



VŠEOBECNÁ FAKULTNÍ
NEMOCNICE V PRAZE



1. LÉKAŘSKÁ
FAKULTA
Univerzita Karlova

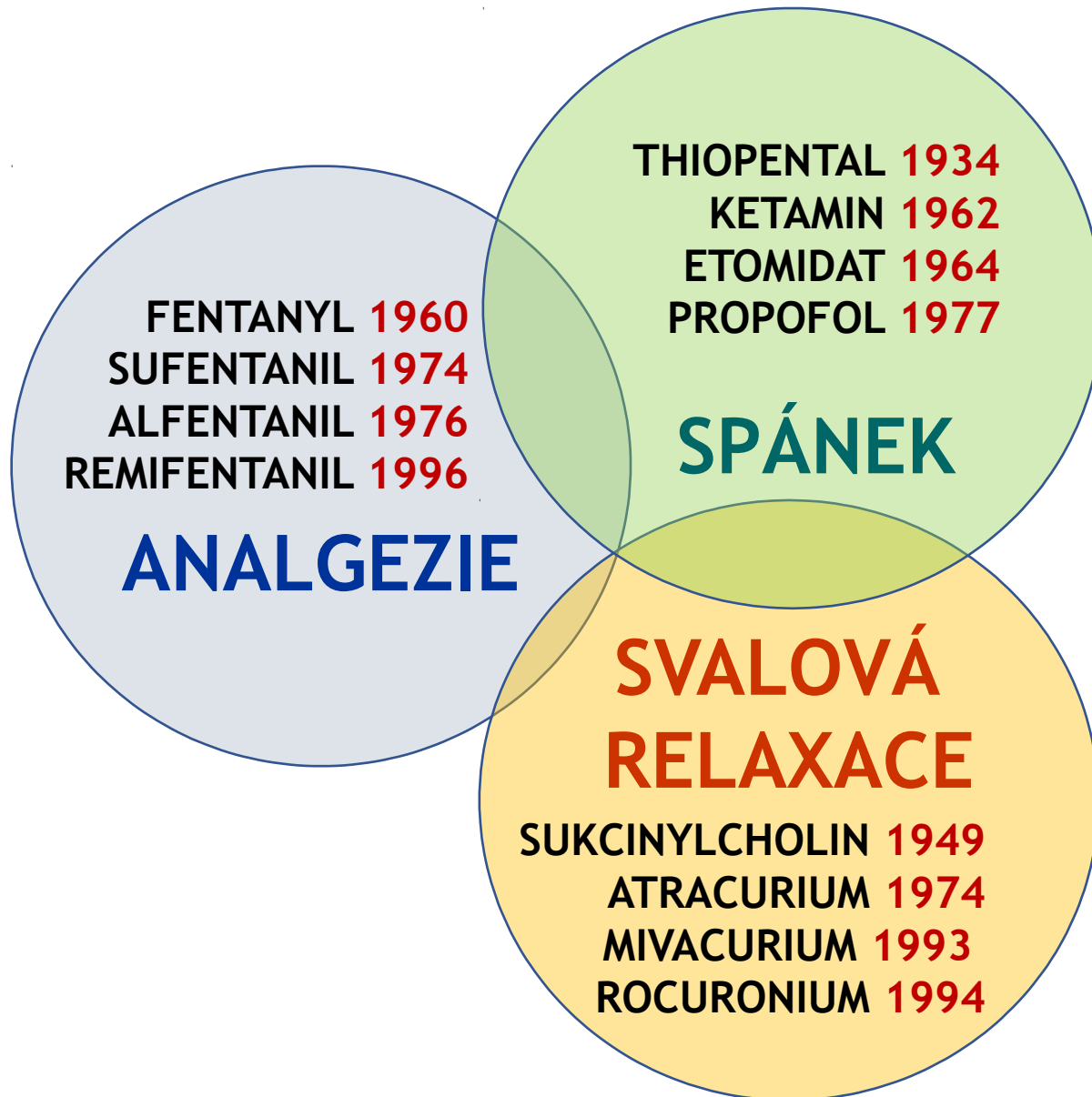
JAN BLÁHA

KLINIKA ANESTEZIOLOGIE,
RESUSCITACE
A INTENZIVNÍ MEDICÍNY

jan.blaha@vfn.cz

NEJČASTĚJŠÍ CHYBY PŘI POUŽÍVÁNÍ MYORELAXANCIÍ

Střet zájmů: žádný



PROČ DĚLÁME VĚTŠINOU CHYBY (NEBO MÁME PROBLÉMY) ?

1. Podceníme důležitost.
2. Přecenění vlastních schopností.
3. Nedomyšlený postup bez řádného záložního plánu.
4. Pozdě zavoláme pomoc.



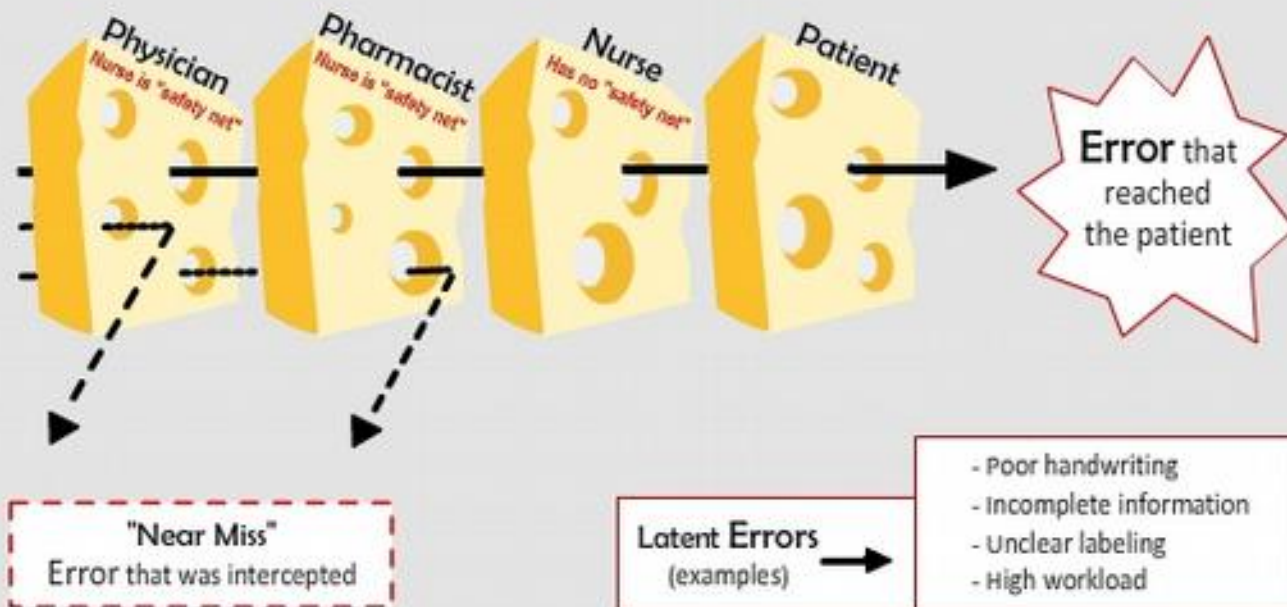


Medication Error

The Swiss Cheese Model

Originator: Reason

High Reliability Organizations (HROs) deploy "Independent Redundancies"

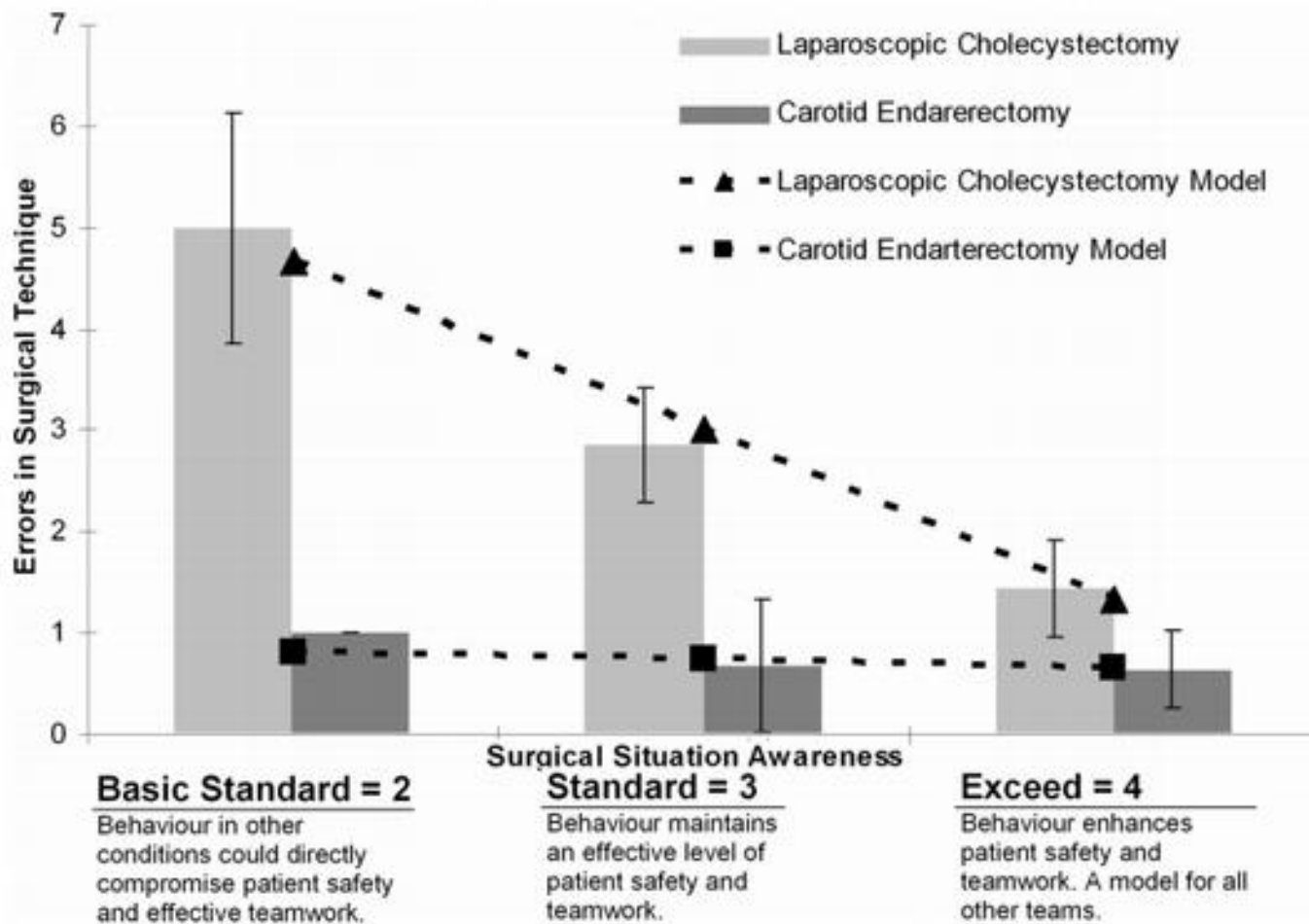


v současnosti se
mluví už o
400 000/rok

Předpokládá se, že v USA ročně zemře více než 100 000 pacientů díky preventabilním medicínským chybám.

Skoro polovina všech nežádoucích událostí (46.1 %) se stane na operačním sále během chirurgického výkonu.

(Sexton, Thomas & Helmreich, 2000)



Stoupající komplikovanost →

FIGURE 3. Effect of surgical situation awareness on errors in surgical technique. As surgical situation awareness increases, surgical errors decrease. Although still significant, the effect is considerably less marked in carotid endarterectomy.



Preoperative Briefing in the Operating Room

Shared Cognition, Teamwork, and Patient Safety

Yael Einat, PhD; Daniel Gopher, PhD; Itzik Kara, RN, BSN, MHA; Orna Ben-Yosef, RN, BSN; Margaret Lauen, RN; Neri Laufer, MD; Meir Liebergall, MD; and Yoel Donchin, MD

Table 1—Nonroutine Events

Category of Nonroutine Event	Examples
1. Information	Missing hemoglobin value prior to surgery Wrong radiograph on screen
2. Lack of situation awareness (knowing what is happening during surgery)	The anesthesiologist begins to wake the patient up while the surgeon declares that they are actually in the middle of the procedure rather than at the end
3. Equipment improperly assembled or not prepared on time	The diameter of the laparoscope is too big The laparoscopic screen is not properly connected
4. Problems with teamwork	Patient moved to recovery without the anesthesiologist who is busy completing paperwork The surgeon requests an additional instrument, but there is no response from the circulating nurse The nurse tilts the table at the end of surgery without coordinating with the anesthesiologist
5. Compliance with procedures	Surgeons begin skin closure before the nurses finish their count
6. Lack of operational knowledge	Nurse does not know how to operate the fluid regulator
7. Equipment failure	Drill does not work

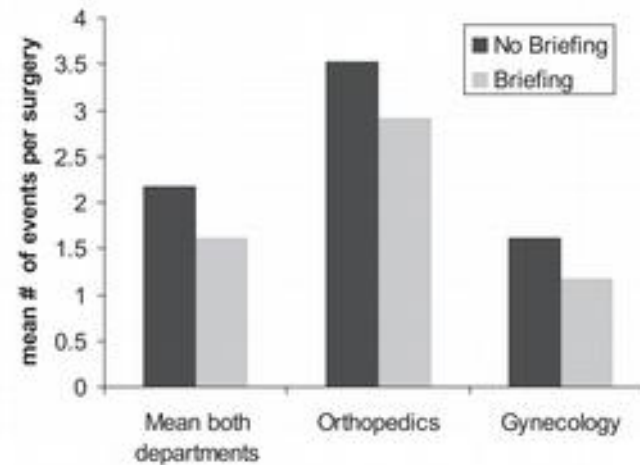


FIGURE 3. Mean number of nonroutine events per surgery.

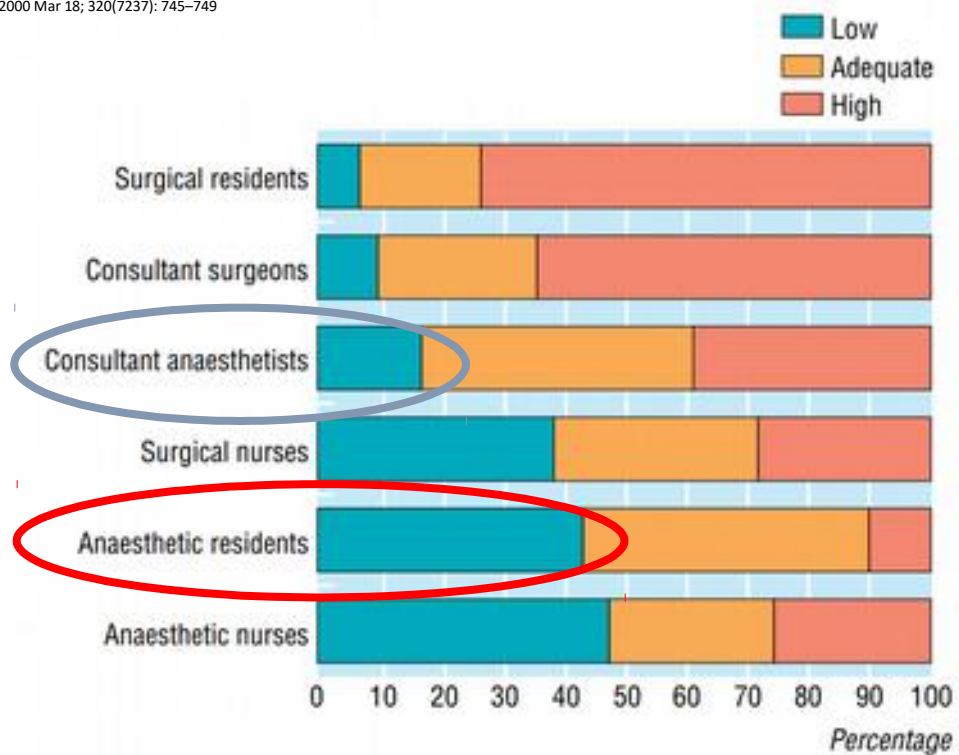


Fig 1 Rating of teamwork with consultant surgeons

S kým jak komunikuje
chirurg konzultant

Analysis of surgical errors in closed malpractice claims at 4 liability insurers

Selwyn O. Rogers, Jr, MD, MPH,^{a,b} Atul A. Gawande, MD, MPH,^{a,b} Mary Kwaan, MD,^a Ann Louise Puopolo, BSN, RN,^c Catherine Yoon, MS,^a Troyen A. Brennan, MD, JD, MPH,^{a,d} and David M. Studdert, LLB, ScD, MPH,^d *Boston, Mass*

Table V. Trainee involvement in surgical injuries attributable to error

<i>Contributing factors</i>	<i>Cases with errors involving trainees (n = 118)</i>		<i>Cases with errors not involving trainees (n = 140)</i>		<i>P value</i>
		<i>%</i>		<i>%</i>	
Lack of supervision	43	36	4	3	<.001
Communication breakdown	27	30	26	19	.04
Emergency surgery	20	17	10	7	.01

Rogers et al. *Surgery* 2006;140:25-33.



Mental Workload in the Operating Room

NASA-Task Load Index (NASA TLX) (n=30)

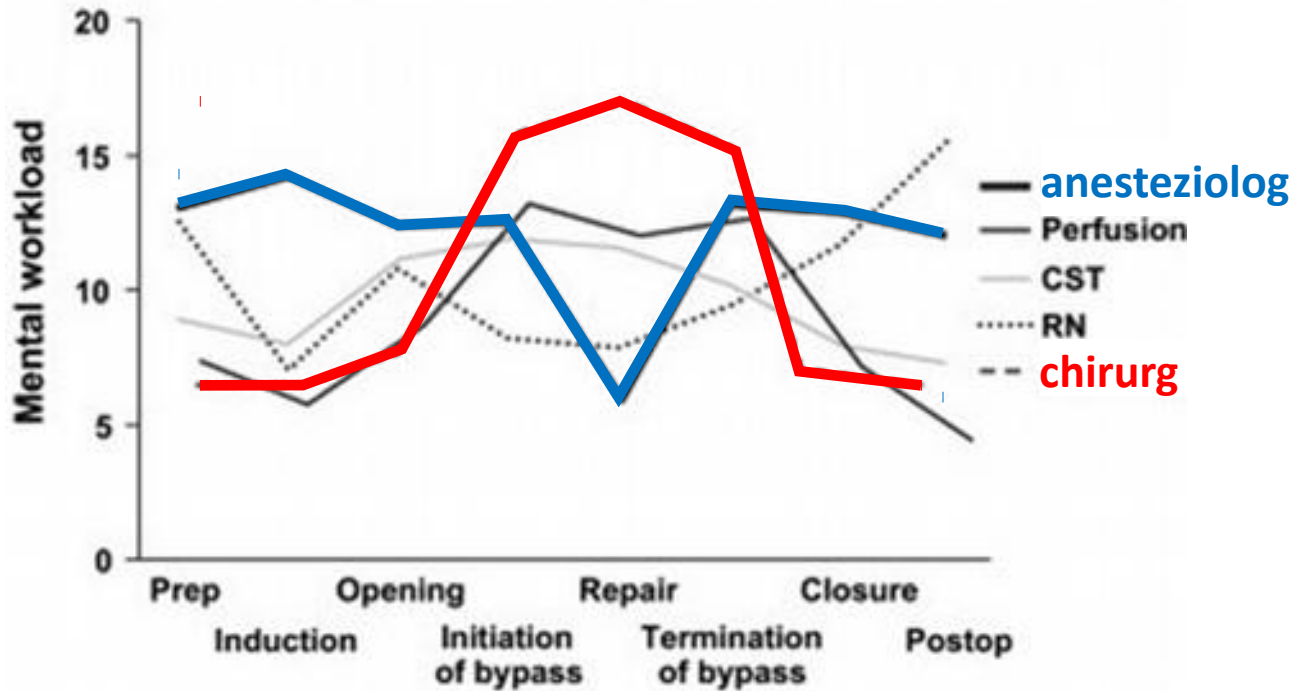


Figure 4: Mental workload in the cardiac surgery operating room varies across the cardiac surgery procedure for individual providers depending on task complexity and responsibilities. CRNA indicates certified registered nurse anesthetist; CST, certified surgical technologist; NASA, National Aeronautics and Space Administration; Postop, postoperative; Prep, surgical preparation; RN, registered nurse; and TLX, Task Load Index. Reprinted from Wadhwa et al²⁶³ with permission from Elsevier. Copyright © 2010, The American Association for Thoracic Surgery.

Mental Workload in the Operating Room

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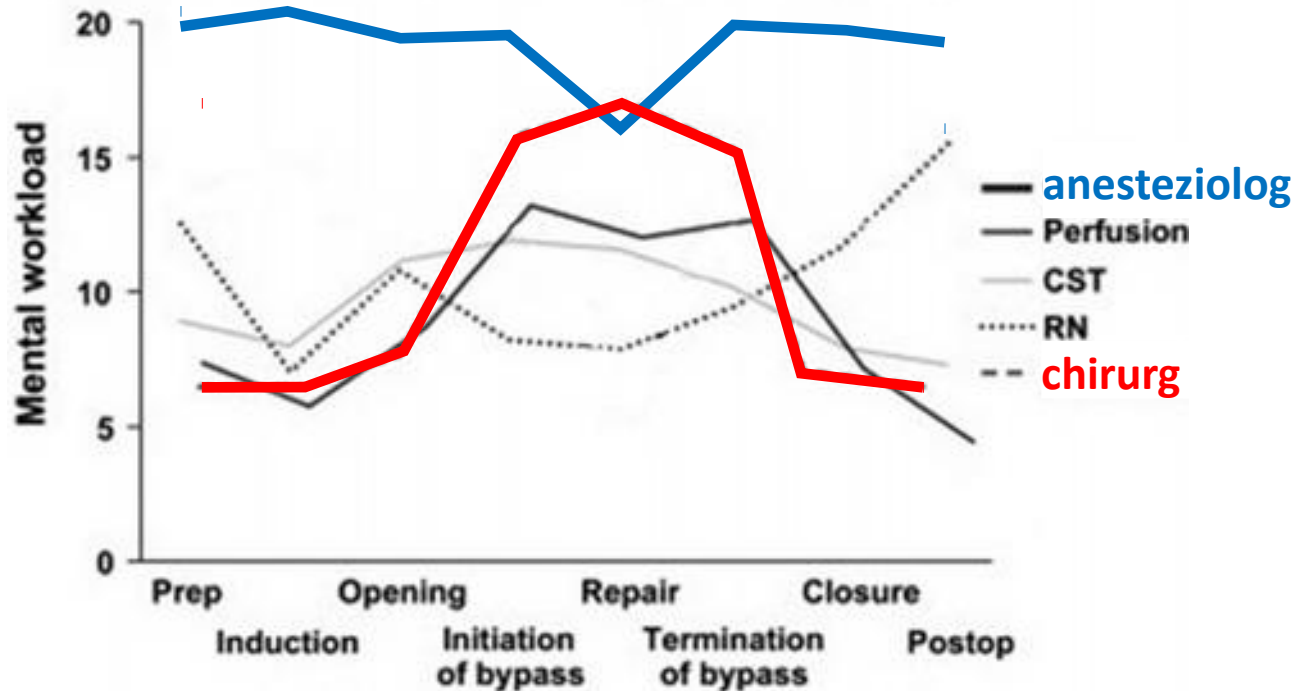
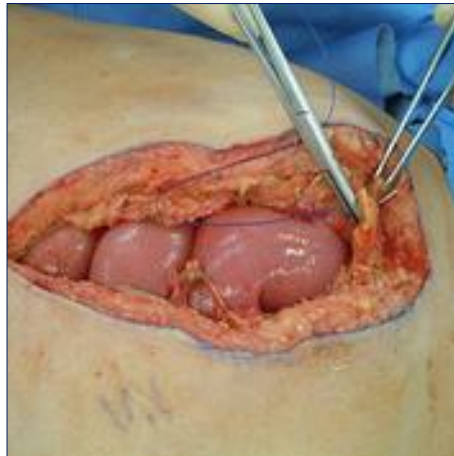


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ÚVOD



5-5





**IT'S
ABOUT
TIME**



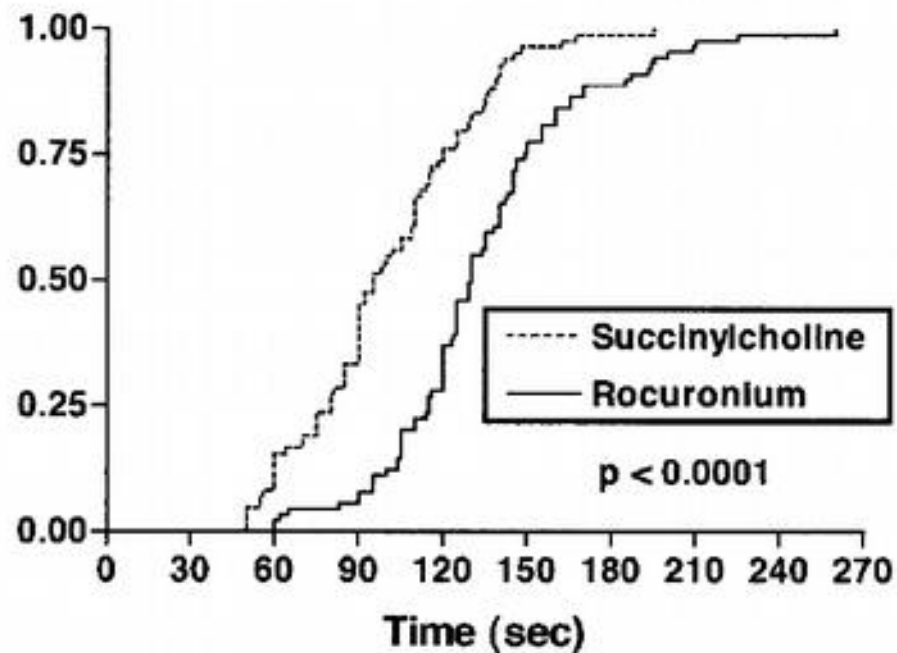


Figure 2. Kaplan-Meier curve of the probability of the completion of the endotracheal intubation sequence including succinylcholine or rocuronium as the neuromuscular blocking drug. Time 0 denotes the beginning of the injection of the induction drug propofol. The endotracheal intubation sequence was defined to be completed upon the first appearance of end-tidal carbon dioxide after intubation. Curves differ significantly ($P < 0.0001$; logrank test).

Sluga M et al. Anesth Analg 2005;101:1356 –61



ELSEVIER

www.obstetranesthesia.com

ORIGINAL ARTICLE

Surgical conditions with rocuronium versus suxamethonium in cesarean section: a randomized trial

J. Bláha,^{a,†} P. Nosková,^{a,†} K. Hlinecká,^b V. Krakovská,^c V. Fundová,^a T. Bartošová,^a
 P. Michálek,^a M. Stříteský^a

^aDepartment of Anesthesiology, Resuscitation and Intensive Medicine, 1st Faculty of Medicine, Charles University and General University Hospital in Prague, Czech Republic

Table 2 Times from induction of anesthesia to end of surgery; and induction characteristics.

	Rocuronium group		Suxamethonium group		Difference in means	P-value
	Mean	Median	mean	median		
Induction – delivery interval (s)	268.4 (72.9)	265 (223–330)	275.6 (63.4)	267 (239–400)	–7.2 (–39.5 to 19.3)	0.62
Induction – intubation interval (s)	105.8 (33.7)	108 (77–134)	67.6 (32.1)	63 (50–123)	38.2 (24.4 to 52.0)	<0.001
Incision – delivery interval (s)	146.6 (68.3)	130 (99–179)	196.2 (50.7)	201 (167–277)	–49.7 (–74.8 to –24.4)	0.0002
Intubation – incision interval (min)	15.8 (6.9)	15 (4–43)	11.7 (6.4)	10 (3–29)	4.1 (0.4 to 7.8)	0.061
Length of surgery (min)	39.3 (8.9)	39 (27–53)	39.4 (9.6)	38 (26–54)	0.1 (–4.0 to 3.8)	0.976
End of surgery to extubation (min)	5.3 (4.6)	4 (0–11)	8.8 (5.8)	8 (2–19)	–3.5 (–5.8 to 1.4)	0.002
SRSD (points)	0.002 (0.01)	0.093 (0.090–0.106)	2.77 (0.55)	3 (2–4)	1.0 (–0.01 to 0.20)	<0.001
Blood loss (mL)	533 (76)	500 (500–600)	538 (98)	500 (500–650)	–5 (–38 to 28)	0.859
Thiopental (mg/kg)	4.7 (0.16)	4.7 (4.5–5.1)	4.7 (0.21)	4.7 (4.5–5.3)		0.471
Muscle relaxant dose (mL/kg)	0.092 (0.01)	0.093 (0.090–0.106)	0.095 (0.00)	0.094 (0.09–0.106)		0.072
Muscle relaxant dose (mg/kg)	0.55 (0.05)	0.56 (0.54–0.65)	0.95 (0.04)	0.94 (0.9–0.11)		0.177

Data are presented as mean (SD) or median (range). Difference between the groups is expressed as median (95% confidence interval). SRSD: Surgical rating scale for delivery.

Čas indukce - intubace

From the most sensitive to the most resistant muscle for NMB



az sint-jan
brugge - oostende - av



Tongue, throat muscles



Peripheral muscles, adductor pollicis



Orbicularis oculi
Corrugator supercilii



Abdominal muscles,



Vocal cords

Clinical definition of deep block:
TOF = 0 and PTC < 5

Diaphragm



ED₉₅

- the effective dose of a drug in 95% of individuals
- for neuromuscular blockers, one often specifies the dose that produces 95% twitch depression in 50% of individuals
- denotes potency of a NDMR

Drug	ED ₉₅ for Adductor Pollicis During Nitrous Oxide/Oxygen/Intravenous Anesthesia (mg/kg)
Succinylcholine	0.5
Gantacurium ¹	0.19
Rocuronium	0.3
Mivacurium ²	0.08
Atracurium	0.2
Cisatracurium	0.05
Vecuronium	0.05
Pancuronium	0.07
Pipecuronium ²	0.05
Doxacurium ²	0.025

SUKCINYLCHOLIN

- ❖ Nejrychlejší nástup účinku
- ❖ Výborné intubační podmínky
- ❖ Neprochází placentou
- ❖ Doporučená dávka 1-1,5 mg/kg



Table 3. Onset Times and Durations of Neuromuscular Block

Succinylcholine dose (mg/kg)	Onset time(s)	Duration of block (min)	n
0.3	72 ± 30	4.4 ± 1.4	13
0.5	68 ± 44	5.2 ± 1.8	27
1.0	53 ± 23	5.9 ± 1.9†	30
1.5	56 ± 31	7.2 ± 2*	30
2.0	52 ± 21	7.5 ± 1.7*	30

Values are means ± SD.

* $P < 0.01$ versus succinylcholine 0.3, 0.5, and 1.0 mg/kg groups; † $P < 0.05$ versus succinylcholine 0.3 mg/kg group.

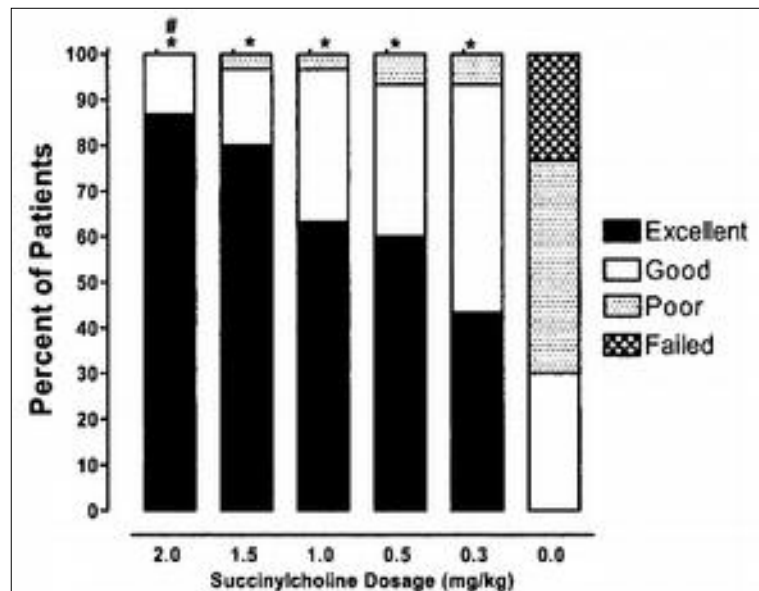
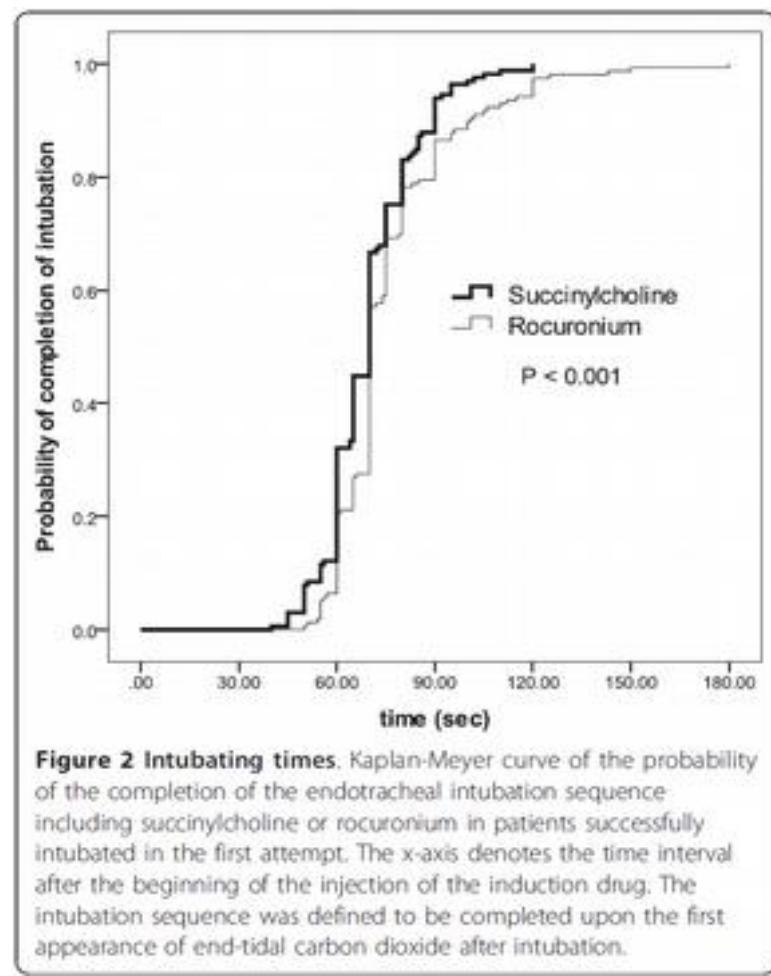
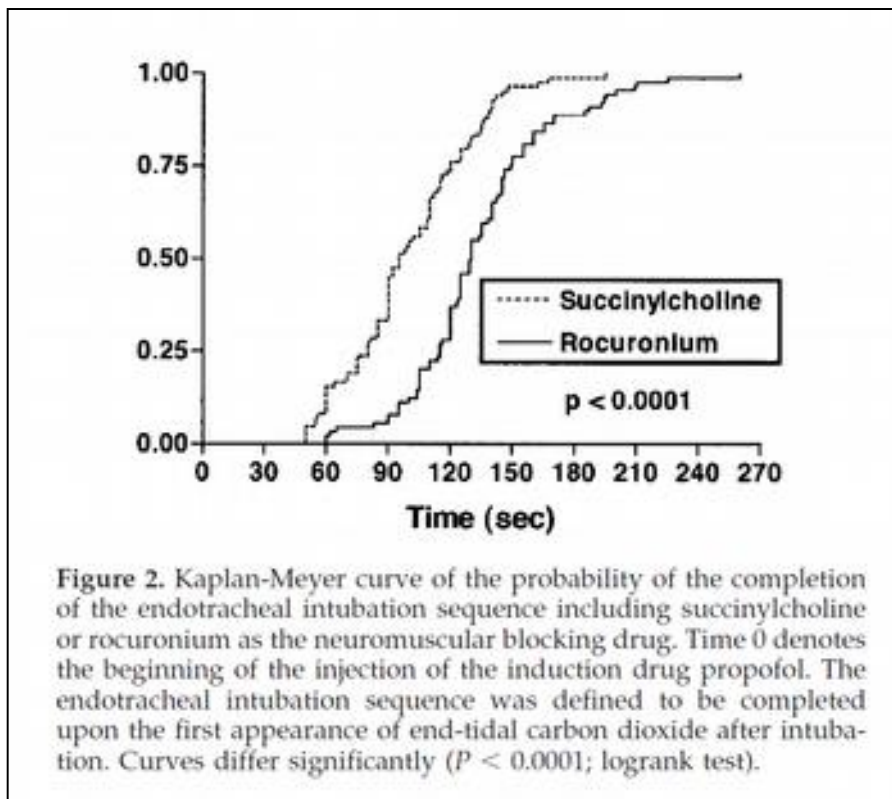


Figure 1. Intubating conditions with different doses of succinylcholine ($n = 30$ in each group). The incidence of excellent intubating conditions was significantly more frequent ($*P < 0.001$) in patients receiving succinylcholine than in those of the control group and in the 2.0 mg/kg succinylcholine group ($*P < 0.05$) than in the 0.3 mg/kg succinylcholine group (Kruskal-Wallis test for multiple comparisons).

Naguib M et al. Anesth Analg 2006;102:151-5

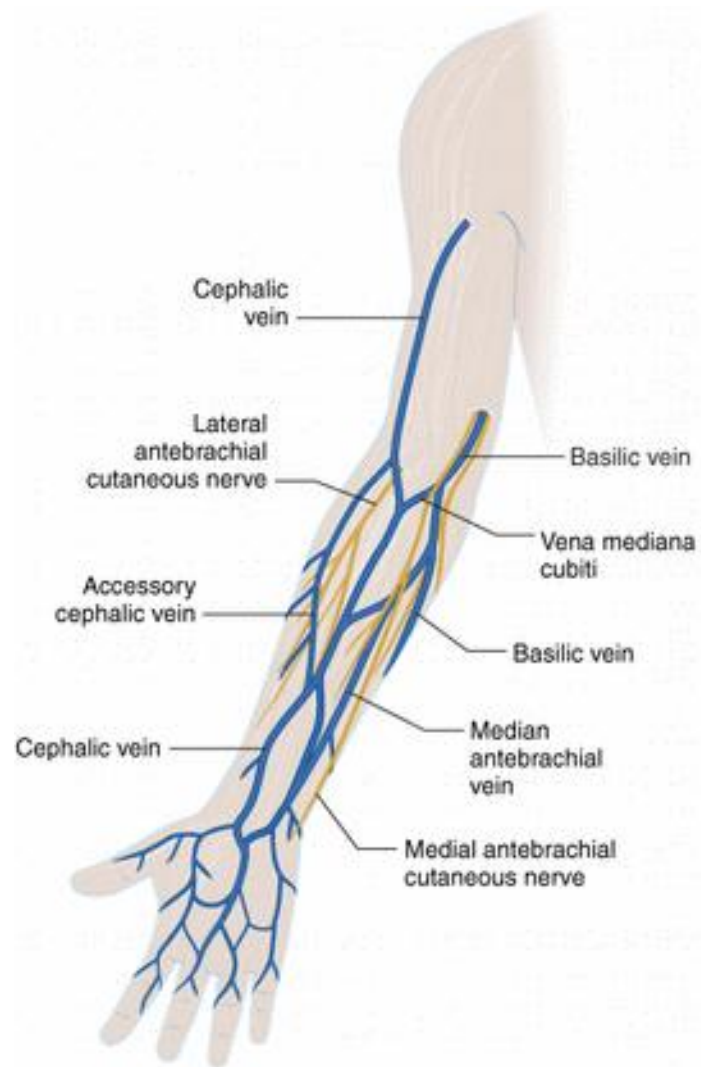
0,6 mg/kg

1 mg/kg



Sluga M et al. Anesth Analg 2005;101:1356 –61

Stephan C Marsch, et al. Crit Care. 2011;15(4):R199-R199



Source: Tintinalli JE, Stapczynski JS, Ma OJ, Cline DM, Cydulka RK, Meckler GD: *Tintinalli's Emergency Medicine: A Comprehensive Study Guide, 7th Edition*; <http://www.accessmedicine.com>
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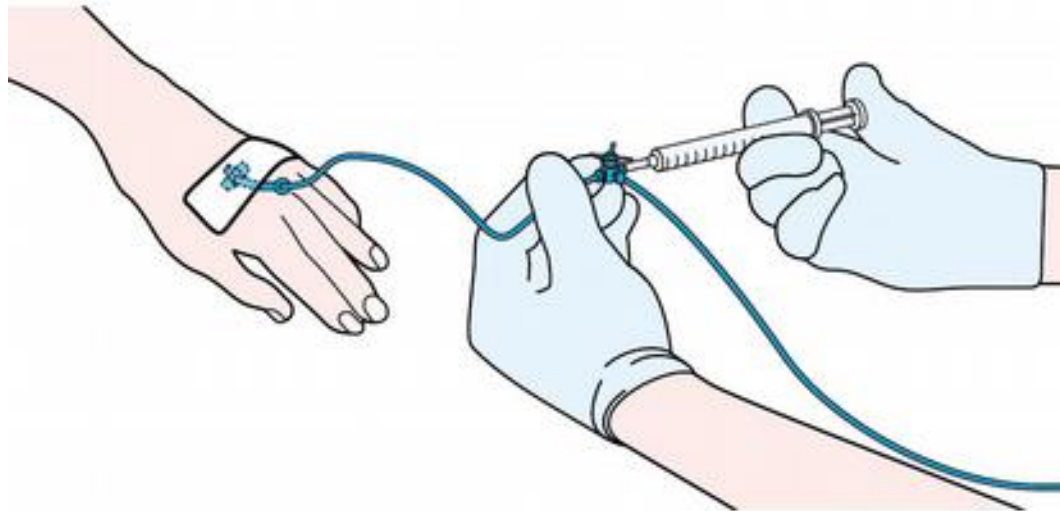
IV CATHETER SIZES AND FLOW RATES

ORANGE	14G			240 ML/MIN 1 LITER = ~4 MINUTES
GRAY	16G			180 ML/MIN 1 LITER = ~5.5 MINUTES
GREEN	18G			90 ML/MIN 1 LITER = ~11 MINUTES
PINK	20G			60 ML/MIN 1 LITER = ~17 MINUTES
BLUE	22G			36 ML/MIN 1 LITER = ~28 MINUTES
YELLOW	24G			20 ML/MIN 1 LITER = 50 MINUTES
VIOLET	26G			13 ML/MIN 1 LITER = ~77 MINUTES





Doba nástupu účinku myorelaxancia vs. “délka cesty“



The salient characteristics of RSI were delineated by Stept and Safar in 1970 [3].

- Preoxygenation
- Predetermined doses of thiopental and SCh
- Cricoid force
- Avoidance of ventilation by bag and mask
- Tracheal intubation



Sharp LM, Levy DM. Current Opinion in Anaesthesiology 2009, 22:357-361

The Response of Newborns to Succinylcholine and d-Tubocurarine

Leonard F. Walts, M.D., and John B. Dillon, M.D.†*

Anesthesiology. 1969 Jul;31(1):35-8.

Results

Mean age of the 60 adult patients was 41 years. The group given succinylcholine received an average of 68 mg (range 54–83) of drug. All patients had 100 per cent depression in twitch force. Recovery times to 10, 50 and 90 per cent of control values averaged 7.0, 8.5, and 10 minutes, respectively.

Desaturation following rapid sequence induction using succinylcholine vs. rocuronium in overweight patients

L. TANG¹, S. LI¹, S. HUANG¹, H. MA¹ and Z. WANG²

Departments of ¹Anesthesiology and ²Pain Management, Shanghai First People's Hospital, Shanghai Jiaotong University, Shanghai, China

Background: Rapid sequence induction may be associated with hypoxemia. The purpose of this study was to investigate the possible difference in desaturation during rapid sequence induction in overweight patients using either succinylcholine or rocuronium.

Methods: Sixty patients with a body mass index (BMI) between 25 and 30 kg/m², American Society of Anesthesiologists class I or II, undergoing general anaesthesia were randomly divided into a succinylcholine group and a rocuronium group. After a 3-min preoxygenation, patients received rapid sequence induction of general anaesthesia with midazolam/fentanyl/propofol and succinylcholine (1.5 mg/kg) or rocuronium (0.9 mg/kg). Ventilation was not initiated until oxygen saturation declined to 92%. We measured the times when oxygen saturation reached 95%, 90%, 94% and 92%. Safe Apnea Time was defined as the time from administration of neuromuscular blocking drugs to oxygen saturation fell to 92%. The recovery period was defined as the time from initiation of

ventilation until oxygen saturation was 97%. Arterial blood gases were taken at baseline, after preoxygenation and at 92% oxygen saturation.

Results: The mean Safe Apnea Time (95% CI) was 283 (257–309) s in succinylcholine vs. 328 (303–354) s in rocuronium ($P = 0.01$). The mean recovery period (95% CI) was 43 (39–48) s in succinylcholine vs. 36 (33–39) s in rocuronium ($P = 0.025$). Blood gas analysis showed no difference between the two groups.

Conclusions: Succinylcholine was associated with a significantly more rapid desaturation and longer recovery of oxygen saturation than rocuronium during rapid sequence induction in overweight patients.

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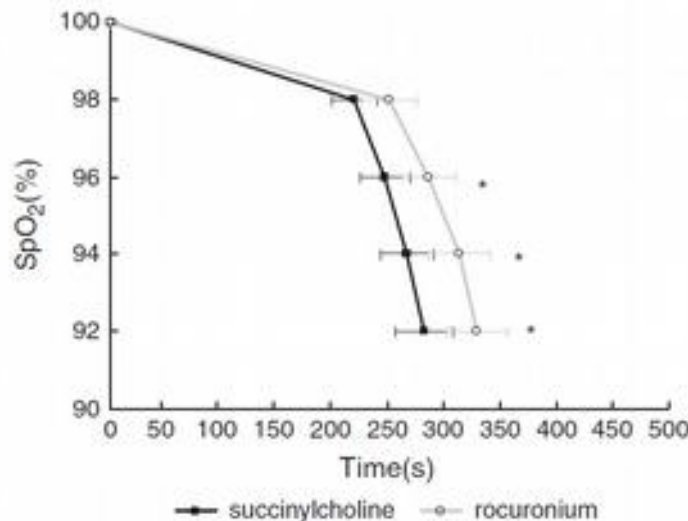


Fig. 2. Changes in oxygen saturation (S_pO_2) with time during non-hyperoxic apnea in the succinylcholine or the rocuronium group. Mean values (points) for both groups are shown. The vertical lines indicate 95% CI. The curves show smooth before S_pO_2 reach 95%, but afterward fall straightly to 92% S_pO_2 . * $P < 0.05$ compared with succinylcholine.



ORIGINAL ARTICLE

Effect of suxamethonium vs rocuronium on onset of oxygen desaturation during apnoea following rapid sequence induction

S. K. Taha,¹ M. F. El-Khatib,² A. S. Baraka,³ Y. A. Haidar,⁴ F. W. Abdallah,⁵ R. A. Zbeidi⁶ and S. M. Siddik-Sayyid¹

¹Assistant Professor, ²Professor, ³Executive Professor, ⁴Chief Resident, ⁵Fellow, Department of Anesthesiology, American University of Beirut, Beirut, Lebanon

Summary

This study investigates the effect of suxamethonium vs rocuronium on the onset of haemoglobin desaturation during apnoea, following rapid sequence induction of anaesthesia. Sixty patients were randomly allocated to one of three groups. Anaesthesia was induced with lidocaine 1.5 mg/kg⁻¹, fentanyl 2 µg/kg⁻¹ and propofol 2 mg/kg⁻¹, followed by either rocuronium 1 mg/kg⁻¹ (Group R) or suxamethonium 1.5 mg/kg⁻¹ (Group S). The third group received propofol 2 mg/kg⁻¹ and suxamethonium 1.5 mg/kg⁻¹ only (Group SO). The median (IQR, [range]) time to reach S_pO_2 of 95% was significantly shorter in Group S (358 [311–373] [215–430] s) than in Group R, (378 [370–393] [366–420] s; $p = 0.003$), and shorter in Group SO (242 [225–258] [189–370] s) than in both Group R ($p < 0.001$) and Group S ($p < 0.001$). When suxamethonium is administered for rapid sequence induction of anaesthesia, a faster onset of oxygen desaturation is observed during the subsequent apnoea compared with rocuronium. However, time to desaturation is prolonged whenever lidocaine and fentanyl precede suxamethonium.

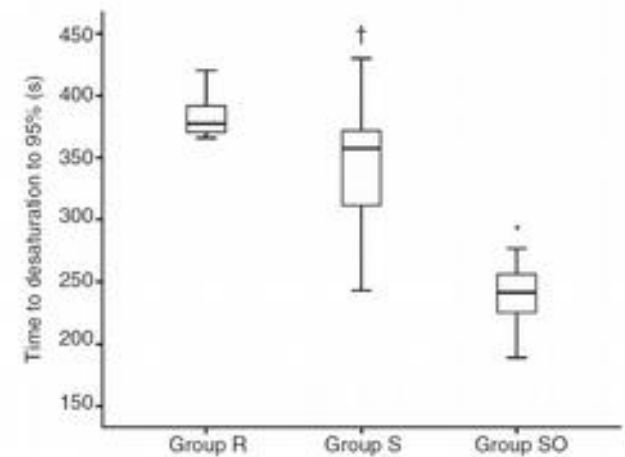


Figure 1 Time to reach S_pO_2 of 95% during apnoea following induction of anaesthesia with lidocaine/fentanyl/propofol/rocuronium (Group R), lidocaine/fentanyl/propofol/suxamethonium (Group S), or propofol/suxamethonium (Group SO).



TABLE 9. *Side effects of succinylcholine.*

- Massive hyperkalemia in susceptible patients
- Cardiac arrhythmias
- Muscle fasciculations
- Myalgias
- Rhabdomyolysis
- Increased intracranial pressure
- Increased intragastric pressure
- Increased intraocular pressure
- Malignant hyperthermia
- Masseter muscle spasm or jaw rigidity
- Prolonged apnea (1–4 hours), if atypical plasma cholinesterase

From Bevan DR. Complications of muscle relaxants. *Semin Anesth.* 1995;14:63.

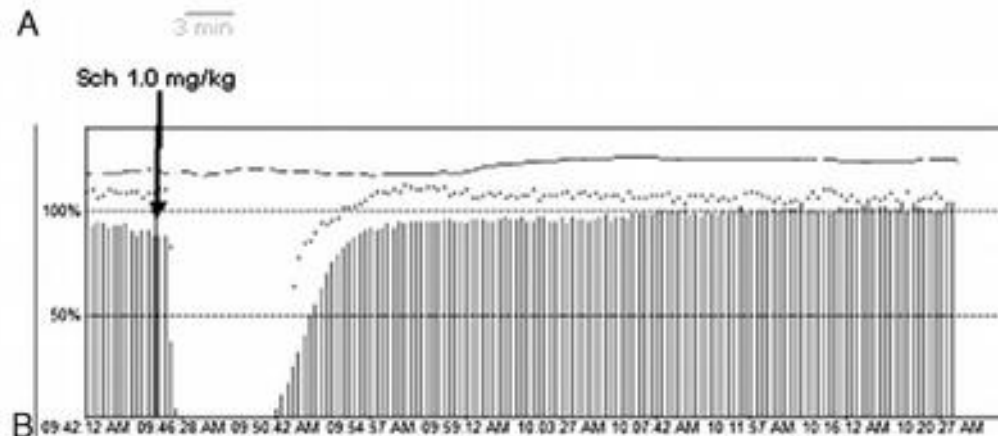
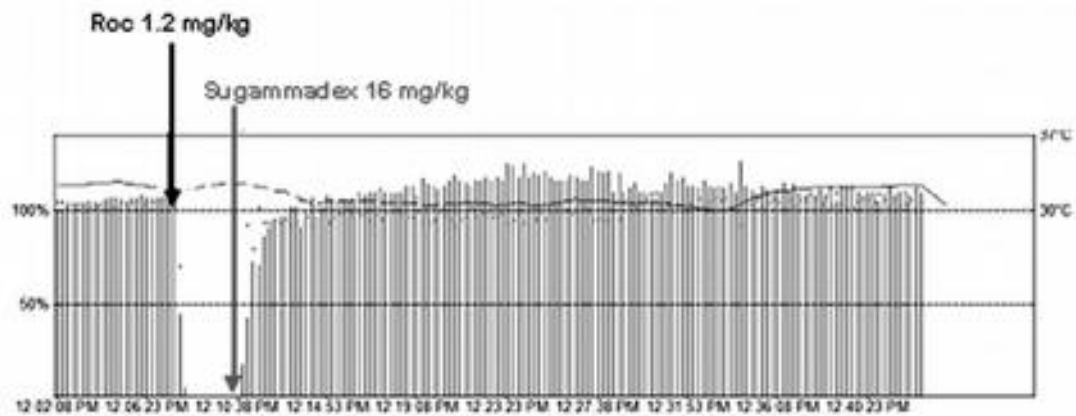
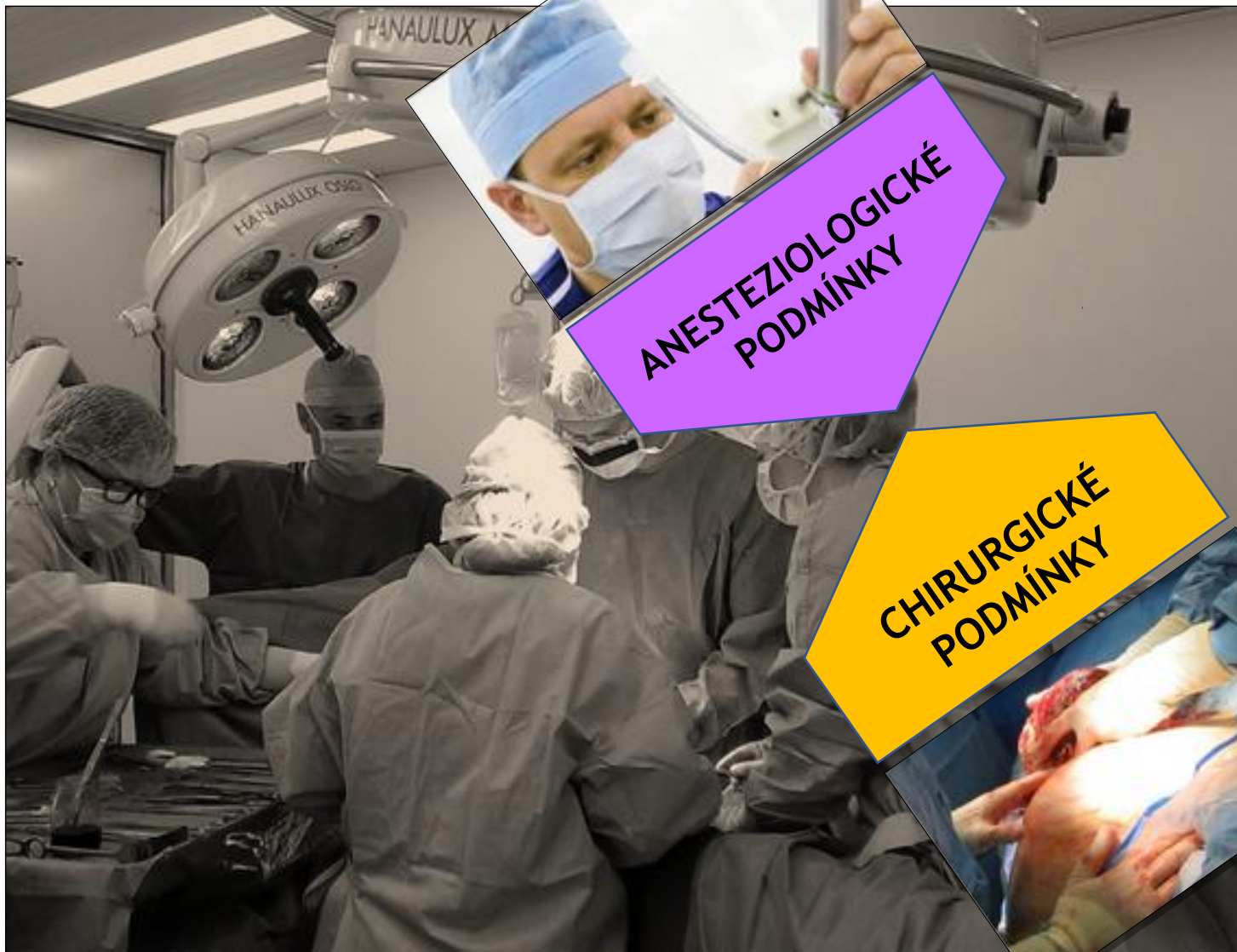


Figure 4. Panel A shows the recovery of the twitch height and train-of-four (TOF) ratio after administration of 1.2 mg/kg rocuronium followed 3 min later by 16 mg/kg sugammadex, both given IV. Recovery to a first twitch height (T1) of 90% and a TOF ratio of 0.94 occurred 110 s later. The onset-offset time with this sequence (i.e., the time from the end of the injection of rocuronium to a T1 recovery to 90%) was 4 min 47 s. Panel B shows the effects of administering 1.0 mg/kg succinylcholine (Sch) with spontaneous recovery to a T1 of 90% occurring after 9 min and 23 s.

STAŤ



**ANESTEZIOLOGICKÉ
PODMÍNKY**

**CHIRURGICKÉ
PODMÍNKY**

**TEĎ JSEM
PŘIDAL ...**

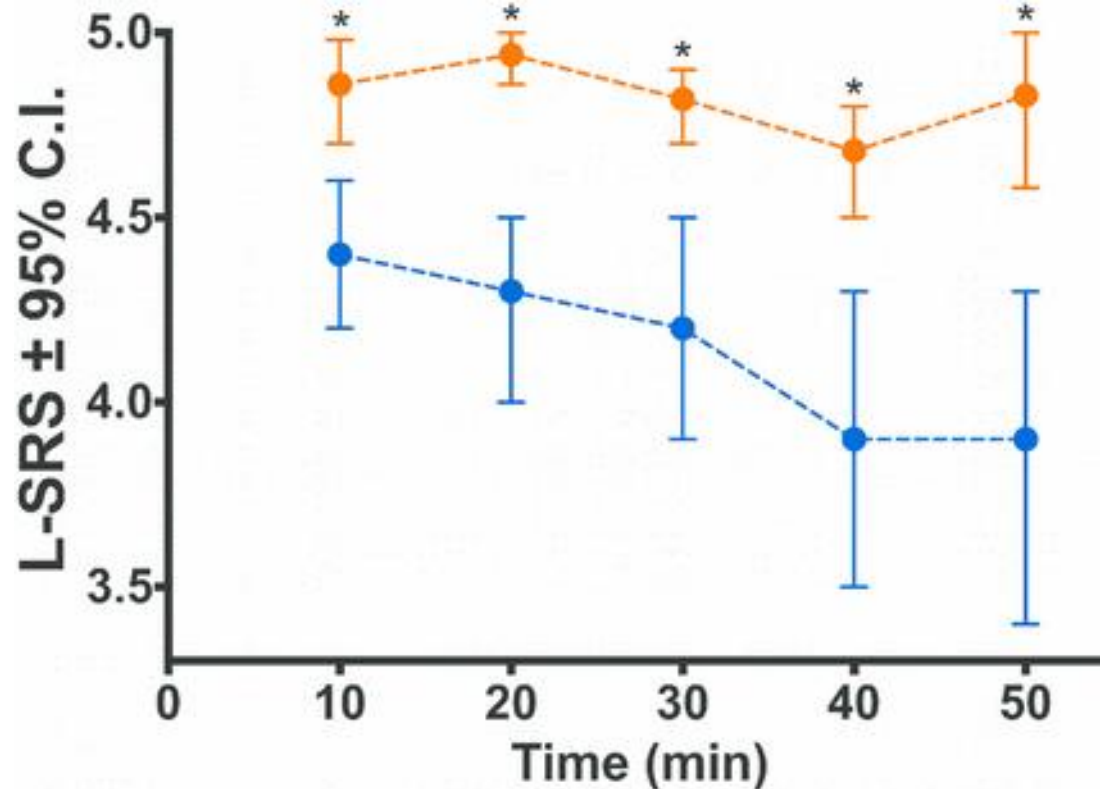
**TEĎ NA KONCI ?
TO VÍŠ ŽE JO...!**



TLAČÍ !



Deep Neuromuscular Block Improves Surgical Conditions during Bariatric Surgery and Reduces Postoperative Pain: A Randomized Double Blind Controlled Trial



Influence of deep relaxation on surgical conditions. Leiden-surgical rating scale (L-SRS) values of patients during a deep neuromuscular block (target PTC 2–3; orange, n = 50) and during a moderate neuromuscular block (target TOF 1–2; blue, n = 50). Values are mean (95% confidence interval) with confidence intervals derived from bootstrap analyses. * Mann-Whitney-U test p < 0.01 versus moderate block.
doi:10.1371/journal.pone.0167907.g002



Score	Interpretation	Treatment group	
		Moderate block	Deep block
5	Optimal conditions	10%	70%
4	Good conditions	20%	20%
3	Acceptable conditions	55%	10%
2	Poor conditions	10%	0%
1	Extremely poor conditions	5%	0%



Discussion: We aim to show that under the right conditions the perceived opposing goals of surgeons and anesthesiologists (optimal surgical conditions vs. optimal postoperative conditions) may be met without compromise to either.

Boon et al. *Trials*. 2013 Mar 1;14:63

MĚLKÁ RELAXACE



HLUBOKÁ RELAXACE



ORIGINAL ARTICLE

Surgical conditions with rocuronium versus suxamethonium in cesarean section: a randomized trial

J. Bláha,^{a,†} P. Nosková,^{a,†} K. Hlinecká,^b V. Krakovská,^c V. Fundová,^a T. Bartošová,^a
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^aDepartment of Anesthesiology, Resuscitation and Intensive Medicine, 1st Faculty of Medicine, Charles University and General University Hospital in Prague, Czech Republic

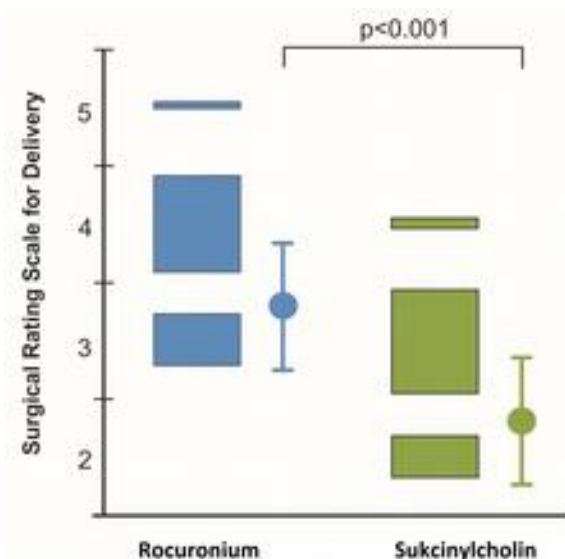
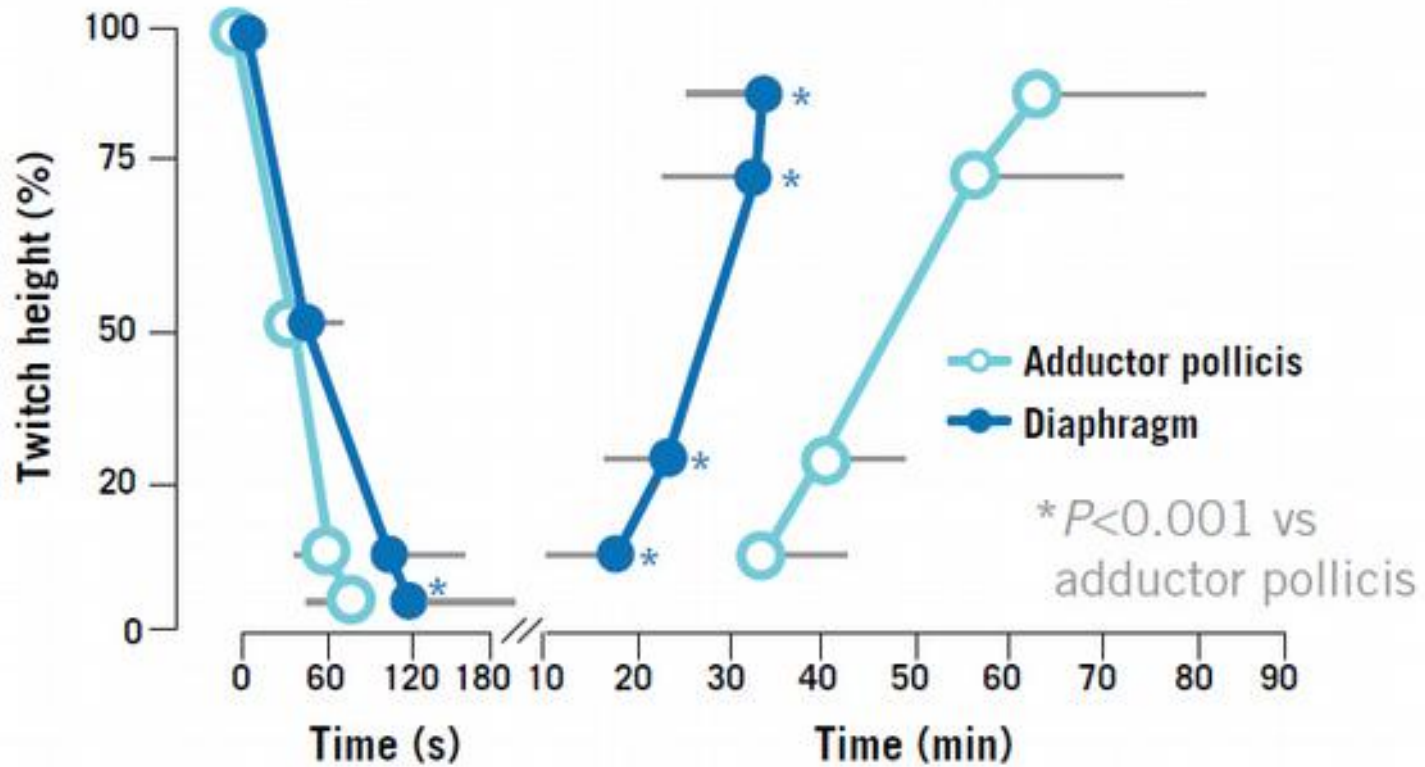


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SRSD (points)	3.73 (0.53)	3 (2–4)	2.77 (0.55)	3 (2–4)	1.0 (–0.01 to 0.20)	<0.001
Blood loss (mL)	533 (100)	500 (500–600)	538 (98)	500 (500–650)	–5 (–38 to 28)	0.859
Thiopental (mg/kg)	4.7 (0.16)	4.7 (4.5–5.3)	4.7 (0.21)	4.7 (4.5–5.3)		0.471
Muscle relaxant dose (mL/kg)	0.092 (0.01)	0.093 (0.090–0.106)	0.095 (0.00)	0.094 (0.09–0.106)		0.072
Muscle relaxant dose (mg/kg)	0.55 (0.05)	0.56 (0.54–0.65)	0.95 (0.04)	0.94 (0.9–0.11)		0.177

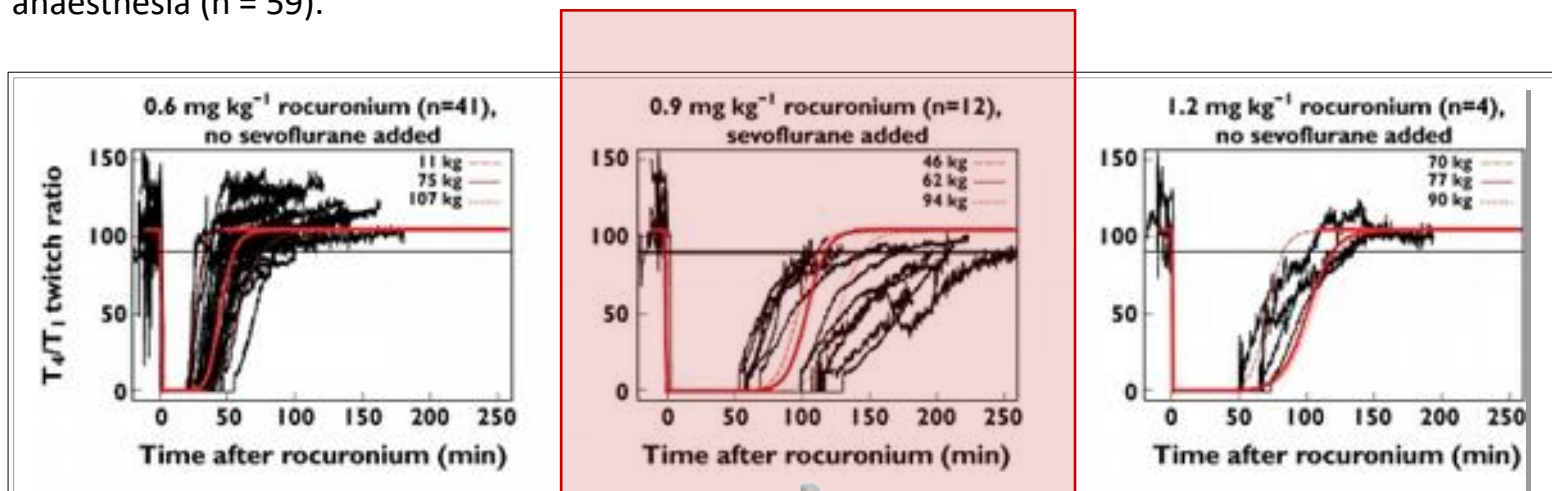
Data are presented as mean (SD) or median (range). Difference between the groups is expressed as median (95% confidence interval). SRSD: Surgical rating scale for delivery.



Cantineau et al. Anesthesiology. 1994;81(3):585-590.

ZÁVĚR

Figure 5. Graphs show the observed T₄/T₁ twitch ratio upon spontaneous neuromuscular blockade reversal following rocuronium administration, conditioned on administered dose and use of sevoflurane anaesthesia (n = 59).



Br J Clin Pharmacol. 2011 September; 72(3): 415–433.

The Prolonged Duration of Rocuronium in Chinese Patients

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We compared the potency and duration of action of rocuronium in Chinese and Caucasian patients during general anesthesia. Thirty-six women (18 Caucasian and 18 Chinese) and 36 children (18 Caucasian and 18 Chinese) were evaluated during the administration of propofol/fentanyl anesthesia. Patients in each age group were randomized into three subgroups to receive single doses of 0.06, 0.12, or 0.18 mg/kg rocuronium (adults) or 0.12, 0.18, or 0.24 mg/kg rocuronium (children). Neuromuscular blockade was assessed by electromyography of the adductor pollicis after train-of-four (TOF) stimulation of the ulnar nerve. Dose response curves were constructed when maximum neuromuscular depression of the first twitch of the train (T_1) was obtained. A second bolus dose of rocuronium was then administered to a total dose of 0.6 mg/kg. The times of spontaneous recovery to T_1 10%, 25%, and 90%

of control and to TOF 0.25, 0.50, and 0.70 were recorded. For both adults and children, recovery occurred later in Chinese than in Caucasian patients ($P < 0.05$ for T_1 of 10%, 25%, 75%, and 90% and TOF to 0.7). The 50% effective dose was smaller in Chinese adults (125 ± 63 vs 159 ± 66 $\mu\text{g}/\text{kg}$) and Chinese children (171 ± 43 vs 191 ± 46 $\mu\text{g}/\text{kg}$) than in Caucasian adults and children, but the difference was not statistically significant. In adults, time to 25% T_1 recovery was 43 ± 13 min in Chinese patients and 33 ± 10 min in Caucasian patients ($P < 0.05$). The corresponding values were more rapid for children: 30 ± 10 and 24 ± 6 min ($P < 0.05$). We conclude that the recovery from rocuronium neuromuscular blockade was longer in Chinese compared with Caucasian patients and in adults compared with children.

(Anesth Analg 2000;91:1526-30)

Table 2. Pharmacodynamic parameters.

	men (n = 121)	women (n = 124)
ONSET TIME (seconds)	104.7 (12.2)	92.5 (14.2)***
CLINICAL DURATION (minutes)	31.3 (5.5)	43.1 (7.9)***
RECOVERY INDEX (minutes)	14.8 (4.0)	14.7 (5.0)

Data are means (SD - standard deviation), ***p < 0.0001

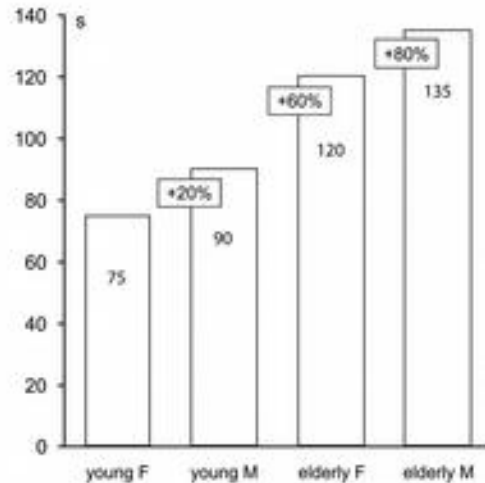


Fig. 2. Onset time in seconds (= time interval from the completion of the intravenous injection of rocuronium to maximal T_1 depression in TOF-stimulation). Data are medians. The percentage values describe the increase compared to young females. M = males, F = females. Young = age 20-40 yrs. Elderly = 60-75 yrs

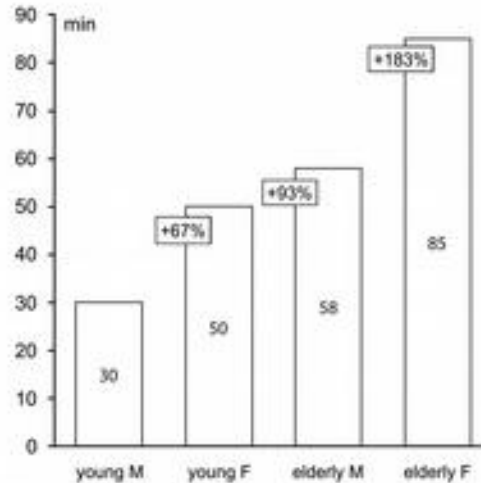


Fig. 3. Clinical duration in minutes (= time interval from the completion of the intravenous injection of rocuronium to spontaneous recovery of T_1 to 25% of the control value in TOF-stimulation). Data are medians. The percentage values describe the increase compared to young males. M = males, F = females. Young = age 20-40 yrs. Elderly = 60-75 yrs

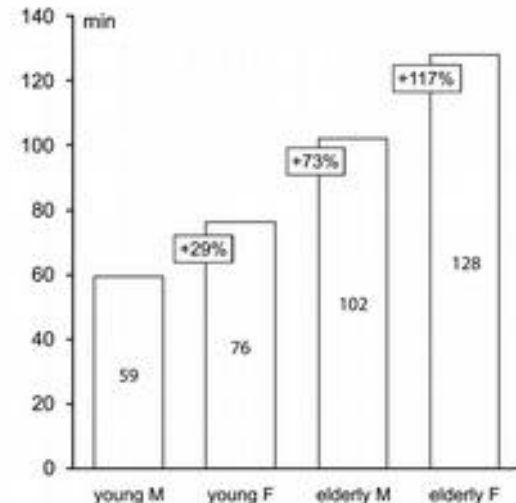


Fig. 4. Interval to full recovery in minutes (= interval from the completion of the intravenous injection of rocuronium to spontaneous recovery to TOF-ratio 0.90, which reflects complete recovery from the block). Data are medians. The percentage values describe the increase compared to young males. M = males, F = females. Young = age 20-40 yrs. Elderly = 60-75 yrs

REVIEW

Myths and facts in neuromuscular pharmacology - New developments in reversing neuromuscular blockade

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ABSTRACT

Pharmacologic reversal of neuromuscular blockade is a topic not very well acknowledged and controversially discussed. Reasons for this are numerous and include missing perception of the potential complications of residual neuromuscular paralysis including an increased morbidity and mortality, as well as low efficacy and numerous unwanted side effects of the available antagonists. Duration of action of muscle relaxants cannot be pharmacologically predicted. Objective neuromuscular monitoring is the only way to detect residual paralysis. This review article would like to discuss in its first part some of the myths which revolve around the use of muscle relaxants, then highlight the problems regarding the use of acetylcholine esterase inhibitors and, in the third part, discuss the steroidal muscle relaxant encapsulator sugammadex. (*Minerva Anesthesiol* 2012;78:473-82)

Key words: Pharmacology - Neuromuscular blockade - Acetylcholinesterase.



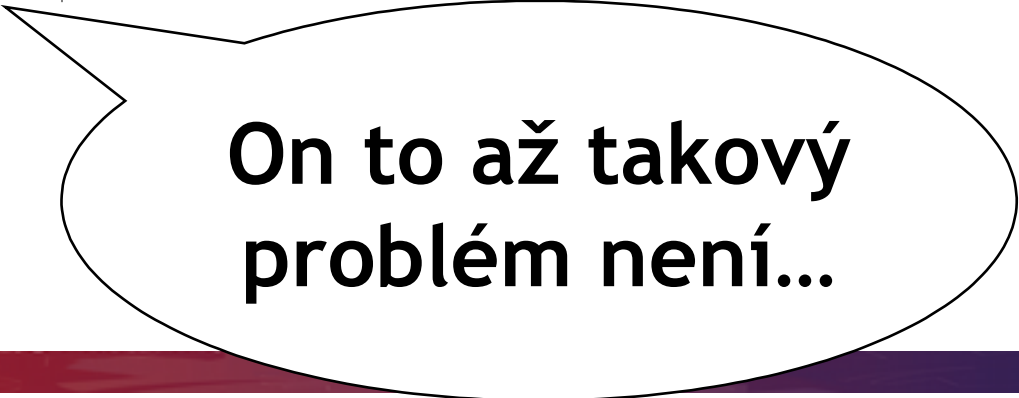
**Umím to i
bez toho...**

Myth #2

IF YOU KNOW THE PHARMACOKINETICS OF MUSCLE RELAXANTS, NEUROMUSCULAR MONITORING AND REVERSAL DRUGS ARE NOT NECESSARY

Myth #3

THE CLINICAL EFFECTS OF POST-OPERATIVE RESIDUAL CURARIZATION (PORC) IS COMPLETELY OVERRATED



**On to až takový
problém není...**

Residual neuromuscular block is a risk factor for postoperative pulmonary complications

A prospective, randomised, and blinded study of postoperative pulmonary complications after atracurium, vecuronium and pancuronium

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Departments of Anaesthesia and Intensive Care, Copenhagen University Hospital, Rigshospitalet and Glostrup Hospital, Denmark

Background: After anaesthesia involving pancuronium a high incidence of both residual neuromuscular block and postoperative pulmonary complications (POPC) has been reported. The aim of this study was to compare the incidence of POPC following the use of pancuronium, atracurium, and vecuronium, and to examine the effect of residual neuromuscular block on the incidence of POPC.

Methods: A total of 691 adult patients undergoing abdominal, gynaecological, or orthopaedic surgery under general anaesthesia were randomised to receive either pancuronium, atracurium, or vecuronium. Perioperatively, the response to train-of-four (TOF) nerve stimulation was evaluated manually. Postoperatively, the TOF ratios were measured mechanomyographically, and through a 6-day follow-up the patients were examined for pulmonary complications.

Results: The incidence of residual block, defined as a TOF ratio <0.7 , was significantly higher in the pancuronium group (59/226: 26%) than in the atracurium/vecuronium groups (24/450: 5.3%). In the pancuronium group, significantly more patients

with residual block developed POPC (10/59: 16.9%) as compared to patients without residual block (8/167: 4.8%). In the atracurium/vecuronium groups, the incidence of POPC was not significantly different in patients with (1/24: 4.2%) or without (23/426: 5.4%) residual block. Multiple regression analysis indicated that abdominal surgery, age, long-lasting surgery, and a TOF ratio <0.7 following the use of pancuronium were potential risk factors for the development of POPC.

Conclusion: Postoperative residual block caused by pancuronium is a significant risk factor for development of POPC.

Key words: Anesthesia complications; complications: postoperative pulmonary, atelectasis, pneumonia; monitoring: neuromuscular function, TOF ratio; neuromuscular relaxants: atracurium, pancuronium, vecuronium; postoperative period: neuromuscular recovery, neuromuscular testing, pulmonary complications, residual neuromuscular block.

© *Acta Anaesthesiologica Scandinavica* 41 (1997)

Risk of POPC %

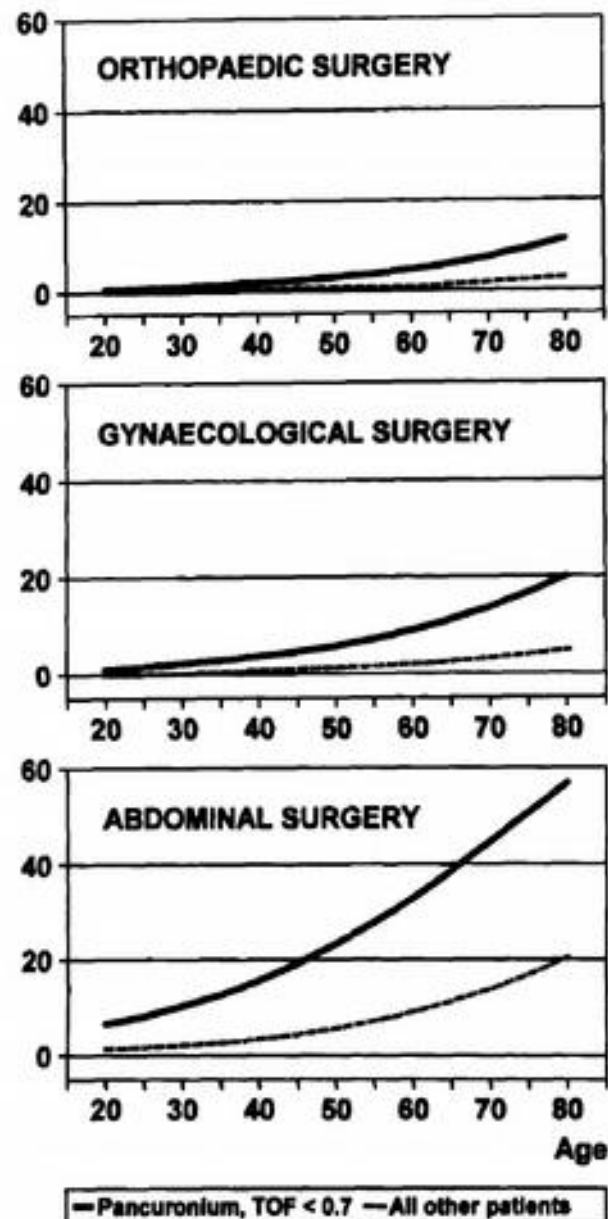


Fig. 4. Predicted probabilities of postoperative pulmonary complications in different age groups in orthopaedic, gynaecological, and major abdominal surgery with a duration of anaesthesia of less than 200 min. The full lines represent patients having residual neuromuscular block (TOF < 0.70) following the use of pancuronium, the broken lines patients with TOF \geq 0.70 following pancuronium and all atracurium and vecuronium patients, independent of the TOF ratio at end of anaesthesia (see text for further explanation).

Table 5

Comparison between patients with and without POPC. Median values and 25th–75th percentiles are given.

	Patients without POPC (n=644)	Patients with POPC (n=46)	Significance level P
Age in years	51.6 (38–66)	65.0 (56–76)	0.000011
Duration of anaesthesia	150 (115–190)	193 (160–230)	0.000027
Duration of surgery	92 (65–130)	121 (90–165)	0.00028
Central temperature at end of anaesthesia (°C)	36.0 (35.6–36.5)	35.7 (35.2–36.2)	0.00084

Berg H et al. Acta Anaesthesiol Scand. 1997 Oct;41(9):1095-1103

Proč je svalová relaxace tak (NE)POPULÁRNÍ

doc. MUDr. Petr Štourač, Ph.D.

- Výrazné rozdíly v citlivosti k NMBA
- Variabilita v nástupu účinku i hloubce účinku
- Naprosto nepredikovatelná délka trvání účinku
- Citlivost k účinku myorelaxans je podmíněná věkem a pohlavím
- Prodloužená u pacientů nad 60 let věku

Proč je svalová relaxace tak (NE)POPULÁRNÍ

doc. MUDr. Petr Štourač, Ph.D.

Reziduální nervosvalová blokáda u dospělých

Reziduální nervosvalová blokáda

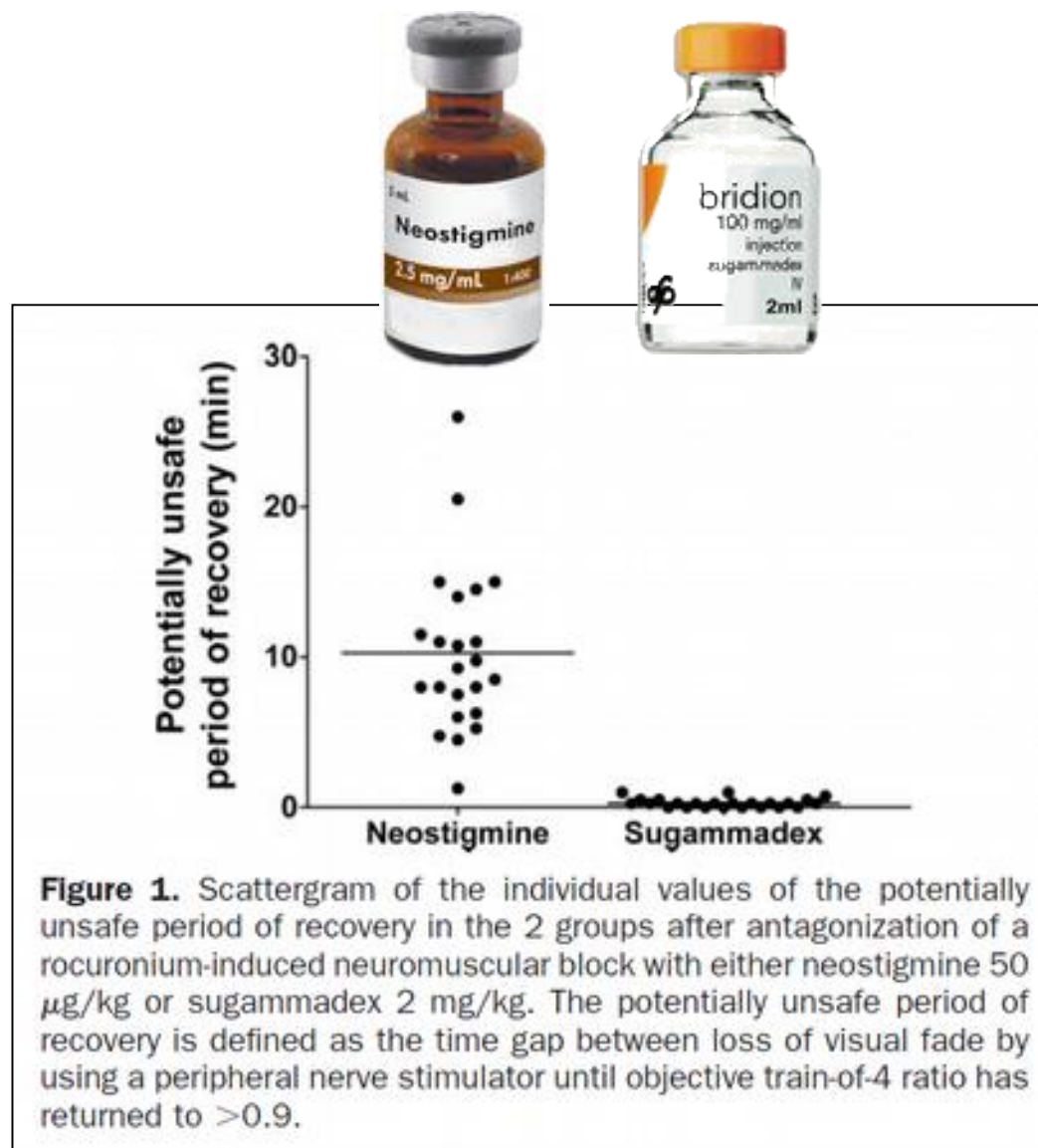
- Nedokonalé zotavení z nervosvalové blokády
 - TOFr < 0,9
 - U dospělých
 - 25-50%
 - Zvyšuje incidenci pooperačních komplikací
 - Předpoklad rychlejšího zotavení u dětí a těhotných
- Objektivizace hloubky blokády v průběhu operace a pooperačně
 - Kvalitativně vs kvantitativně vs klinicky
- Aktivní reverze blokády farmakologicky
 - Zrychluje zotavení z účinků svalové relaxace

RECITE Kanada a RECITE USA

- Prospektivní studie
 - Kanada a USA
 - 302 vs 255 pacientů
 - Monitorace nervosvalové blokády akcelerometricky
 - Incidence reziduální blokády na sále a dospávacím pokoji (Kanada)
 - 63,7% vs 64,7% na sále
 - 56,5% na PACU
 - Aktivní reverze neostigminem více než 70%
 - Bez zjištěného demografického rizikového faktoru

Fortier LP et al.
Anesthesia and Analgesia, 2015
Saager L et al.
Journal of Clinical Anesth, 2019

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Illman HL et al. Anesth Analg 2011;112:63–8

Table 5: Recovery times (min) to TOF ratio 0.9 from moderate neuromuscular blockade induced by rocuronium[28]

	Sugammadex dose mg/kg					
	0.5	1.0	2.0	3.0	4.0	6.0
Sorgenfrei <i>et al.</i>	3.7 (1.0)	2.3 (0.6)	1.7 (0.6)	1.9 (1.2)	1.1 (0.3)	-
Suy <i>et al.</i>	4.3 [1.3-8.5]	3.3 [1.4-4.9]	1.3 [0.9-1.7]	1.2 [0.7-3.2]	1.1 [1.0-1.4]	-
Shields <i>et al.</i>	5.29 [4:50-11:26]	2.42 [1:49-3:40]	1.46 [1:00-2:31]	-	1.04 [0.57-2:19]	2.41 [1:08-3:56]
Puehringer <i>et al.</i>	16.3 (20.6)	4.6 (6.0)	1.4 (0.5)	-	1.5 (0.4)	-
Plaud <i>et al.</i>	4.2 [2.3-4.8]	1.7 [1.2-2.10]	1.4 [1.0-2.0]	-	1.2 [0.9-1.6]	-

Sorgenfrei *et al.*^[8] mean (standard deviation, SD); Suy *et al.*^[12] median (range); Shields *et al.*^[22] median (range, time in min:s); Puehringer *et al.*^[13] mean (SD); Plaud *et al.*^[21] median (range).

Table 6: Recovery times (min) to TOF ratio of 0.5 from profound neuromuscular blockade induced by rocuronium[28]

	Sugammadex dose mg/kg					
	0.5	1.0	2.0	4.0	6.0	8.0
Groudine <i>et al.</i>	44.2 [22.4-84.1]	19.1 [5.0-33.2]	5.4 [1.8-15.2]	3.3 [2.2-4.7]	-	1.5 [1.0-2.1]
Sparr <i>et al.</i>	-	6.5 (1.7)	2.7 (0.7)	2.1 (1.2)	2.1 (2.0)	1.4 (0.2)
Duvaldestin <i>et al.</i>	79.8 (33)	28 (43.7)	3.2 (1.5)	1.6 (0.7)	-	1.1 (0.3)

Groudine^[11] median (range); Sparr^[6] mean (SD); Duvaldestin^[8] mean (SD).

Table 7: Recovery times (min) to TOF ratio of 0.9 in immediate (rescue) reversal[28]

	Sugammadex dose mg/kg				
	2.0	4.0	8.0	12.0	16.0
de Boer <i>et al.</i>	55.3 [50.5-65.1]	12.3 [3.3-46.6]	2.5 [2.2-3.7]	1.3 [1.0-1.9]	1.3 [0.7-6.9]
Puehringer <i>et al.</i>	34.4 [23.3-94.3]	6.8 [3.4-11.9]	2.2 [1.3-4.8]	1.4 [1.0-7.1]	1.3 [0.9-4.8]
Puehringer <i>et al.</i>	63.3 [36.3-117.2]	11.3 [5.3-28.5]	3.6 [1.5-4.7]	1.9 [1.2-4.1]	1.3 [0.8-2.3]

de Boer *et al.*^[24] median (range); sugammadex administered 5 min after 1.2 mg/kg of rocuronium; Puehringer *et al.*^[13] mean (range); sugammadex administered 3 min after 1.0 and 1.2 mg/kg of rocuronium.

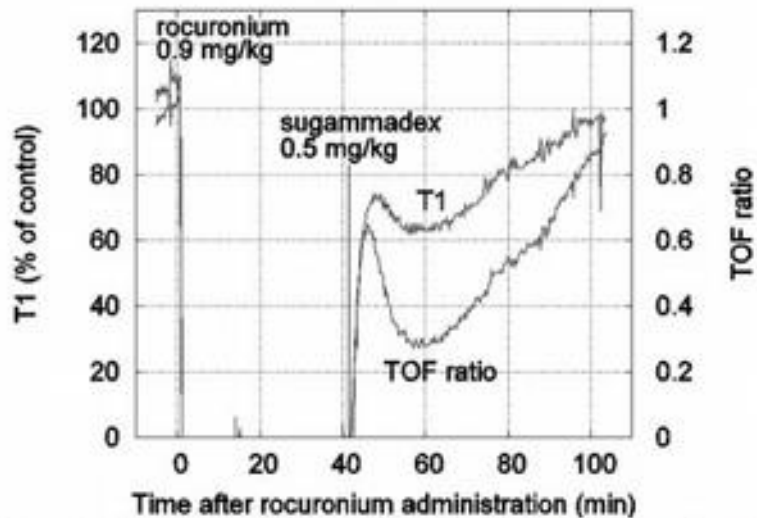


Figure 1. Temporary decrease in train-of-four (TOF) ratio and T1 during reversal of rocuronium-induced muscle relaxation (0.9 mg/kg) with sugammadex (0.5 mg/kg administered 42 min after rocuronium). At the time of sugammadex administration the posttetanic-count (PTC) value was 1.

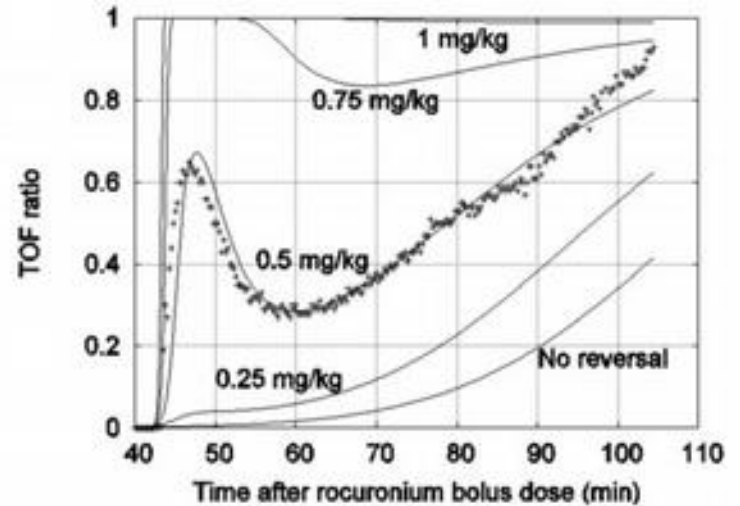


Figure 2. Observed train-of-four (TOF) data (+) and the results of simulations (solid lines) of various sugammadex dosing amounts. Muscle relaxation rebound only occurs for sugammadex doses in a limited range. The simulations indicate that for this patient, doses larger than about 1 mg/kg are sufficient to achieve rapid muscle relaxation reversal and avoid muscle relaxation rebound.



1 000 Kč



19 000 Kč



jan.blaha@vfn.cz