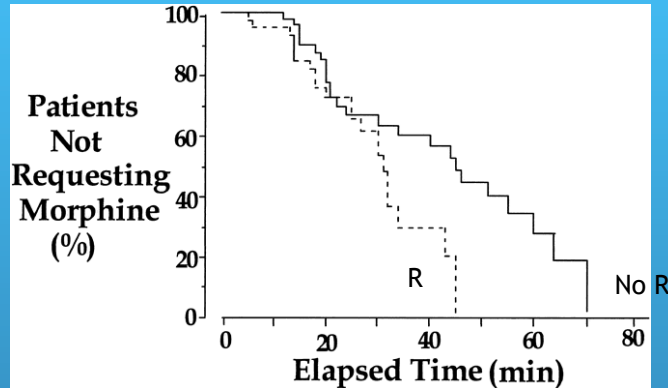
11.5 to 47 %

*of the patients undergoing surgery !!*

*Perkins & Kehlet, Anesthesiology 2000*



# Hyperalgesia to opioids....



## Intraoperative Remifentanyl 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 <sup>a</sup>	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

<sup>a</sup> 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  $\mu$ -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)

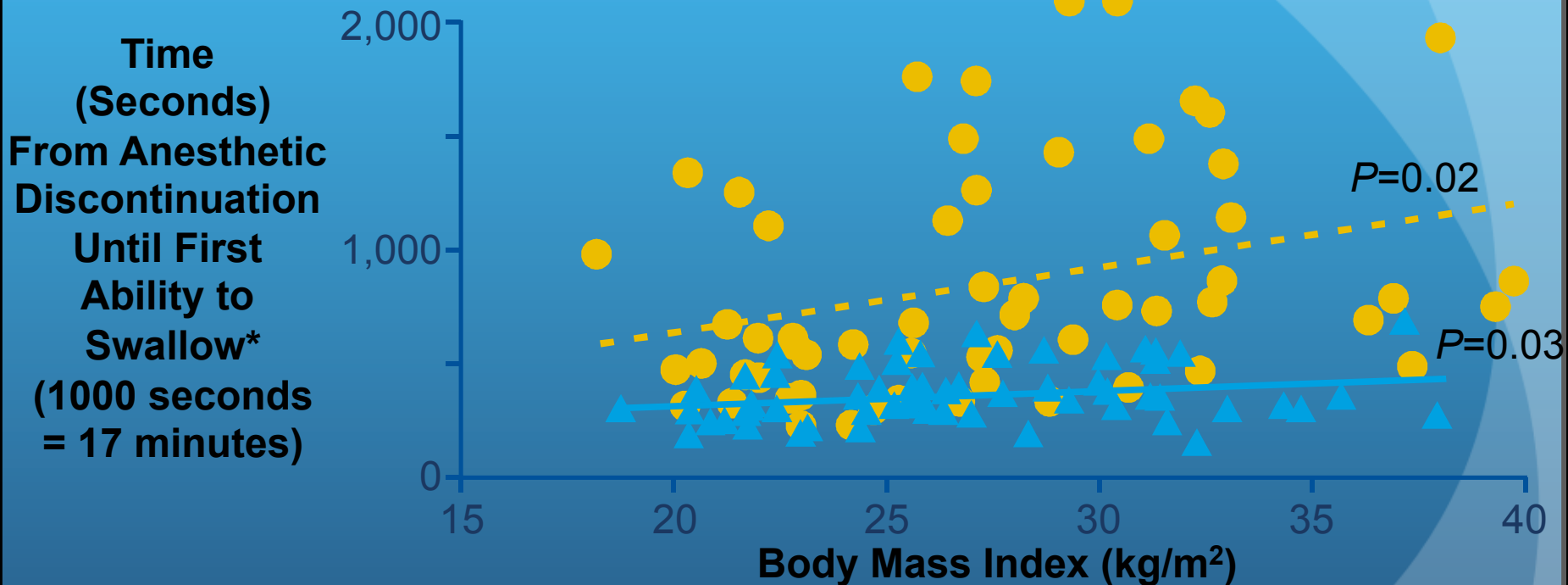
- No Premedication Epidural if possible, but not done in laparoscopic gastric bypass
- Induction for intubation
  - Clonidine 150 - 300 ug po avoid sedative doses
  - Ketamine 10 - 25 ug iv only painkiller no sedation post op
  - Seloken 2 - 5 mg iv according to heart rate
  - Propofol (dexmetodine? 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



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

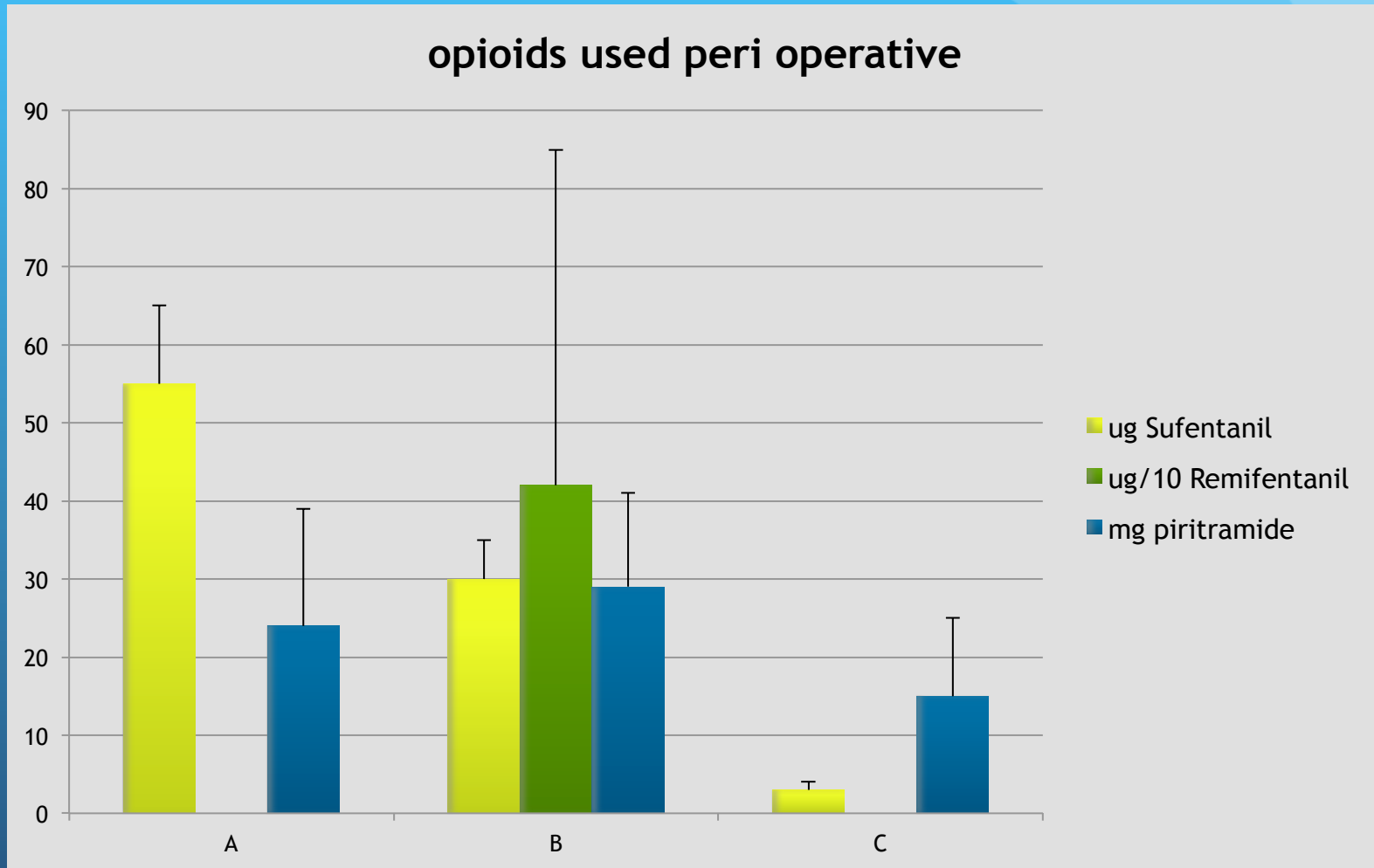
Time From Anesthetic Discontinuation to First Ability to Swallow by BMI

▲ Desflurane ● Sevoflurane — Desflurane - - Sevoflurane



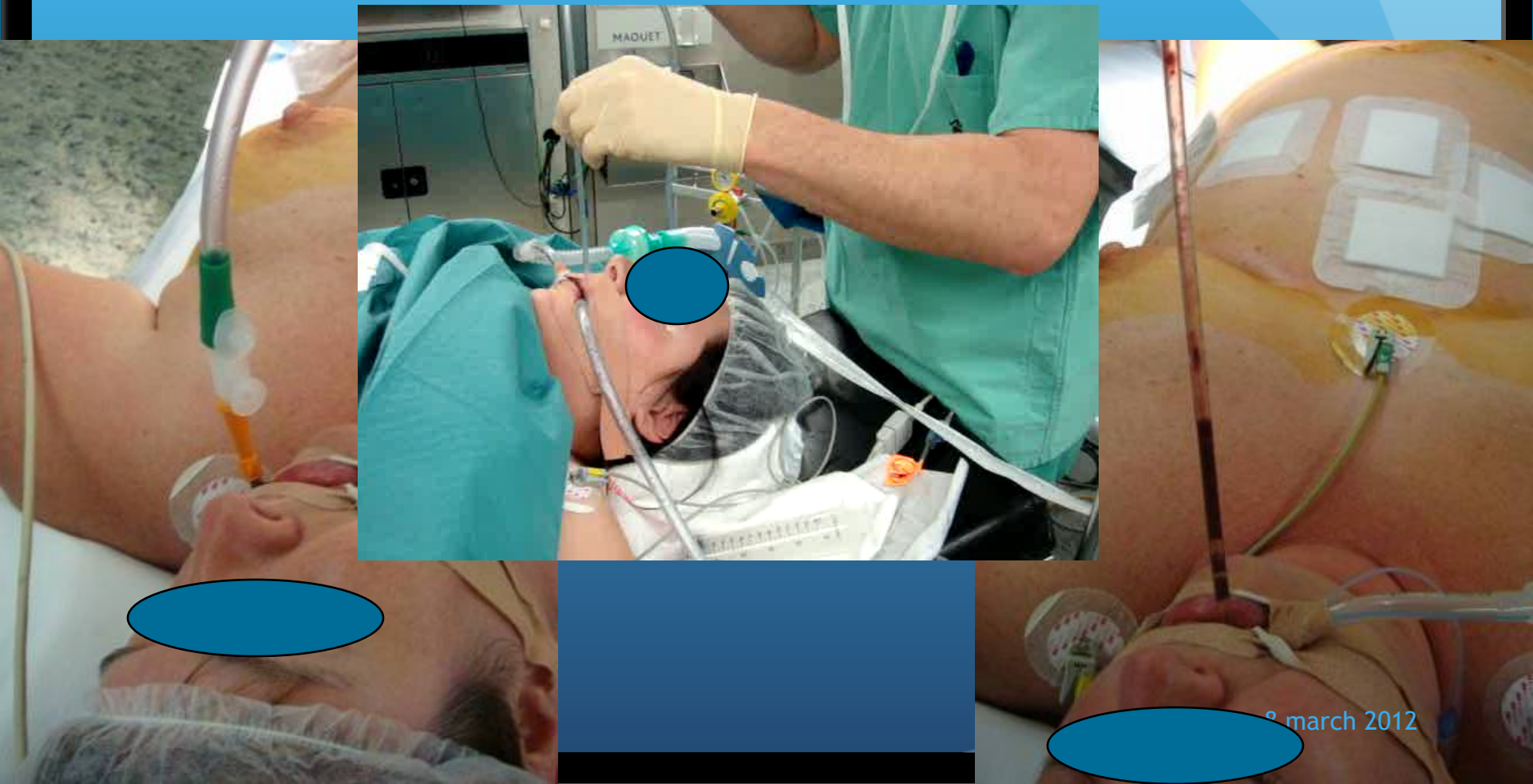
\* Regarding Swallowing: Administering water to patients after anesthetic discontinuation is not a standard of care.

# Operating Room and PACU 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



# 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
  - Accelerate 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 optimal 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. Predictable 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.**