



**NAVA**t



# The SmartPilot<sup>©</sup> : how I use it

Rik Carette MD

OLV hospital Aalst Belgium

SECOND INTERNATIONAL SYMPOSIUM ON  
AUTOMATED LOW FLOW ANESTHESIA AND  
VISUAL DRUG DISPLAY SYSTEMS



NO CONFLICTS OF INTEREST

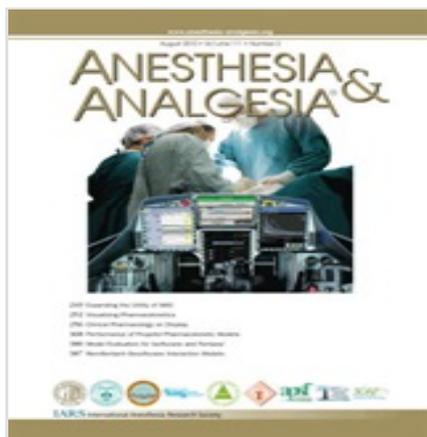
# ANESTHESIA & ANALGESIA<sup>®</sup>



- 249 Expanding the Utility of MAC
- 252 Visualizing Pharmacokinetics
- 256 Clinical Pharmacology on Display
- 368 Performance of Propofol Pharmacokinetic Models
- 380 Model Evaluation for Isoflurane and Fentanyl
- 387 Remifentanyl–Sevoflurane Interaction Models

August 2010 - Volume 111 - Issue 2

pp: 249-588



## Editorials

### Editorials

#### Using Response Surfaces to Expand the Utility of MAC

Short, Timothy G.

#### Seeing the Future of Anesthesia Drug Dosing: Moving the Art of Anesthesia from Impressionism to Realism

Kennedy, R. Ross

#### Clinical Pharmacology on Display

Gin, Tony

# Clinical Pharmacology on Display

Tony Gin, MD, FRCA, FANZCA, FHKCA

In this issue of *Anesthesia & Analgesia* are 3 articles that most subscribers will never read.<sup>1-3</sup> Not even the abstract will garner their interest. Nevertheless, these articles and related work help form the foundation underlying 2 recently introduced commercial displays, Navigator Applications Suite (GE Healthcare, Helsinki, Finland) and SmartPilot View (Dräger Medical, Lübeck, Germany), intended for everyday use in the operating room. These sophisticated displays show the concentrations and predicted effects of combined anesthetic drugs to facilitate more precise titration and outcome. The accuracy of these displays depends on the accuracy of the models they use. This editorial, and the following two,<sup>4,5</sup> attempt to explain how complex research in pharmacokinetic/ pharmacodynamic (PK/PD) modeling is being translated to everyday clinical practice.

We need to titrate anesthetic drugs because of the individual variability in response, and the rapidly changing level of stimulation in the operating room. We adjust our dose according to the effect that we want to achieve. However, the variability in response is not only due to the

resurgence of interest in neuromuscular monitoring, with integration into anesthesia workstations permitting centralized displays of neuromuscular block. With this ready display of drug effect, anesthesiologists have not generally been interested in knowing the actual plasma concentration of neuromuscular blocking drugs.

For the volatile anesthetics, the picture is more complex because they cause more than one desirable effect. Is the drug being titrated to cause hypnosis, suppress somatic responses, or suppress autonomic responses? The effect of volatile anesthetics on the suppression of somatic response has long been characterized by the minimum alveolar concentration (MAC). This value (sometimes uncorrected) is displayed on many anesthetic monitors, permitting anesthesiologists to adjust inhaled anesthetic delivery to obtain a desired fraction or multiple of MAC. MAC is an effective dose (ED)<sub>50</sub> on the quantal response/no response curve, meaning that it is the concentration at which 50% of subjects do not move. Who wants to give a concentration at which half the patients move? Who knows at what concen-

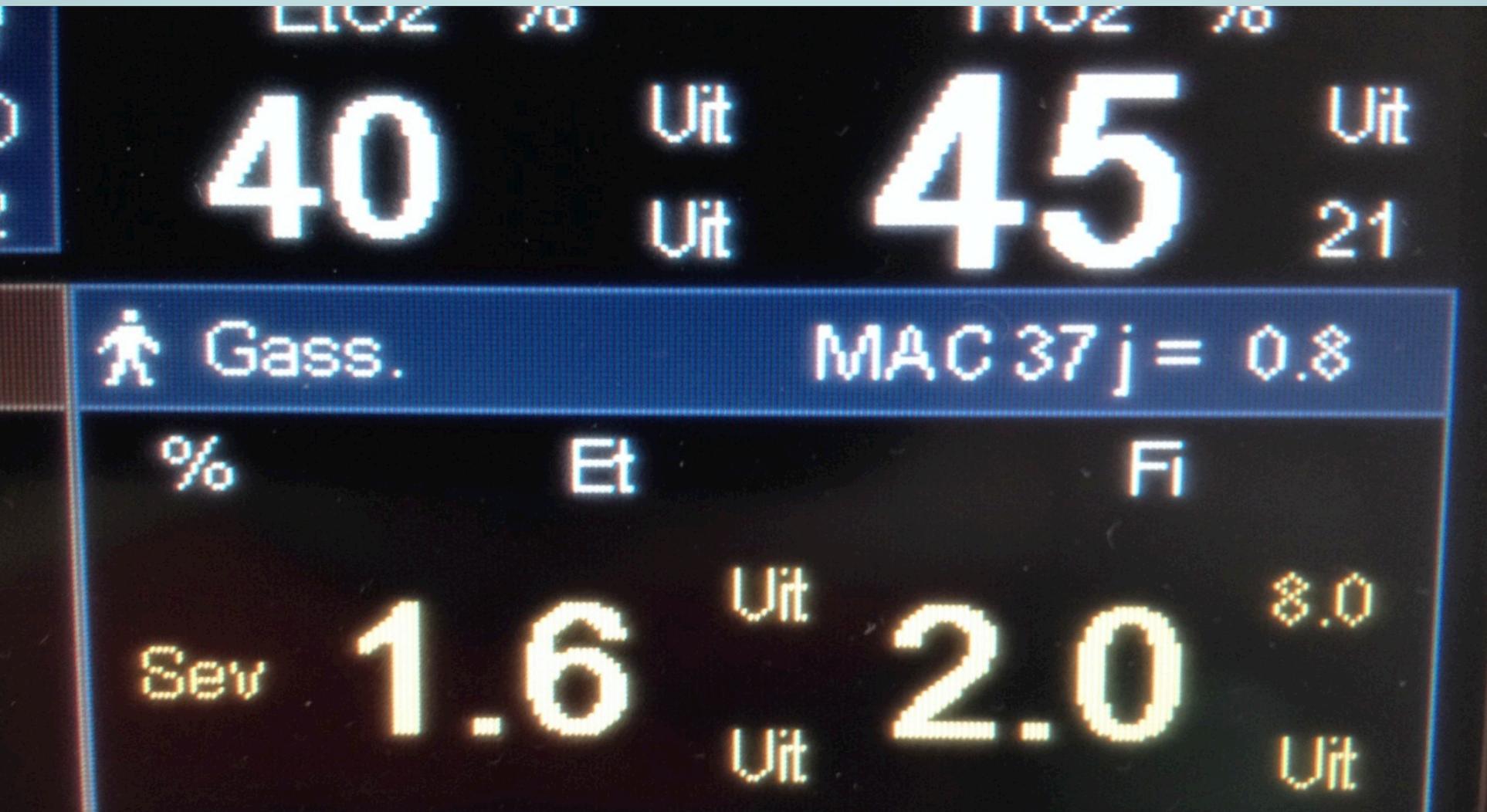
# Joe the plumber

- male
- 40 years
- 75 kg
- 1,75 m
- ASA I
- left inguinal hernia





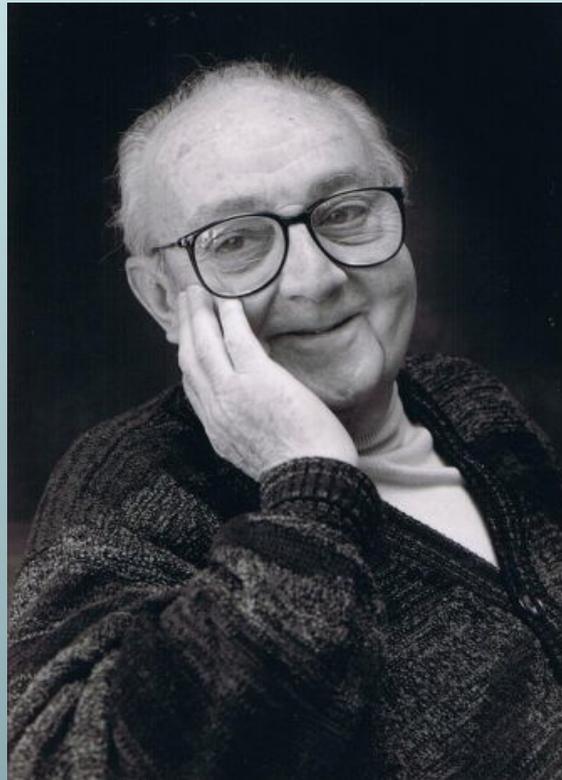
# MAC



# PHARMACOLOGY COMBINED DRUG EFFECTS

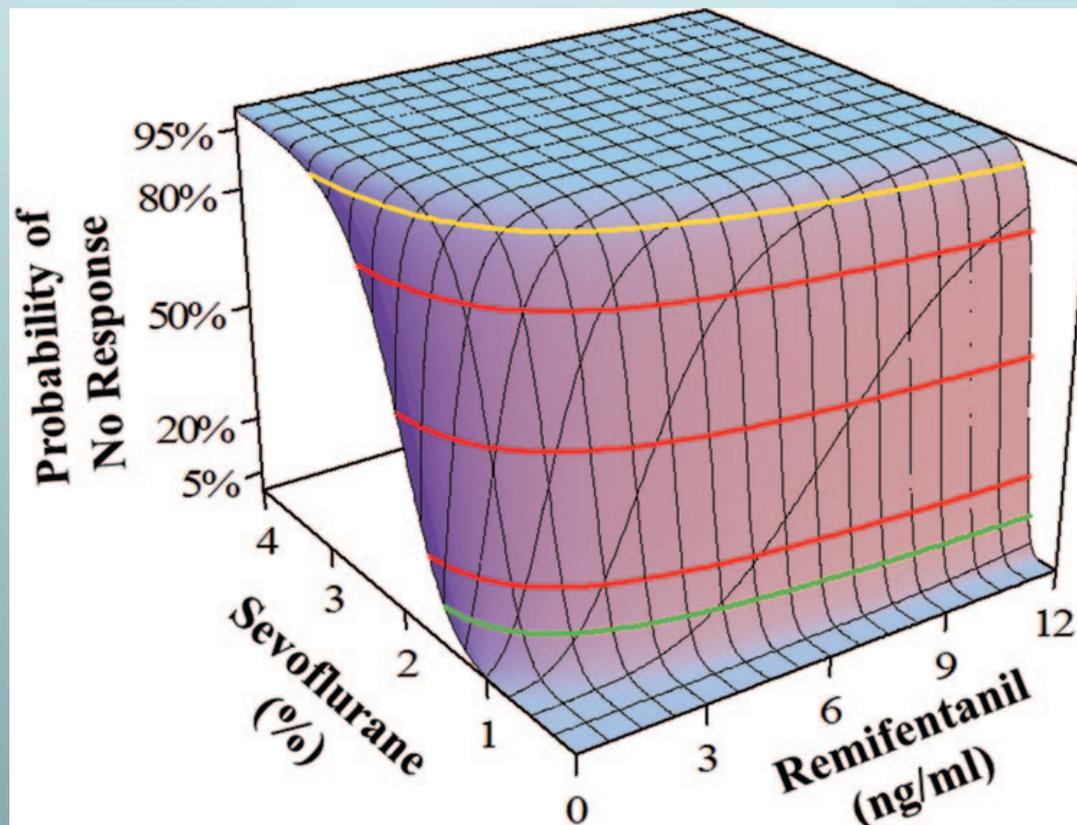


Essentially all models are wrong  
but some are useful.



George E.P. Box

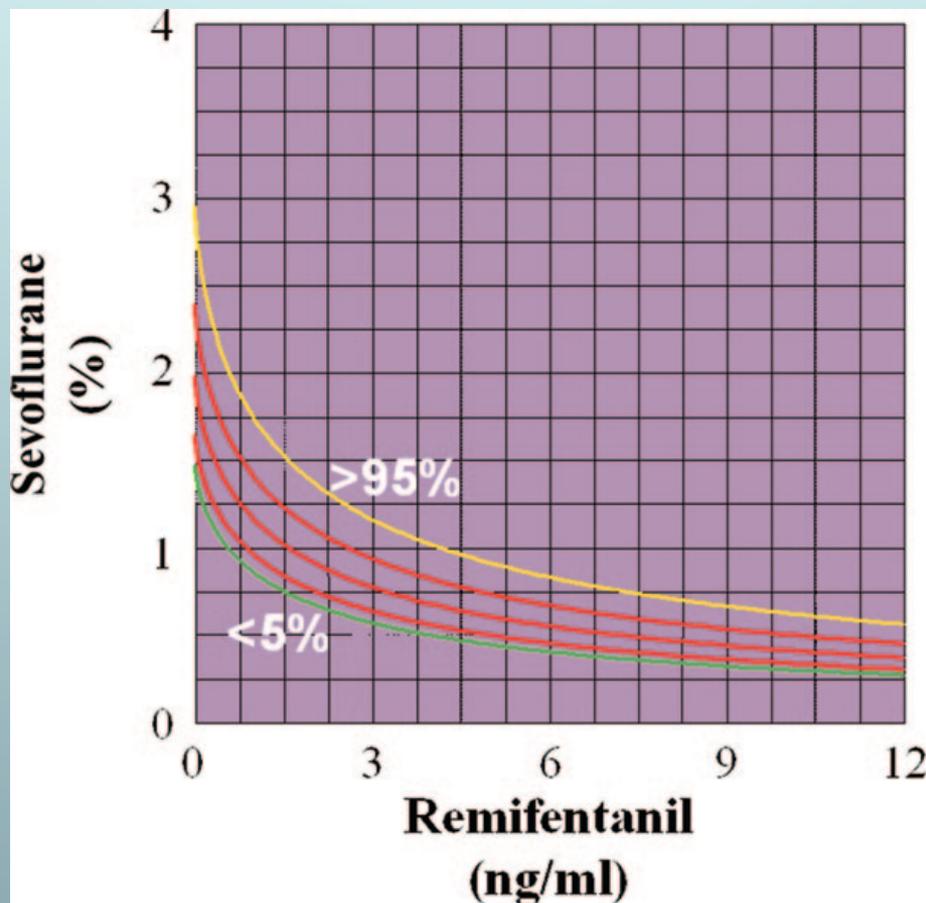
# RESPONSE SURFACE MODEL



Interaction of sevoflurane and remifentanil on the probability of response to intubation

Shafer SL. Anesthesiology. 2012 Feb; 116(2):240-1

# RESPONSE SURFACE MODEL

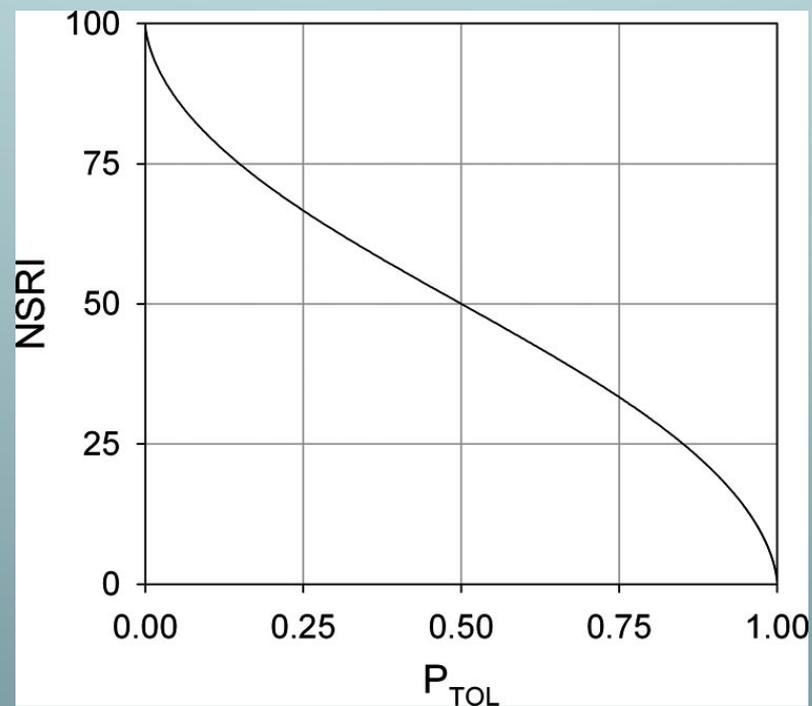


Interaction of sevoflurane and remifentanil on the probability of response to intubation

## Noxious Stimulation Response Index

### *A Novel Anesthetic State Index Based on Hypnotic–Opioid Interaction*

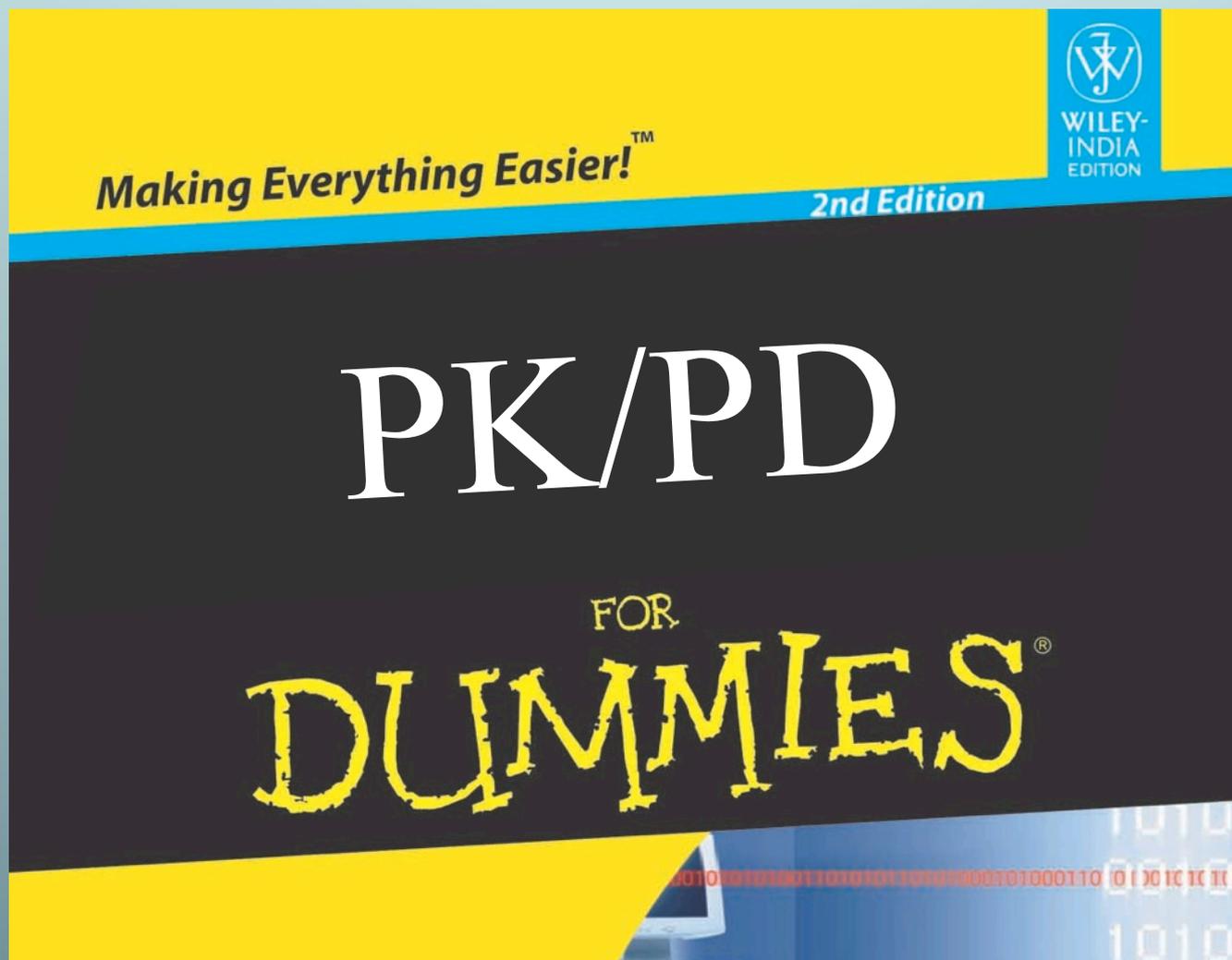
Martin Luginbühl, PD Dr. med.,\* Peter M. Schumacher, M.Sc., Ph.D.,† Pascal Vuilleumier, M.D.,‡  
Hugo Vereecke, M.D., Ph.D.,§ Björn Heyse, M.D.,§ Thomas W. Bouillon, PD Dr. med.,||  
Michel M. R. F. Struys, M.D., Ph.D.#

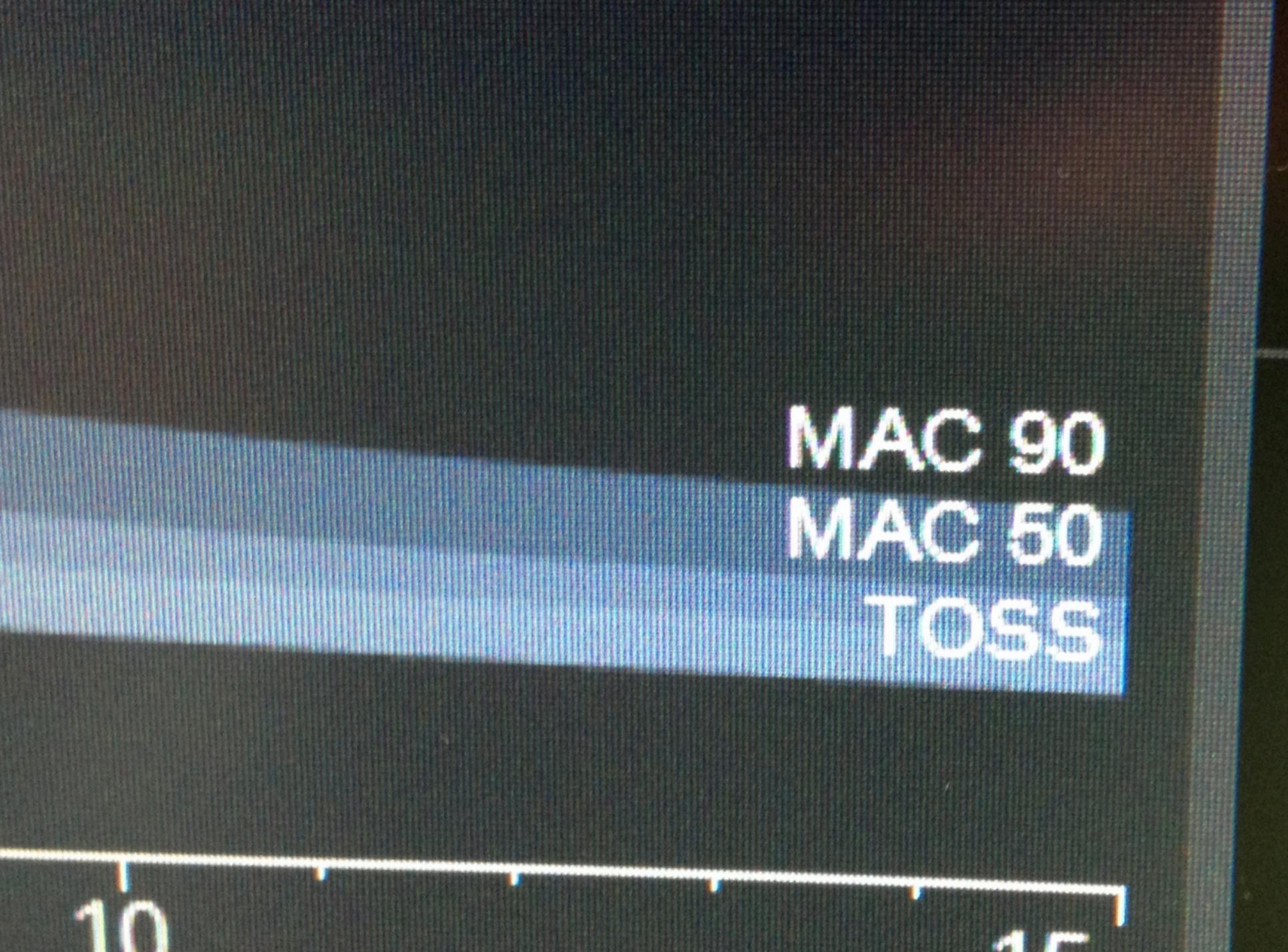


# NSRI

Reference of combined drug effects	NSRI
Anesthesia lighter than TOSS 50. High probability for patient to be awake.	90 to 100
TOSS 50	91
TOSS 90	70.5
TOL 50/MAC 50	50
TOL 90/MAC 90	20
Anesthesia is deeper than TOL 90/MAC 90. High probability for tolerating highly painful stimuli.	0 to 19

# From smart people to the SmartPilot<sup>©</sup>





MAC 90

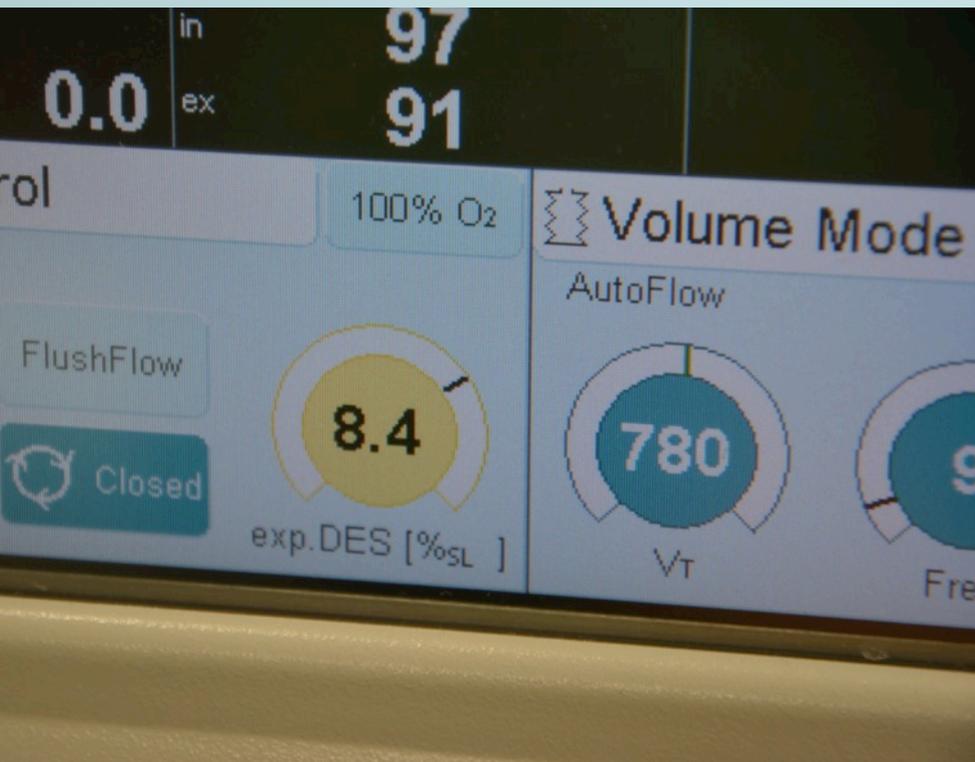
MAC 50

TOSS

10

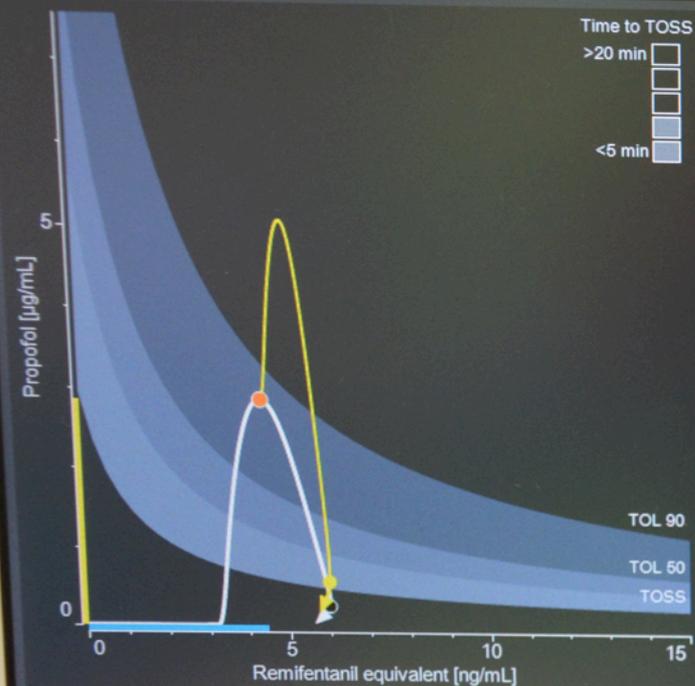
15

# What if...



# What if...

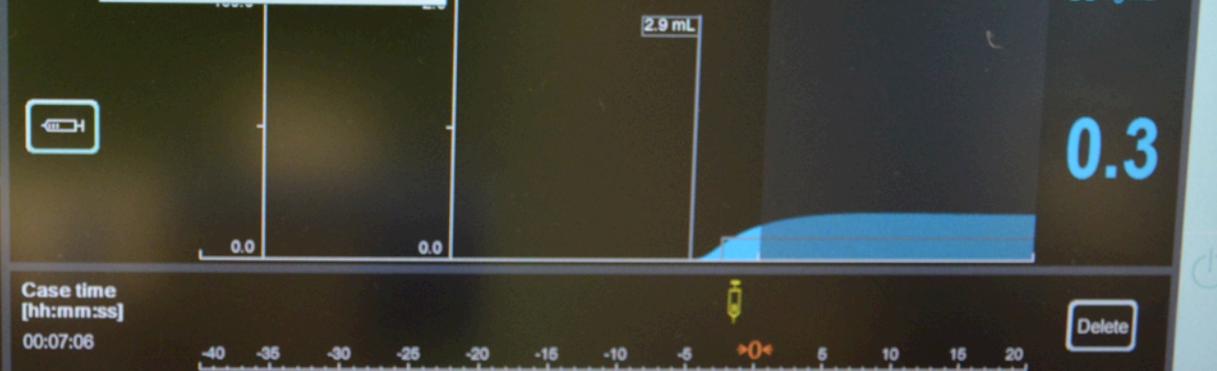
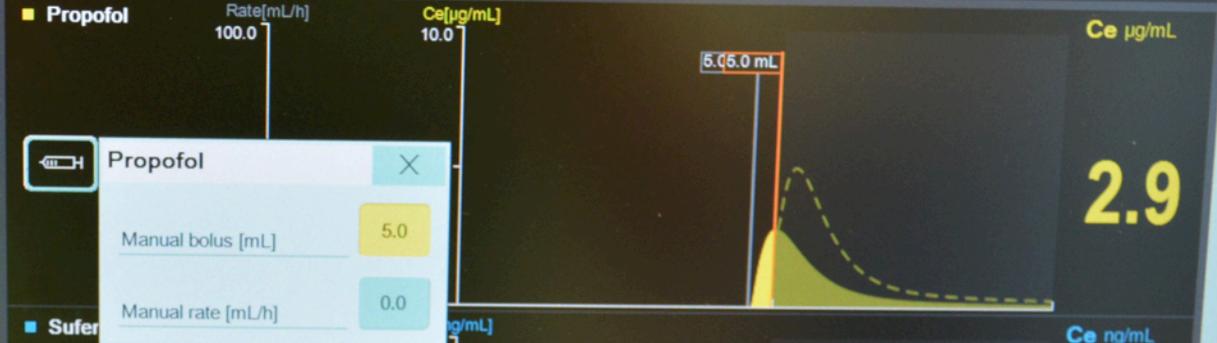
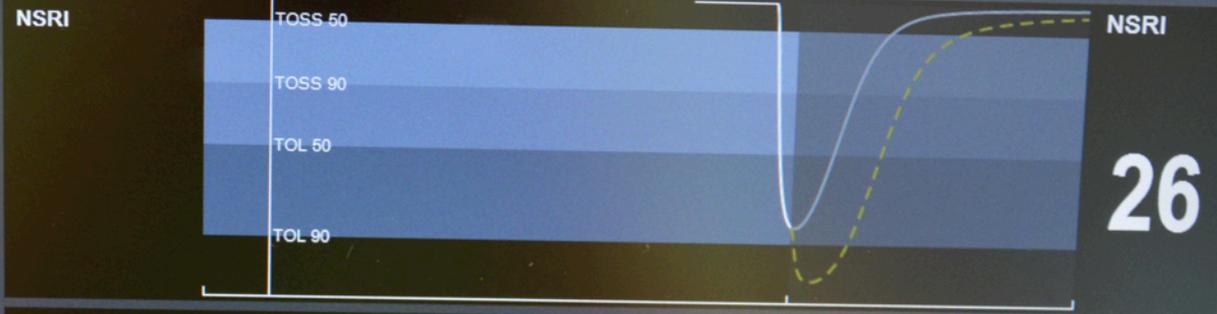
SmartPilot View Version 2.01.05



- Drugs**
- Manual Propofol [10 mg/mL]
  - SUFEN Sufentanil [5  $\mu\text{g/mL}$ ]
  - Manual Sufentanil [5  $\mu\text{g/mL}$ ]

- Symbols**
- Now
  - 10 min
  - 15 min
  - Cursor

- Events**
- LOC
  - Intub.
  - Cut
  - Move
  - Extub.
  - Other



# Back to work



# Joe the plumber

- male
- 44 years
- 75 kg
- 1,75 m
- ASA I
- right inguinal hernia

Adult

175 cm, 44 Y, 75.0 kg



Volwassenen



Adult

Age [years]: 44

Height [cm]: 175

Weight [kg]: 75

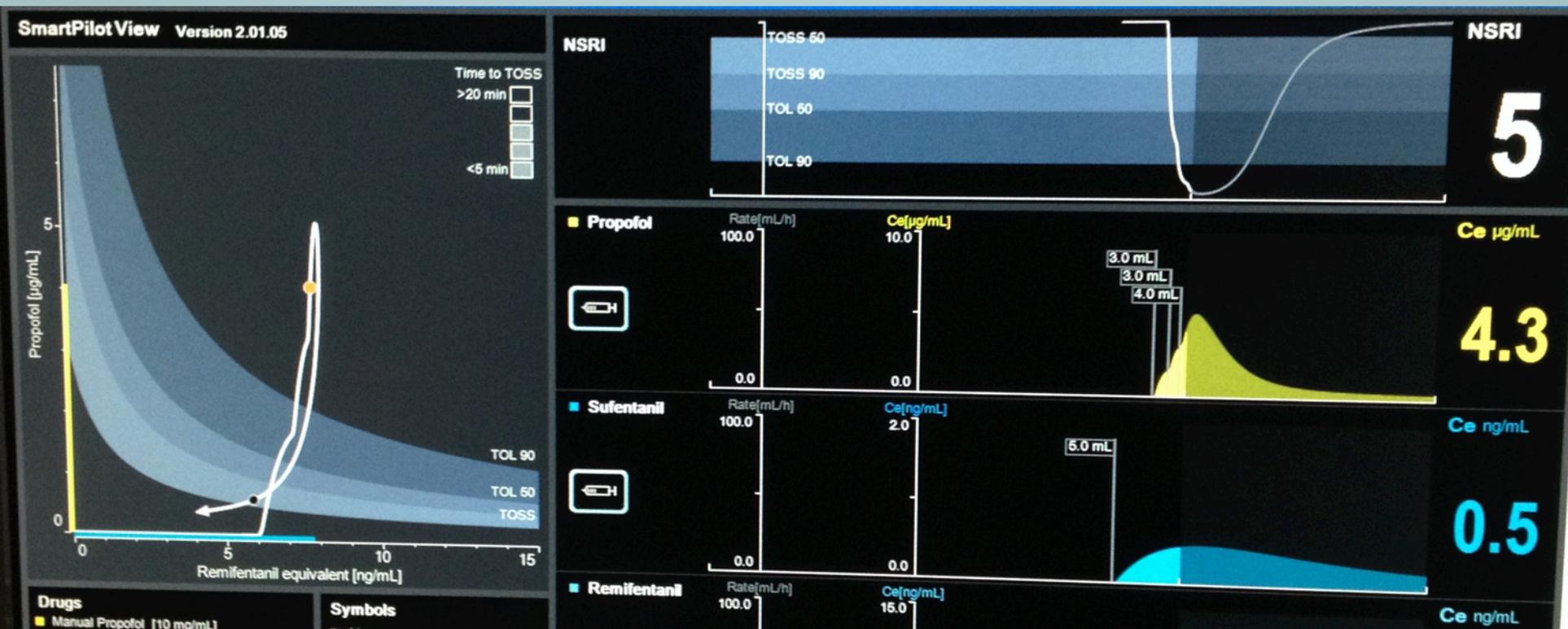
Gender: Male

SmartPilot View Version 2.01.05



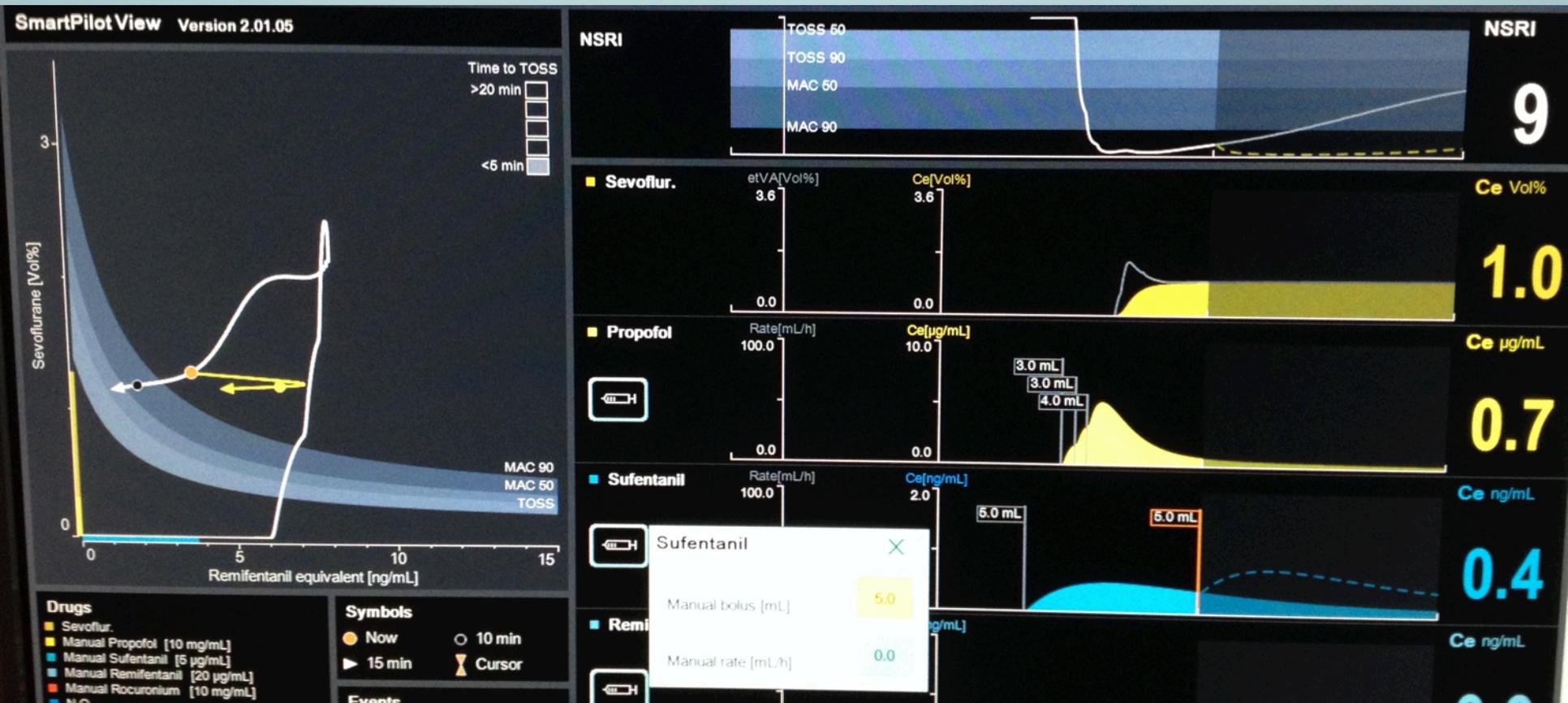
# Joe the plumber

- Propofol 30 mg (no TOSS) + 30 mg (TOSS) + 40 mg = 100 mg
- TOL, BP and HR stable



# Joe the plumber

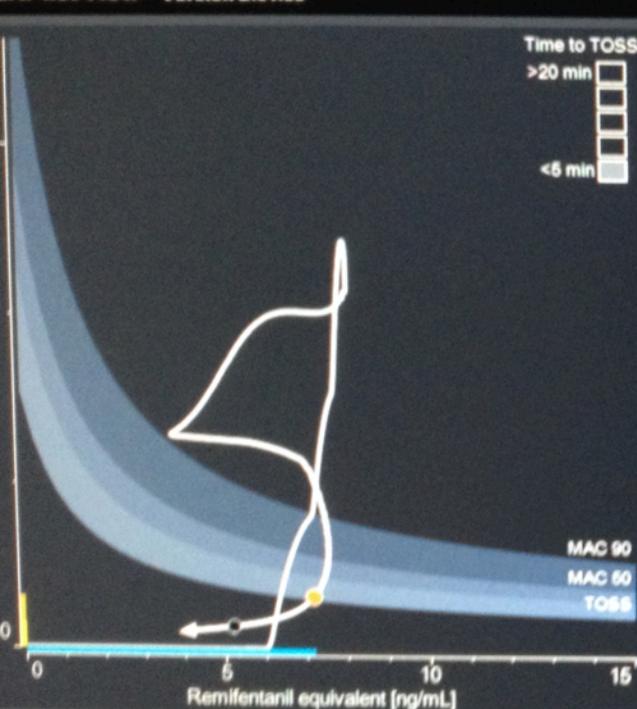
- Sevoflurane Et target 1.3% (0.7 MAC)
- Top-up 25 mcg sufentanil



# Joe the plumber

- Eyes open at removal of the drapes
- No pain

artPilot View Version 2.01.05



NSRI



NSRI

89

■ Sevoflur.

eIVA[Vol%]

Ce[Vol%]

Ce Vol%

3.6

3.6

0.2

0.0

0.0

0.2

■ Propofol

Rate[mL/h]

Ce[μg/mL]

Ce μg/mL

100.0

10.0

0.3

0.0

0.0

0.3

■ Sufentanil

Rate[mL/h]

Ce[ng/mL]

Ce ng/mL

100.0

2.0

0.6

0.0

0.0

0.6

■ Remifentanyl

Rate[mL/h]

Ce[ng/mL]

Ce ng/mL

100.0

15.0

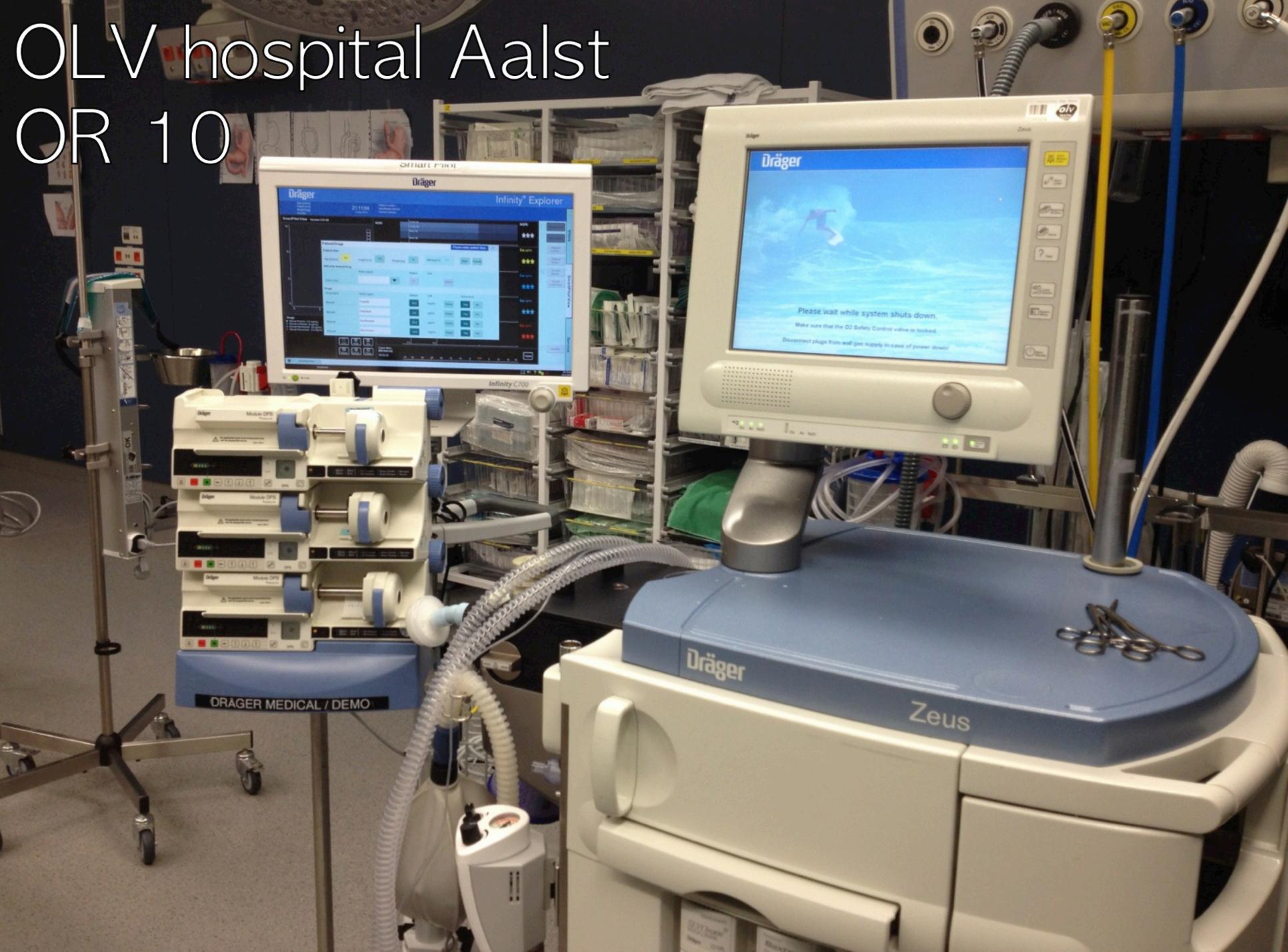
0.6

0.0

0.0

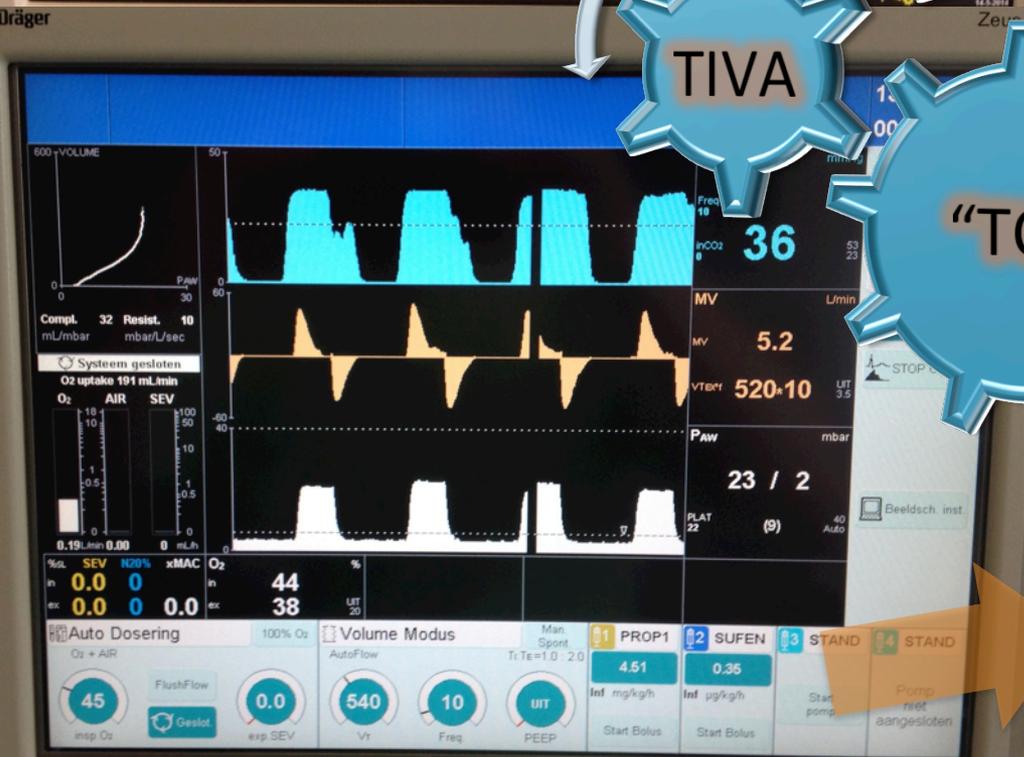
0.6

# OLV hospital Aalst OR 10



Dräger

Infinity Explorer



PROF 1 2 SUFEN 3 STAND

4.51  
 Inf mg/kg/h

0.35  
 Inf  $\mu\text{g/kg/h}$

Start Bolus

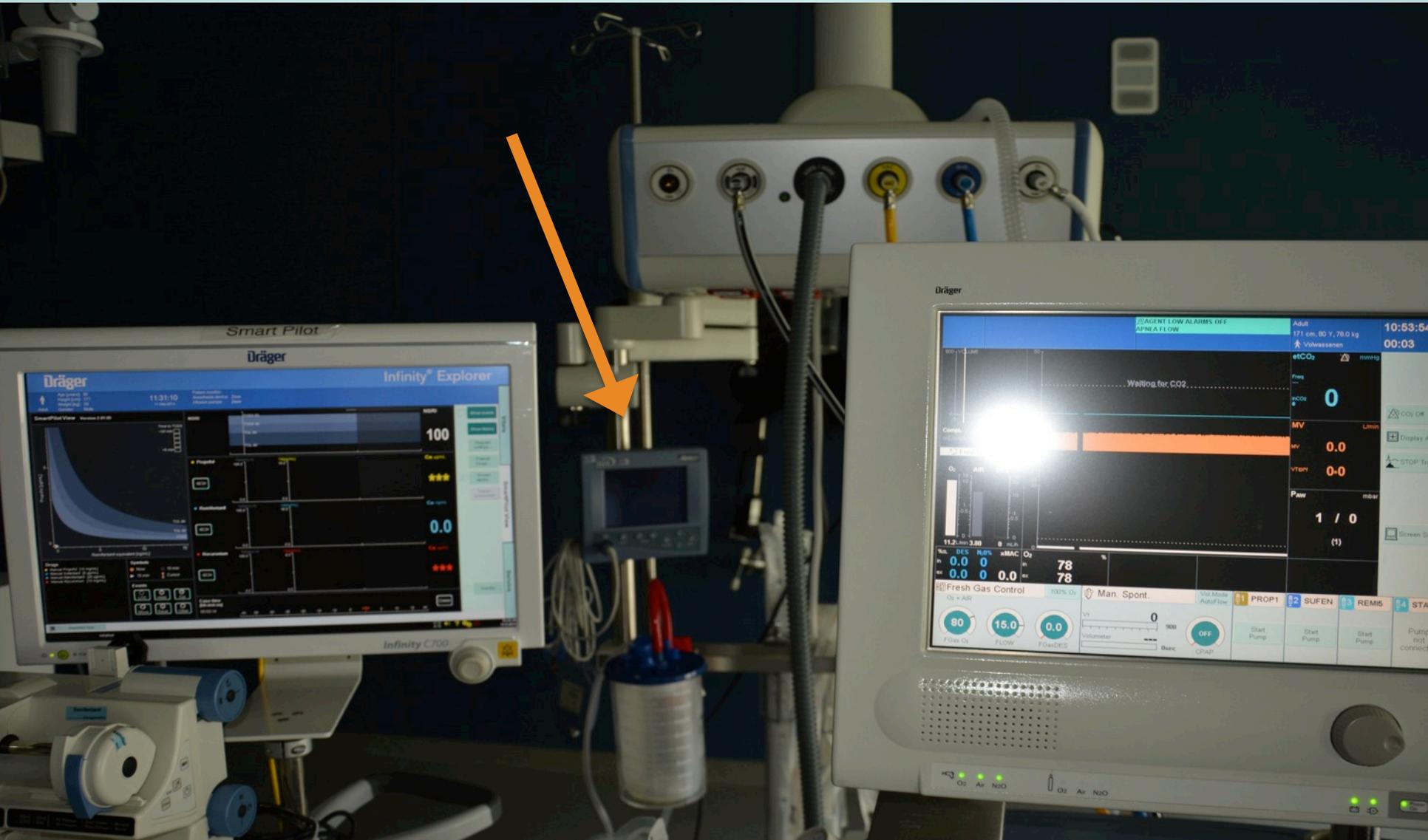
Start Bolus

Start pomp

# Sufentanil context-sensitive $t_{1/2}$



# NSRI vs. BIS



# NSRI vs. BIS

## EUROANAESTHESIA 2013

The European Anaesthesiology Congress

Barcelona, Spain, 1 - 4 June 2013

**Drug interaction models are better predictors of tolerance/ response to noxious stimuli compared to individual measured parameters**

Hannivoort L.N., Proost J.H., Eleveld D.J., Struys M.M.R.F, Luginbühl M., Vereecke H.E.M.

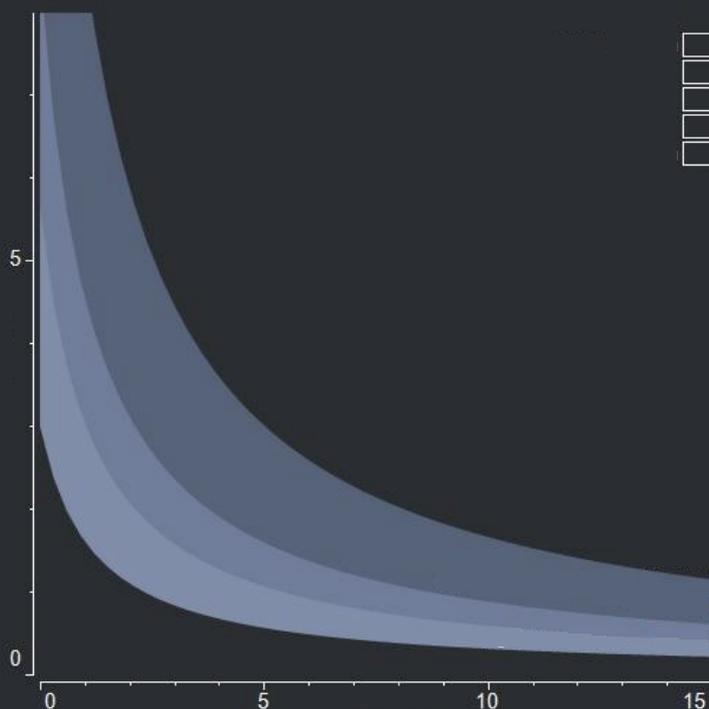
*University of Groningen, University Medical Center Groningen, Dept of Anaesthesiology, Groningen, Netherlands*

	U	NSRI	Sevo	Remi	BIS	SE	RE	CVI	SPI
<b>SAS</b>	96%	96%	89% *	60% *	95%	93%	93%	92%	57% *
<b>TET</b>	96%	94%	79% *	69% *	84% *	84% *	84% *	83% *	53% *
<b>LMA</b>	98%	95%	81% *	63% *	83% *	81% *	81% *	79% *	57% *
<b>LAR</b>	98%	95%	76% *	72% *	78% *	78% *	77% *	74% *	58% *

# SmartPilot<sup>©</sup> limitations

## Instructions for use

### SmartPilot View



#### WARNING

To properly use this medical device, read and comply with these instructions for use.

Software 2.0n for C700 for IT

#### NOTE

Limitations in patient demographics

The SmartPilot View limits the patient demographics to certain ranges based on statistical data. This applies to height, weight, and age. If the patient demographics are outside these ranges, the software will lower the demographic values to the upper limit or heighten them to the lower limit.

#### Patient data

SmartPilot View is intended for use with data from adults only. The demographic ranges for these patient data are as follows:

Height	150 cm to 200 cm
Weight	40 kg to 140 kg
Age	18 to 90 years

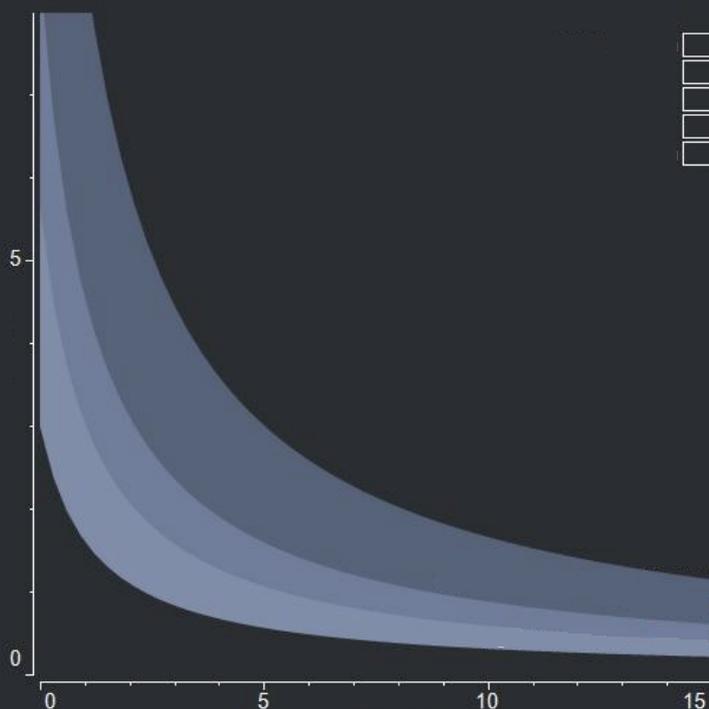
Furthermore the software is not intended for data from:

- Alcoholics
- Obese patients (BMI >35)
- Seriously ill patients (ASA score  $\geq$ IV)

# SmartPilot<sup>©</sup> limitations

Instructions for use

## SmartPilot View



### CAUTION

Incorrectly calculated data

SmartPilot View does not take into account any premedication and no other drugs than those mentioned in these instructions for use when showing patient effects.

### CAUTION

Incorrectly calculated data

SmartPilot View does not take into account other drugs than those mentioned in these instructions for use.

The correct manual input is under the responsibility of the clinician.

### WARNING

To properly use this medical device, read and comply with these instructions for use.

Software 2.0n for C700 for IT

# Start working with the SmartPilot©

Ce is calculated, not measured

- Interindividual variability
- Probability of no-response is a prediction  
(a good one though)

# Start working with the SmartPilot<sup>©</sup>

See depth and composition of your anesthesia

Gain confidence with depth of anesthesia monitors and by minimizing use of NMB

Fine tune for better hemodynamic stability, faster awakening, better titrating opioids

# If you don't have a SmartPilot<sup>©</sup>

Currently limited use

Sufentanil <<5 minutes>> propofol

Use depth of anesthesia monitors and minimize NMB for better titration (TIVA/TCI, inhaled below 1 MAC)

Sufentanil continuous infusion (better HD stability, context-sensitive  $t_{1/2}$  not an issue)

## ■ EDITORIAL

## Clinical Pharmacology on Display

Tony Gin, MD, FRCA, FANZCA, FHKCA

I hope that anesthesiologists will be interested in this technology, and that it will improve the accuracy with which we titrate anesthetic drugs, benefiting patient care. It is the translation to everyday clinical practice of the nearly unreadable articles, published by the anesthetic PK/PD community over the past 20 years, that mathematically characterize the behavior of our anesthetic drugs. ■

A large number of glowing jellyfish are swimming in a dark blue tank. The jellyfish are translucent and emit a soft, yellowish-green glow. They are scattered throughout the frame, with some appearing closer and larger, and others further away and smaller. The background is a deep, dark blue, which makes the glowing jellyfish stand out prominently. The overall scene is serene and visually striking.

Thank you!

# NOTICE



People asking

# questions

about extraterrestrial  
intelligent life will be subject  
to immediate removal from  
the audience by laser  
evaporation