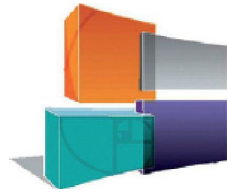


Svalová relaxancia a jejich antidota

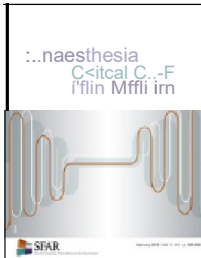
MUDr. Michal Horáček
KARIM 2. LF UK
Katedra AIM IPVZ
Praha

10. 2. 2025



SFAR

Société Française d'Anesthésie et de Réanimation



Guidelines

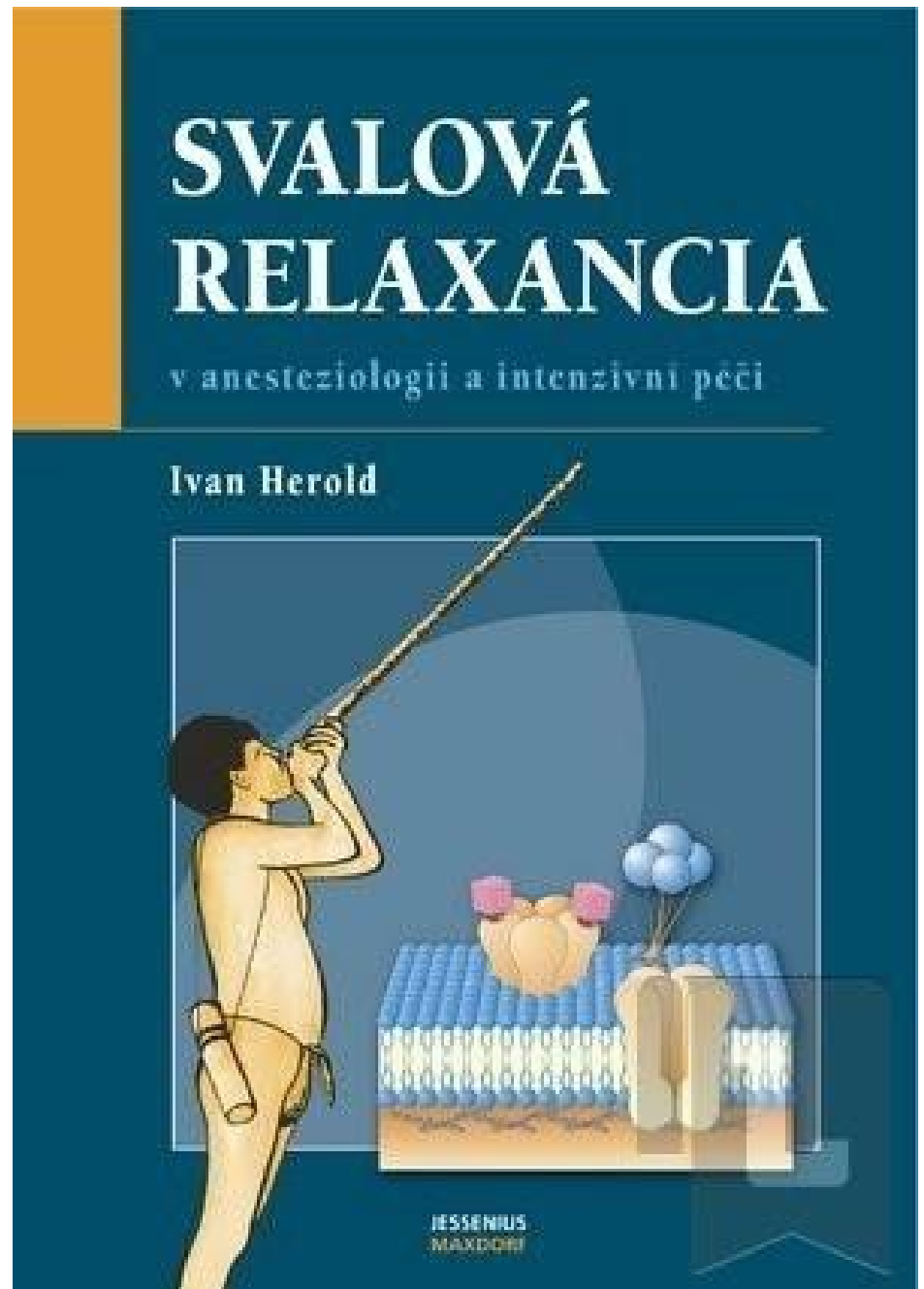
Guidelines on muscle relaxants and reversal in anaesthesia ***

Benoit Pfaud ^{a*,1}, Christophe Bahard ^{b,1}, Jean-Louis Bourgain ^c, Gaëlle Bouroche ^{ct},
Laetitia Despfanque ^e, Jean-Michel Devys ^r, Dominique Fletcher ^{g, 2}, Thomas Fuchs-Bu. der ¹¹,
Gilles Lebuffe ⁱ, Claude Meistelnlan ¹¹, Cyrus Motamed ^c, Julien Rafit. l. , Frédérique Servin ^e,
Didier Sirieix ^{1<}, Karenl SHm, ¹ Uonel Vellym, ², Franek Verdonk ⁿ, Bertrand Debaene ^{0.1}

Check for
updates



2004



SVALOVÁ RELAXANCIA A JEJICH ANTIDOTA



AUTOR KURZU

**MUDr. Michal
Horáček, DEAA**

Zobrazit

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AKC E ZAŘAZENA DO eV

ČLnK: 21703 (2 body)

Spustit kurz



Proč podávat svalová relaxancia?

- ✓ usnadnění intubace
- ✓ usnadnění přístupu do tělních dutin anestezie
- ✓ zajištění nehybnosti během výkonu
- snížení nociceptivního dráždění?
- usnadnění ventilace intenzivní medicína
 - odejmutí dechové práce - snížení spotřeby kyslíku
 - snížení inspiračních tlaků
 - zlepšení souladu s ventilátorem
 - snížení intrakraniálního a intraabdominálního tlaku
 - umožnění léčebné hypotermie

THE USE OF CURARE IN GENERAL ANESTHESIA

HAROLD R. GRIFFITH, M.D., AND G. ENID JOHNSON, M.D.*

Montreal, Canada

Every anesthetist has wished at times that he might be able to produce rapid and complete muscular relaxation in resistant patients under general anesthesia. This is a preliminary report on the clinical use of a drug which will give this kind of relaxation, temporarily and apparently quite harmlessly.

ANESTHESIOLOGY. (1942). 3 414–20



Zavedení SR do praxe

	BEECHER AND TODD		Annals of Surgery July, 1954		Annals of Surgery July, 1954	
TABLE XII. Incidence of Use and of Death Associated With "Curare"^o by Year. Year.						
	1948	1949	1950	1951	1952	Total or Average
Anesthesia which Included "Curare".	6,000	6,800	9,100	10,900	11,300	44,100
Incidence of Use of "Curare".....	1 : 18	1 : 17	1 : 14	1 : 11	1 : 11	1 : 14
Incidence of "Curare Death".....	1 : 380	1 : 360	1 : 320	1 : 390	1 : 420	1 : 370
Incidence of Use of "Curare" in All "Anesthesia Deaths".....	1 : 5	1 : 4	1 : 3	1 : 2.5	1 : 2.5	1 : 3

*"Curare" in this and other Tables refers to all muscle relaxants. Data on specific muscle relaxants are presented in Table XXII.

- mortalita 1 : 1560, 1:2 100 s kurare x 1:370 bez kurare¹
 1. Beecher, HK, Todd, DP A study of the deaths associated with anesthesia and surgery: Based on a study of 599, 548 anesthetics in ten institutions 1948-1952, inclusive.. *Ann Surg.* (1954). 140 2-35
- 70. léta: anesteziologická mortalita 2:10 000 →
 - 2006 1:200-300 000² → dnes 1 : 100 000
 - 2. *Anesth Clin N Amer* 2006;24:255-278

Post-anaesthesia pulmonary complications after use of muscle relaxants (POPULAR): a multicentre, prospective observational study.

Kirmeier E, Eriksson LI, Lewald H, Jonsson Fagerlund M, Hoefft A, Hollmann M, Meistelman C, Hunter JM, Ulm K, Blobner M; POPULAR Contributors.

+ Collaborators (857)

Abstract

BACKGROUND: Results from retrospective studies suggest that use of neuromuscular blocking agents during general anaesthesia might be linked to postoperative pulmonary complications. We therefore aimed to assess whether the use of neuromuscular blocking agents is associated with postoperative pulmonary complications.

METHODS: We did a multicentre, prospective observational cohort study. Patients were recruited from 211 hospitals in 28 European countries. We included patients (aged ≥ 18 years) who received general anaesthesia for any in-hospital procedure except cardiac surgery. Patient characteristics, surgical and anaesthetic details, and chart review at discharge were prospectively collected over 2 weeks. Additionally, each patient underwent postoperative physical examination within 3 days of surgery to check for adverse pulmonary events. The study outcome was the incidence of postoperative pulmonary complications from the end of surgery up to postoperative day 28. Logistic regression analyses were adjusted for surgical factors and patients' preoperative physical status, providing adjusted odds ratios (OR_{adj}) and adjusted absolute risk reduction (ARR_{adj}). This study is registered with ClinicalTrials.gov, number [NCT01865513](https://clinicaltrials.gov/ct2/show/study/NCT01865513).

FINDINGS: Between June 16, 2014, and April 29, 2015, data from 22 803 patients were collected. The use of neuromuscular blocking agents was associated with an increased incidence of postoperative pulmonary complications in patients who had undergone general anaesthesia (1658 [7.6%] of 21 694); OR_{adj} 1.86, 95% CI 1.53-2.26; ARR_{adj} -4.4%, 95% CI -5.5 to -3.2). Only 2.3% of high-risk surgical patients and those with adverse respiratory profiles were anaesthetised without neuromuscular blocking agents. The use of neuromuscular monitoring (OR_{adj} 1.31, 95% CI 1.15-1.49; ARR_{adj} -2.6%, 95% CI -3.9 to -1.4) and the administration of reversal agents (1.23, 1.07-1.41; -1.9%, -3.2 to -0.7) were not associated with a decreased risk of postoperative pulmonary complications. Neither the choice of sugammadex instead of neostigmine for reversal (OR_{adj} 1.03, 95% CI 0.85-1.25; ARR_{adj} -0.3%, 95% CI -2.4 to 1.5) nor extubation at a train-of-four ratio of 0.9 or more (1.03, 0.82-1.31; -0.4%, -3.5 to 2.2) was associated with better pulmonary outcomes.

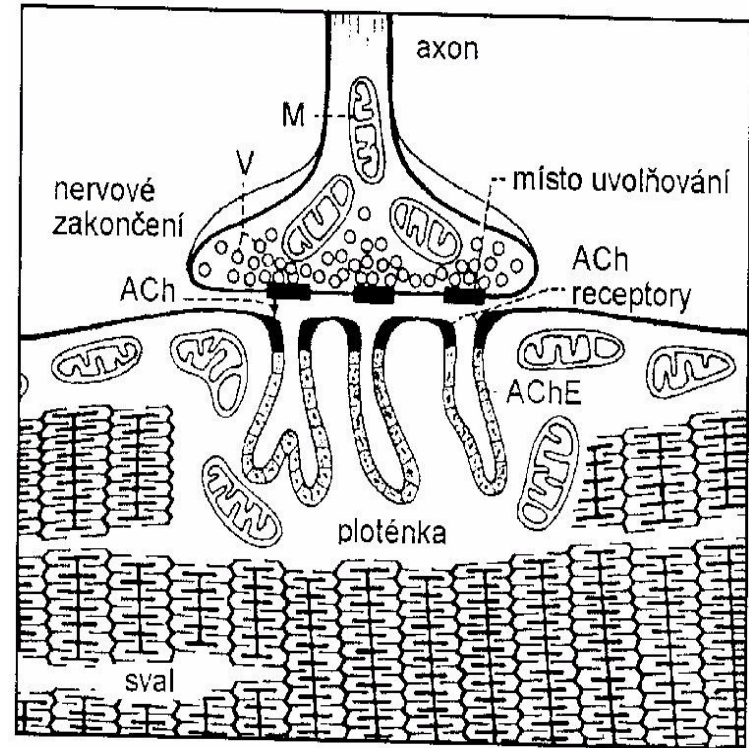
INTERPRETATION: We showed that the use of neuromuscular blocking drugs in general anaesthesia is associated with an increased risk of postoperative pulmonary complications. Anaesthetists must balance the potential benefits of neuromuscular blockade against the increased risk of postoperative pulmonary complications.

FUNDING: European Society of Anaesthesiology.

Svalová relaxancia

- mechanismus účinku

- **depolarizující blok**
agonistická depolarizace +
obsazení receptoru
antagonizace nemožná
- **nedepolarizující blok**
antagonismus ACh
antagonizace bloku možná



Svalová relaxancia

- depolarizující SCH
- nedepolarizující
 - steroidy
 - pancuronium (Pavulon)
 - pipecuronium (Arduan)
 - vecuronium (Norcuron)
 - rocuronium (Esmeron)
 - benzylisochinoliny

Svalová relaxancia

- depolarizující SCH
- nedepolarizující
 - steroidy
 - benzyliochinoliny
 - atrakurium (Tracrium)
 - cis-atrakurium (Nimbex)
 - mivacurium (Mivacron)

Dávky dle Lean Body Weight

Green-Duffull formula (15)

$$LBW_{\text{male}} = 1.1 \times TBW - 0.0128 \times BMI \times TBW$$

$$LBW_{\text{female}} = 1.07 \times TBW - 0.0148 \times BMI \times TBW$$

James formula (16)

$$LBW_{\text{male}} = (1.1 \times TBW) - 128 \times (TBW/H)^2$$

$$LBW_{\text{female}} = (1.07 \times TBW) - 1.48 \times (TBW/H)^2$$

Janmahasatian-Duffull formula (14)

$$LBW_{\text{men}} = (9270 \times TBW) / [6680 + (216 \times BMI)]$$

$$LBW_{\text{female}} = (9270 \times TBW) / [8780 + (244 \times BMI)]$$

$$ABW = LBW + (f^* \times (TBW - LBW)) \quad \text{Adjusted BW}$$

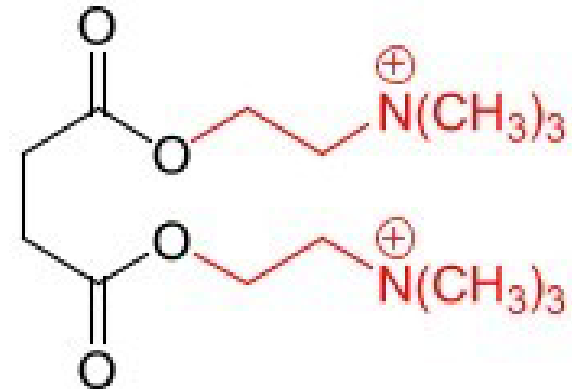
$$IBW_{\text{male}} = 49.9 + 0.89 \times (100H - 152.4)$$

$$IBW_{\text{female}} = 45.4 + 0.89 \times (100H - 152.4)$$

$IBW = 23 \times (\text{výška v m})^2$, kde 23 je ideální Body Mass Index

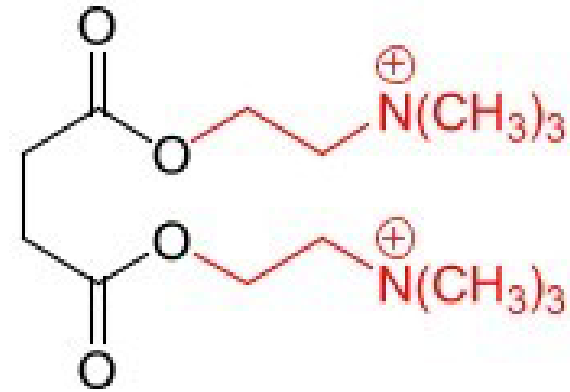
Succinylcholin

-jodid, -chlorid



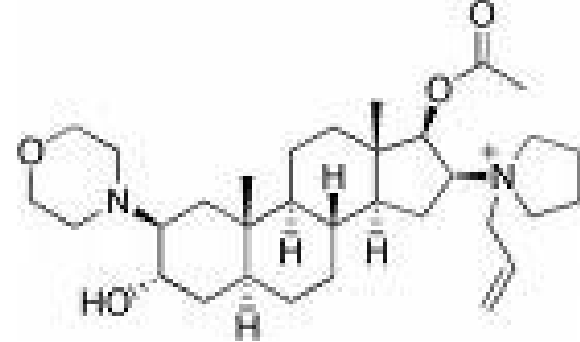
- depolarizující svalové relaxans s krátkým účinkem (5-10 min)
- k intubaci, zejména k bleskové intubaci
- metabolismus: plazmatická cholinesteráza
- nástup účinku do 30-60 s (fascikulace)
- dávka: 1 mg/kg i.v., výjimečně v infúzi

Succinylcholin -jodid, -chlorid



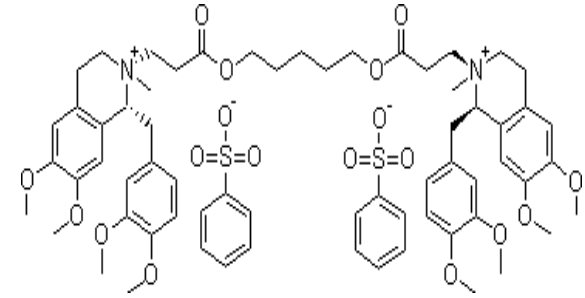
- bradykardie
- anafylaxe: 1:5-10 000
- fascikulace a svalová bolest
 - intragastrický tlak: ↑, ale > ↑ i tonus jícnového svěrače
 - intrakraniální tlak: stoupá, sníženo prekurarizací
 - nitrooční tlak: stoupá o 5-15 mm Hg, intraokulární úč. (přítomen i po odpojení očních svalů)
- hyperkalemie
- spouštěč maligní hypertermie

Rocuronium (Esmeron)



- nedepolarizující svalové relaxans steroidního typu s rychlým nástupem a středně dlouhým účinkem (20-40 min)
- k intubaci a ke svalové relaxaci během operace
- oběhově stabilní
- uptake do jater, redistribuce, eliminace močí a žlučí, mtb na 17-deacetylrocuronium min. význam
- dávka k intubaci: 0,6 mg/kg **lean body weight**
- dávka k udržování relaxace: 0,15 mg/kg
- kapnoperitoneum může prodlužovat účinek snížením hepatic blood flow

Cisatracurium (Nimbex)



- nedepolarizující svalové relaxans benzylochinolinového typu se středně dlouhým účinkem (20-30 min)
- Hofmannova eliminace
- nižší uvolnění histaminu než Tracrium
- dávka k intubaci 0,15 mg/kg i.v. **LBW**
- dávka k udržování relaxace: 0,03 mg/kg

Hloubka blokády

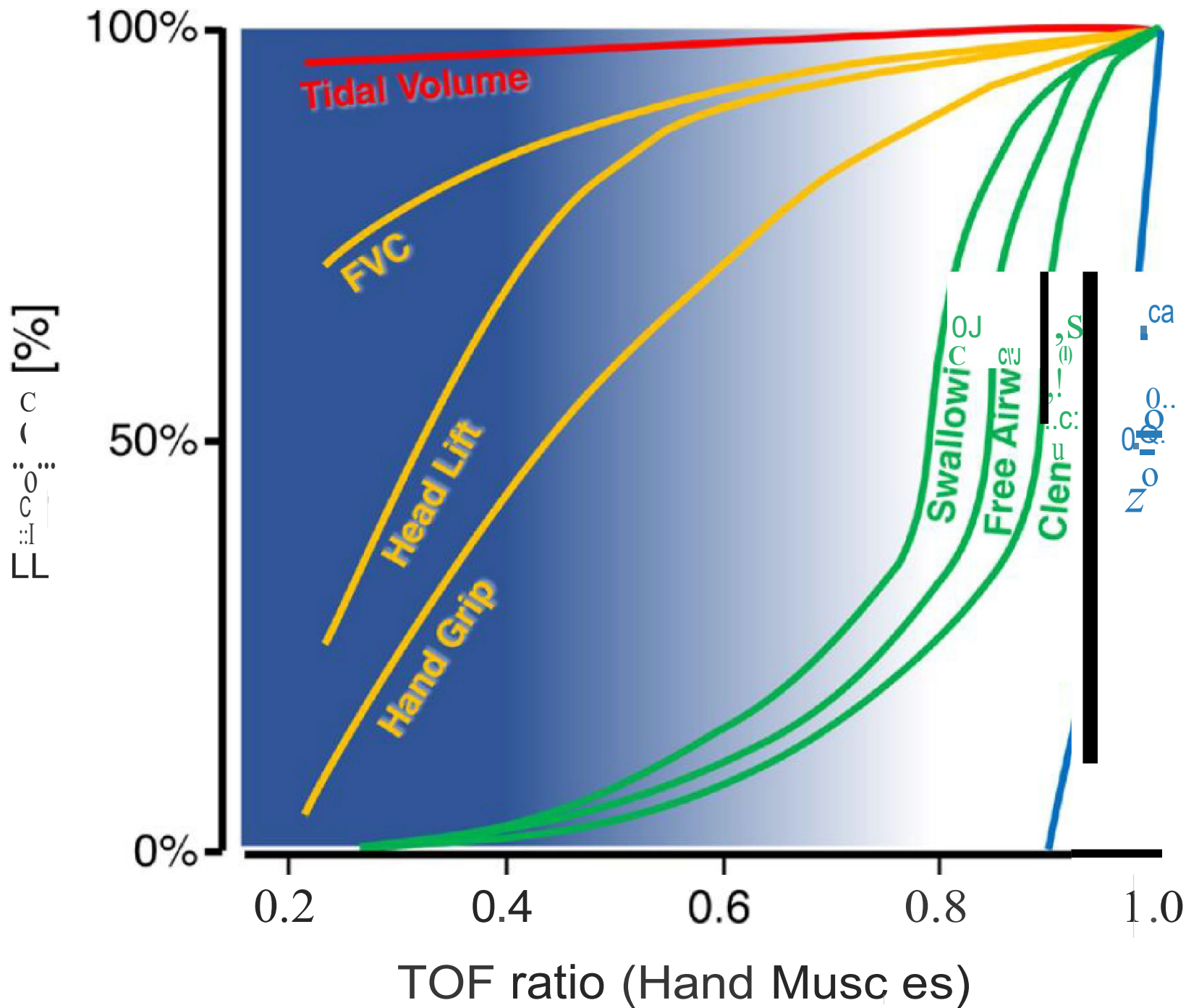
Table 3. Qualitative and Quantitative Observations With TOF Stimulation of Peripheral Nerves to Assess the Level of Neuromuscular Blockade

Block depth	Qualitative (subjective) NMB monitoring		Quantitative (objective) NMB monitoring		
	TOF count	PTC	TOF count	TOF ratio	PTC
Profound	0	0	0	-	0
Deep	0	≥1	0	-	≥1
Moderate	1-3	-	1-3	-	-
Shallow	4, fade detectable	-	4	0.1-0.4	-
Minimal	4, fade not detectable	-	4	0.4-0.9	-
Acceptable recovery	Cannot be distinguished from minimal blockade	-	4	>0.9	-

Adapted from Naguib et al.²

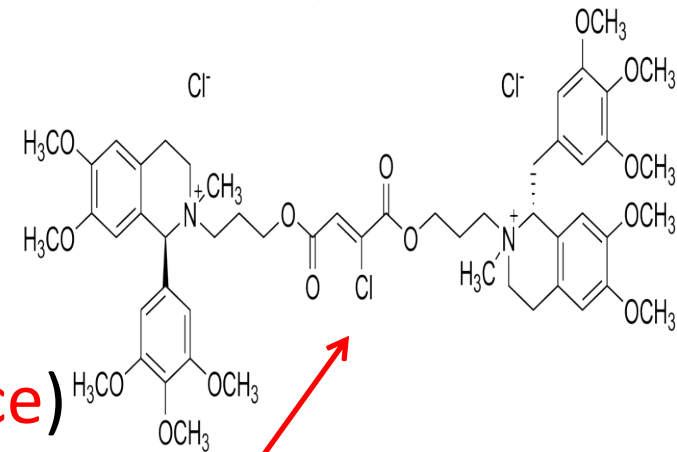
Abbreviations: NMB, neuromuscular blockade; PTC, posttetanic count; TOF, train-of-four.

Anesth Analg. 2022 Jul 1;135(1):39-48. doi:
10.1213/ANE.00000000000005925



Antagonizace svalových relaxancií

- pokračovat v UPV
- farmakologická dekurarizace atropin + neostigmin
 - jediná možnost u benzylochinolinů
- suggamadex (Bridion, **enkapsulace**)
 - rocuronium, méně vecuronium
 - problém: toremifen, flucloxacillin, fusidic acid
- cystein (nahradí Cl^- , **chemoinaktivace**)
 - chlorofumaráty: gantacurium (ultra-krátký < 10 min), CW002, CW011
- calabadion (enkapsulace)
 - aminosteroidy i benzylochinoliny (i LA)



Calabadiion 2-rocuronium

Cucurbit[n]uril family of molecular containers

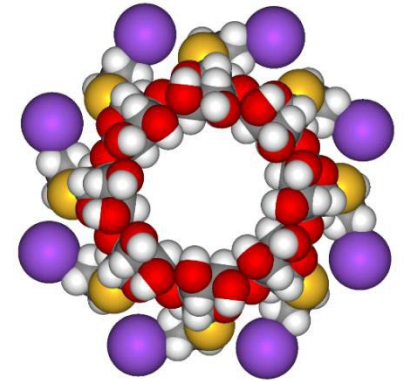
central methylene-bridged glycoluril tetramer capped by two *o*-xylylene rings.

Farmakologická dekurarizace

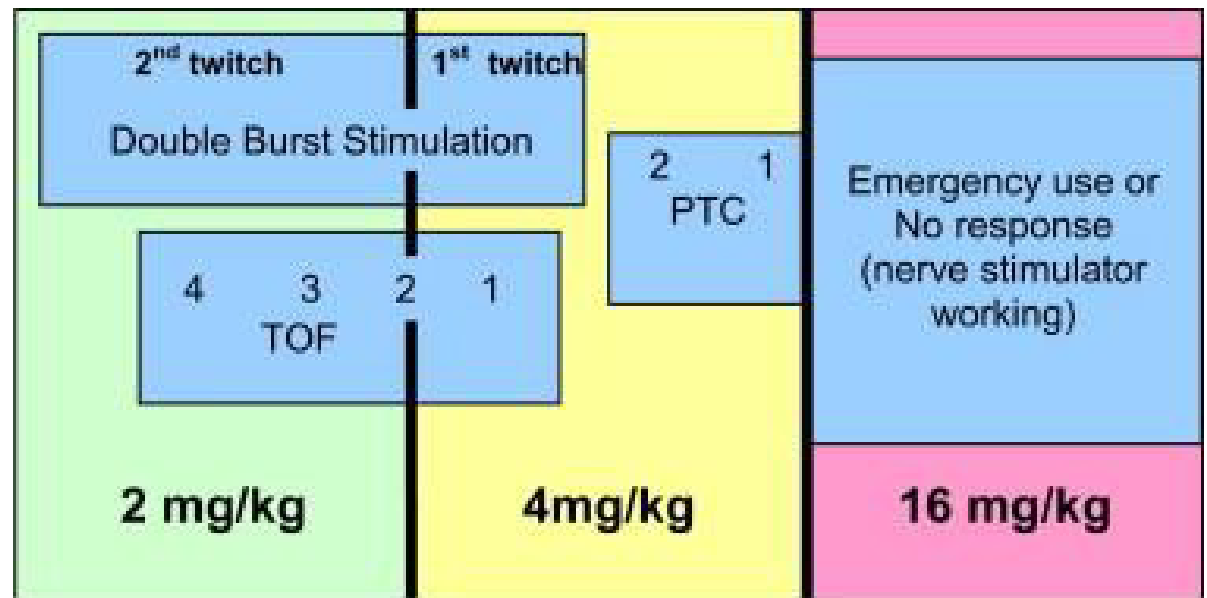
Atropin (atropin) + Syntostigmin (neostigmin)

- neostigmin = Psymimetikum blokující cholinesterázu
- indikace: přetrvávající účinek **nedep.** relaxancí při $\text{TOF} \geq 2$
- dávky:
 - Atropin 0,5-1,0 mg i.v.
 - Syntostigmin obv. 0,5-2,5 mg i. v.
(0,02-**0,035-0,05**-0,07 mg/kg, efekt stropu)
- CAVE:
neostigmine-induced neuromuscular weakness

Suggamadex (Bridion)



sugar-gamma-cyklodextrin



If 2nd twitch of DBS or at least 2nd twitch of TOF count is present: *Dose= 2mg/kg*

If any other response from nerve stimulation: *Dose= 4mg/kg*

For emergency use or no response from working nerve stimulator: *Dose=16mg/kg*

Doporučení k antagonizaci SR

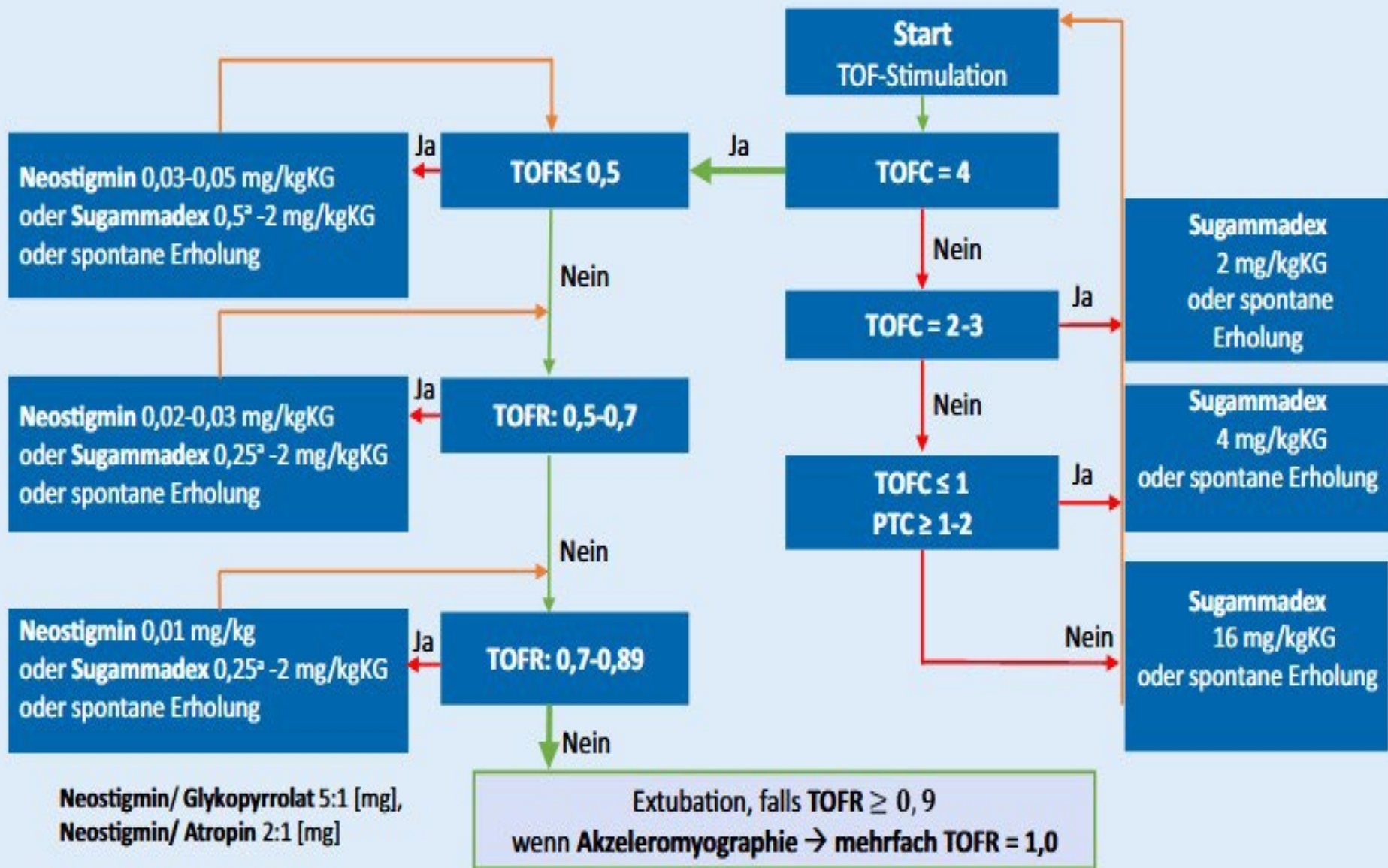
Recommendations for Pharmacologic Antagonism of Nondepolarizing Blockade According to the Depth of Block

Depth of Block	Neostigmine Dose (mg/kg)	Sugammadex Dose* (mg/kg)
Posttetanic count < 2	Delay reversal	4-16†
Posttetanic count ≥ 2	Delay reversal	2-4†
TOF count 0-1		
TOF count 2-4	0.05-0.07	1.0-2.0†
TOF with fade by tactile or visual means		
TOF < 0.40‡		
TOF count 4, no tactile or visual fade	0.02-0.03	0.25-0.5†
TOF = 0.40-0.90‡		
TOF ratio ≥ 0.90‡	Reversal unnecessary	Reversal unnecessary

*Dose ranges reported in the literature; cited doses may deviate from package insert recommendations. †When reversing vecuronium, use higher end of dosing range. ‡TOF ratio confirmed by quantitative monitoring.

TOF = train-of-four.

Brull SJ, Kopman AF.: Current Status of Neuromuscular Reversal and Monitoring: Challenges and Opportunities. *Anesthesiology*. **2017** Jan;126(1):173-190



Algorithm-based preventive strategies for avoidance of residual neuromuscular blocks. Unterbuchner C, Eehalt K, Graf B. Anaesthesist. 2019 Nov;68(11):744-754.

Incidence, risk factors, and consequences of residual neuromuscular block in the United States: The prospective, observational multicenter RECLIFEJUS study.

Saaqer L¹, Alaie S^{EM2}, Bash LD², Ieyer T³, Minkowicz H, Grudine S, Philip Bi, Tanaka P⁷, Gan TJ⁸, Rodriguez-Glanco V⁹, Soto R¹⁰, Heisel O¹¹.

STUDY OBJECTIVE: To determine the incidence burden and associated risk factors of residual neuromuscular block (rNMB) during routine U.S. hospital care.

DESIGN: Blinded multicenter cohort study.

SETTING: Operating and recovery rooms of ten community and academic U.S. hospitals.

PATIENTS Two-hundred fifty-five adults, ASA PS 1-3, underwent elective abdominal surgery with general anesthesia and 2:1 dose of non-depolarizing neuromuscular blocking agent (NMBA) for endotracheal intubation and/or maintenance of NMB between August 2012 and April 2013.

MAIN RESULTS: Most of the study population, 64.7% (n = 165) had rNMB (TOF ratio < 0.9) among them, 31.0% with TOF ratio < 0.6. Among those receiving neostigmine and/or qualitative peripheral nerve stimulation per clinical decision, 65.0% had rNMB. After controlling for confounders, we observed male gender (odds ratio: 2.60, P = 0.008), higher BMI (odds ratio: 1.04/unit, P = 0.043), and surgery at a community hospital (odds ratio: 3.15, P = 0.005) to be independently associated with increased odds of rNMB.

CONCLUSIONS: Assessing TOF ratios blinded to the care team, we found that the majority of patients (64.7%) in this study had rNMB at tracheal extubation, despite neostigmine administration and qualitative peripheral nerve stimulation used for routine clinical care. Qualitative neuromuscular monitoring and clinical judgement often fails to detect rNMB after neostigmine reversal with potential severe consequences to the patient. Our data suggests that clinical care could be improved by considering quantitative neuromuscular monitoring for routine care.

Tři nežádoucí účinky reziduální kurarizace

1. omezení ventilace

2. horní dýchací cesty:

– omezení polykání → riziko aspirace

– zvýšená tendence horních DC kolabovat **i při TOF 1,0!**

Herbstreit F et al.: Impaired upper airway integrity by residual neuromuscular blockade: increased airway collapsibility and blunted genioglossus muscle activity in response to negative pharyngeal pressure. *Anesthesiology*. 2009 Jun;110(6):1253-60.

3. snížení citlivosti karotických tělísek na hypoxii

Jonsson M et al.: Neuromuscular blocking agents block carotid body neuronal nicotinic acetylcholine receptors. *Eur J Pharmacol*. 2004 Aug 23;497(2):173-80.

STANOVISKO K PŘÍSTROJOVÉ MONITORACI HLOUBKY NERVOSVALOVÉ BLOKÁDY

www.csarim.cz

8.4.2017

- 1) Zásadní podmínkou bezpečného podávání svalových relaxancií (SR) v anestezii a/nebo intenzivní péči je přístrojová monitorace hloubky nervosvalové blokády (NSB). V důsledku vysoké variability délky účinku SR nelze zaručit plné zotavení z jejich účinku ani po uplynutí určitého intervalu od jejich podání a neexistuje žádné klinické vyšetření, které spolehlivě posoudí aktuální míru zotavení z NSB. Nedostatečné zotavení z NSB je spojeno s komplikacemi a tím i vyšší morbiditou pacientů.
- 2) Výbor České společnosti anesteziologie, resuscitace a intenzivní medicíny (ČSARIM) doporučuje, aby účinek každého podání SR byl přístrojově monitorován, pokud to přístrojové vybavení pracoviště umožňuje.
- 3) Výbor ČSARIM doporučuje, aby součástí specifikace v zadávací dokumentaci požadavku na pořízení nového anesteziologického přístroje či vybavení pracoviště byla možnost přístrojově, objektivně a kvantitativně monitorovat hloubku NSB.
- 4) Výbor ČSARIM doporučuje dovybavení každého pracoviště dostatečným počtem přístrojů/modulů pro monitoraci hloubky NSB v co nejkratší možné době.

ZÁAD BEZPEČNÉ ANESTEZIOLOGIE PÉČE DOPORUČENÍ CE POSTUP

www.csarim.cz

Česká společnost anesteziologie resuscitace a intenzivní úlédíí (ČSARIV.1) CLS JEP
D0 0 0111č11v oostuo bvI schválen na iedná ú v boru CSARIV.1 dne 6.]2.2017

3.3 11011prováin] : p.r 1bell anes.ezie

6.12.2017

3.3.2

V p:1ulběbu anestezie jsou m:ritol·ovány (kontinuáhlě nebo v pravidelných pñ"ianěř"ených
intelvecb podle povahy operačn ího ci di ag n.o sti ckého v ý k o n u sledovaného pa:ranfletru a
tavu pacienta) následující základní ulrazatefile:

a) E K G

b) :l'ďeční .fre kv en ce

c) l'rev:ní dak (neinvazivní Inetoda ,

d) .aturace henJtoglob:inu ky líkenJt Inetodou pulzní oxylnetlie

e) dechová fire kv en ce spontánne dýchajících pac ile n tů ,

f) nastavení ventilátont

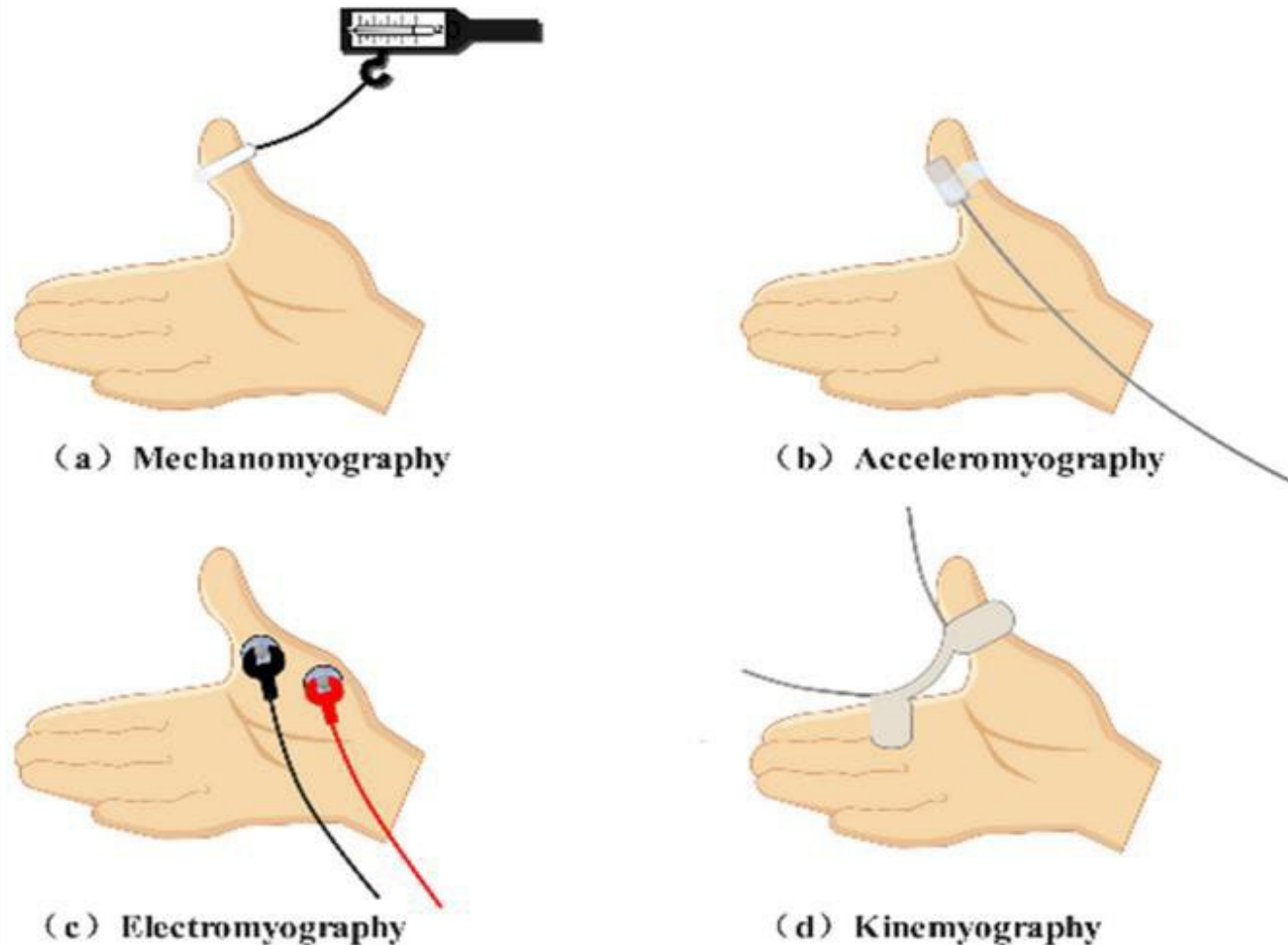
g) tělesná teplota (**u** novorozenců a kojencu vždy u dospělých a dětí **u** výkonu p:edpo
kladein doby trvámí nad 30 1nilnut

b) kapnometlie (u vseh výkonu kde jsou zajilštěny dýchací cesty tn cheální
nhllbac t:r;lc h eo sto ln íí lary_n: eáhtl maskou nebo jmousupra glo tickou polnůckou

i) hloubka nelvosvalo vé blo křidy (NSB
sv alo vý ch Telaxancií.

Poznámka: Neexistuje žádné klinické vyšetietú. ktei-é sp olehli ,, ěposoudí ak máhú m:ini zotaveni z NSB_ K monitoraci
hloubky n,ecv os ,rafo vé blo kády dopm:-učujeme použití někte:i:é z p:ř' t:cojo,-.-ých o bj ek rivn.ích kvantitativních m.etod (např.
akoelernmetrické hodln.o en í TOF nebo PTC)_ Po.žadk v ek . monito:race NSB je závazný pii dostupno ri potřebn ě h o
pfi strojovéhovybavení_ Výbor ČSARIM předpokládá přechodné období loužici k zajištění potiebneho pñs tmjo véh o
vy1baven í v trvání n,ejdále tří let od zveřejnění DopOlllč-e.n.ého postupu [23]. (TOF = trnin of four PTC = p ost-tetani e
cou.nt)

Figure 1. Typical neuromuscular monitoring patterns. (a) Mechanismography directly measures the force generated by the skeletal muscle. (b) Acceleromyography evaluates acceleration yielded by muscle contraction. (c) Electromyography records compound action potentials from the skeletal muscle. (d) Kinemyography employs a piezoelectric crystal to reflect muscle contraction.



Zlatý standard monitorování NSB

stimulace n. ulnaris → m. adductor pollicis



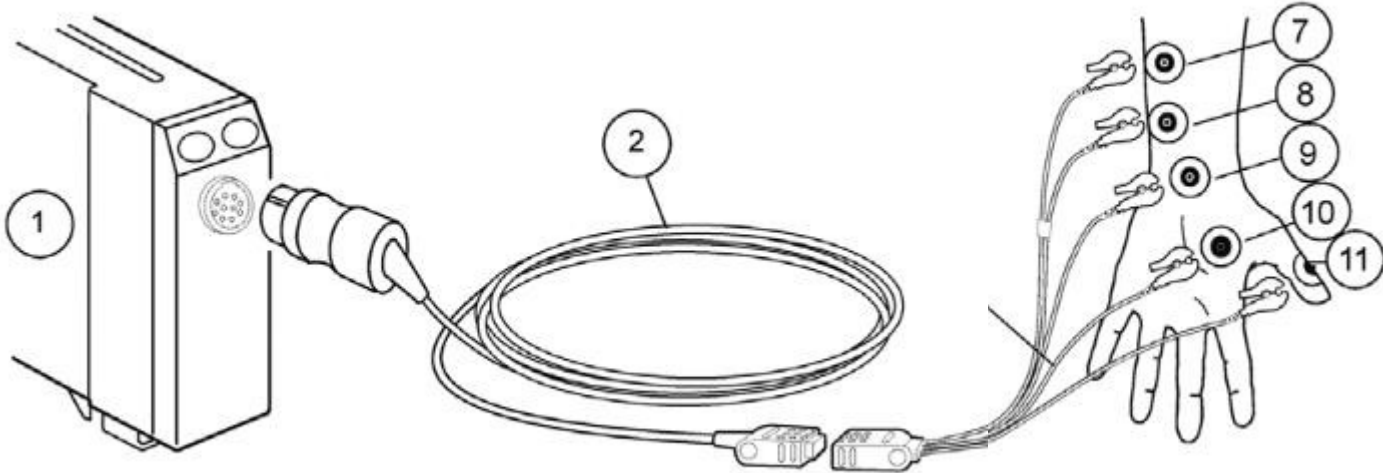
akceleromyografie – měří zrychlení

kinemyografie – využívá piezoelektrický efekt



Neuromuscular Transmission

ElectroSensor



Proč monitorovat NSB?

- úvod do anestezie – načasování intubace
- vedení anestezie – dostatečná chirurgická relaxace
- ukončení anestezie – **vyloučení reziduální kurarizace!**
 - načasování dekurarizace při užití syntostigminu
 - načasování extubace
 - bezpečnost po extubaci



Pro-Con Debate: Do We Need Quantitative Neuromuscular Monitoring in the Era of Sugammadex?

Manfred Blobner, MD,*† Markus W. Hollmann, MD, PhD, DEAA,‡ Markus M. Luedi, MD, MBA,§ and Ken B. Johnson, MD||

See Article, page 35

In this Pro-Con article, we debate the merits of using quantitative neuromuscular blockade monitoring. Consensus guidelines recommend their use to guide the administration of nondepolarizing neuromuscular blockade and reversal agents. A major impediment to this guideline is that until recently, reliable quantitative neuromuscular blockade monitors have not been widely available. Without them, anesthesia providers have been trained with and are adept at using a variety of qualitative neuromuscular blockade monitors otherwise known as peripheral nerve stimulators. Although perhaps less accurate, anesthesia providers find them reliable and easy to use. They have a long track record of using them with the perception that their use leads to effective neuromuscular blockade reversal and minimizes clinically significant adverse events from residual neuromuscular blockade. In the recent past, 2 disruptive developments have called upon anesthesia care providers to reconsider their practice in neuromuscular blockade administration, reversal, and monitoring. These include: (1) commercialization of more reliable quantitative neuromuscular monitors and (2) widespread use of sugammadex, a versatile reversal agent of neuromuscular blockade. Sugammadex appears to be so effective at rapidly and effectively reversing even the deepest of neuromuscular blockades, and it has left anesthesia providers wondering whether quantitative monitoring is indeed necessary or whether conventional, familiar, and less expensive qualitative monitoring will suffice? This Pro-Con debate will contrast anesthesia provider perceptions with evidence surrounding the use of quantitative neuromuscular blockade monitors to explore whether quantitative neuromuscular monitoring (NMM) is just another technology solution looking for a problem or a significant advance in NMM that will improve patient safety and outcomes. (Anesth Analg 2022;135:39–48)

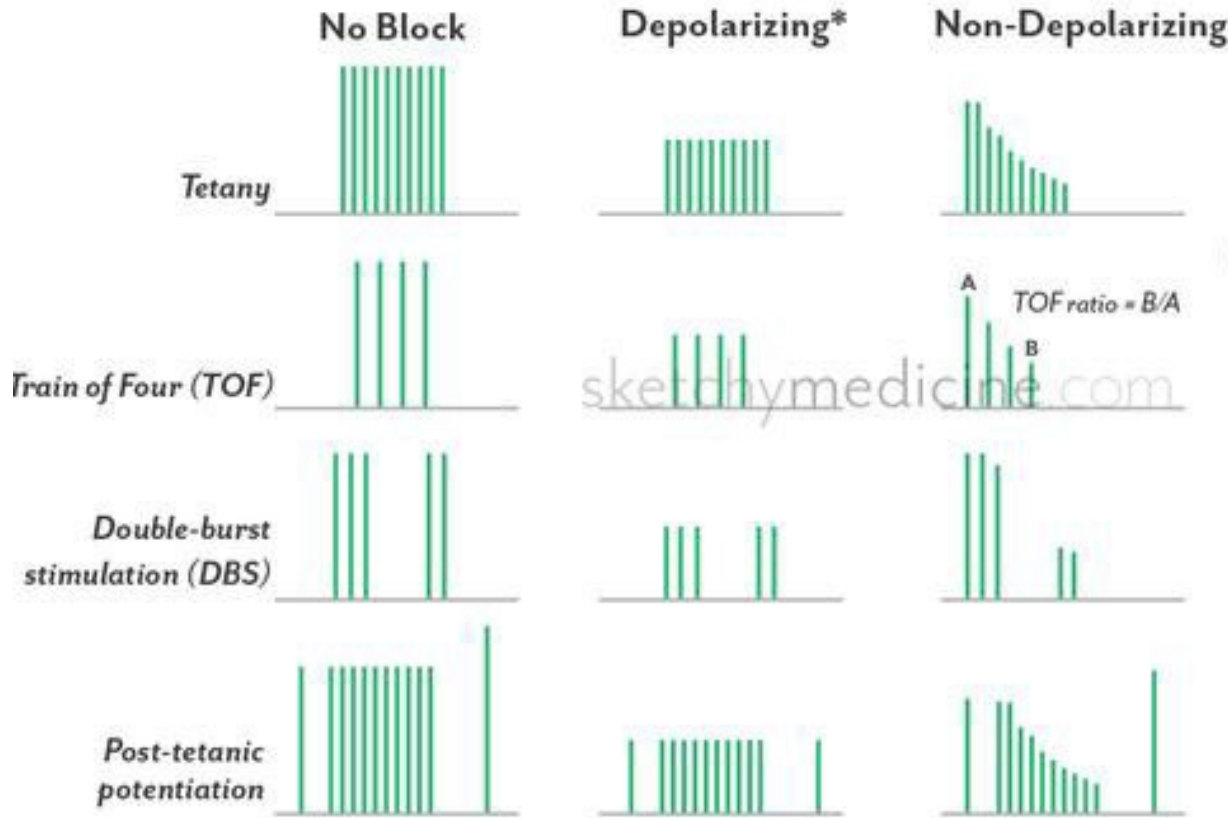
GLOSSARY

AMG = acceleromyography; **EMG** = electromyography; **FVC** = forced vital capacity; **NMB** = neuromuscular blockade; **NMM** = neuromuscular monitor; **PNS** = peripheral nerve stimulator; **POPULAR** = postanaesthesia pulmonary complications after use of muscle relaxants; **PTC** = posttetanic count; **PTC** = posttetanic count; **TOF** = train-of-four; **TOFc** = train-of-four count; **TOFr** = train-of-four ratio

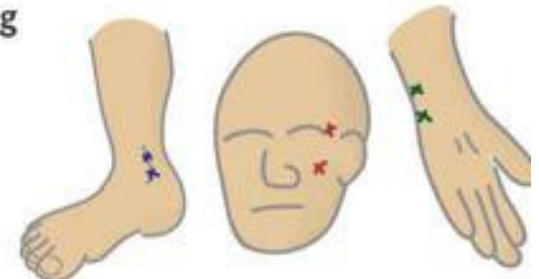
Anesth Analg. 2022 Jul 1;135(1):39-48.
doi: 10.1213/ANE.0000000000005925

Režimy monitorování

Neuromuscular Blockade



*Phase I depolarizing block. Phase II blockade behaves like a non-depolarizing block.



Common Monitoring Sites

Ulnar nerve

Adductor pollicis
• Adducts thumb

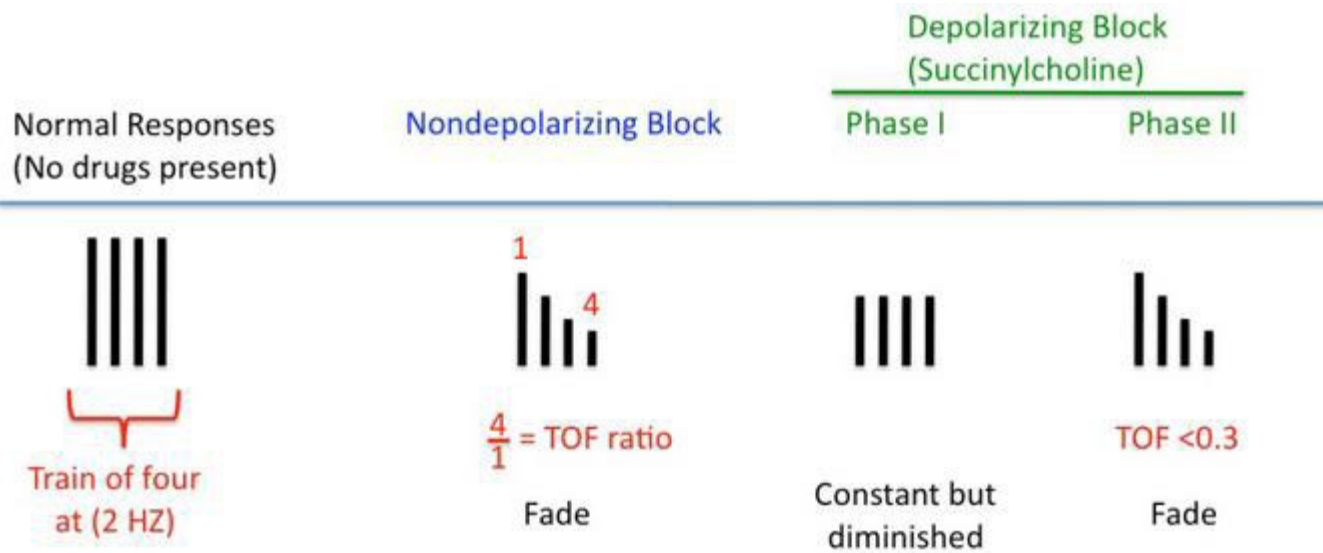
Facial nerve (CN VII)

Orbicularis oculi
• Closes eyelid
Corrugator supercilii
• Furrows brow

Posterior tibial nerve

Flexor hallucis brevis
• Flexes big toe

Train-of-Four



Common TOF Guidelines:

TOF 0.15-0.25: indicates adequate surgical relaxation

TOF >0.9: needed for safe extubation & recovery after surgery

Co dělat, když nelze monitorovat na palci?

1. nemonitorovat vůbec
2. nepoužít svalová relaxancia
3. použít rocuronium a podat sugammadex
4. je-li důvodem nemožnost přístupu k ruce:
 - „smlouvat“ s chirurgem o poloze ruky
 - „chránit“ ruku pod rouškami
5. monitorovat jinde než na ruce, ale:
 - uvědomovat si odlišnosti
 - uvážit důvod monitorace (intubace, peroperační blok, PORC)
6. monitorovat NSB jinak
 - EMG
 - EMG z počítačem zpracovaného EEG (BIS, entropie, PSI aj.)

Avoidance versus use of neuromuscular blocking agents for improving conditions during tracheal intubation or direct laryngoscopy in adults and adolescents.

Lundstrøm LH, Duez CH, Nørskov AK, Rosenstock CV, Thomsen JL, Møller AM, Strande S, Wetterslev J.

Cochrane Database Syst Rev. **2017 May 17**;5:CD009237.

doi: 10.1002/14651858.CD009237.pub2.



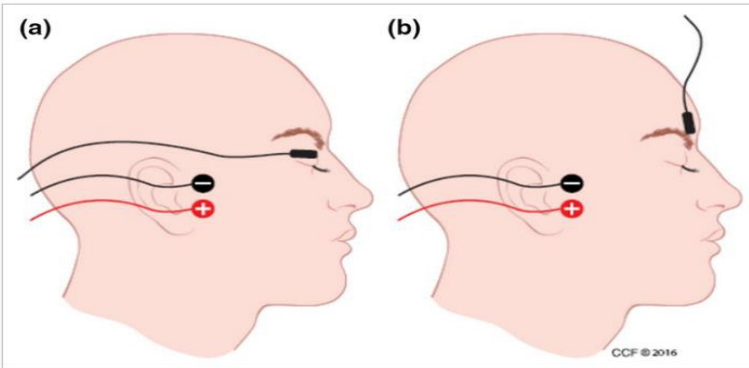
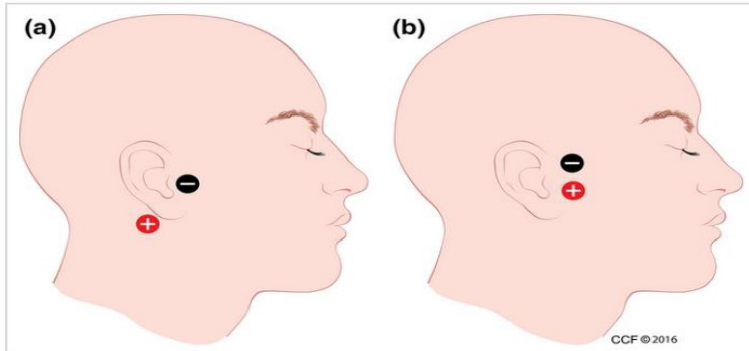
Cochrane
Library

Cochrane Database of Systematic Reviews

BACKGROUND: Tracheal intubation during induction of general anaesthesia is a vital procedure performed to secure a patient's airway. Several studies have identified difficult tracheal intubation (DTI) or failed tracheal intubation as one of the major contributors to anaesthesia-related mortality and morbidity. Use of neuromuscular blocking agents (NMBA) to facilitate tracheal intubation is a widely accepted practice. However, because of adverse effects, NMBA may be undesirable. Cohort studies have indicated that avoiding NMBA is an independent risk factor for difficult and failed tracheal intubation. However, no systematic review of randomized trials has evaluated conditions for tracheal intubation, possible adverse effects, and postoperative discomfort.

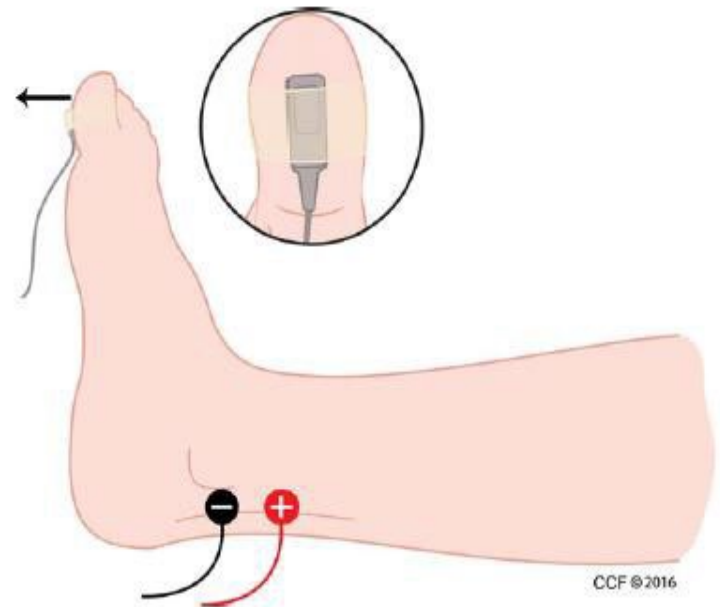
AUTHORS' CONCLUSIONS: This review supports that use of an NMBA may create the best conditions for tracheal intubation and may reduce the risk of upper airway discomfort or injury following tracheal intubation. Study results were characterized by indirectness, heterogeneity, and high or uncertain risk of bias concerning our primary outcome describing difficult tracheal intubation. Therefore, we categorized the GRADE classification of quality of evidence as moderate to low. In light of defined outcomes of individual included trials, our primary outcomes may not reflect a situation that many clinicians consider to be an actual difficult tracheal intubation by which the patient's life or health may be threatened.

5. Monitorovat jinde, ale



n. facialis

- m. orbicularis oculi (≈ palec)
- m. corrugator supercilii (≈ larynx)

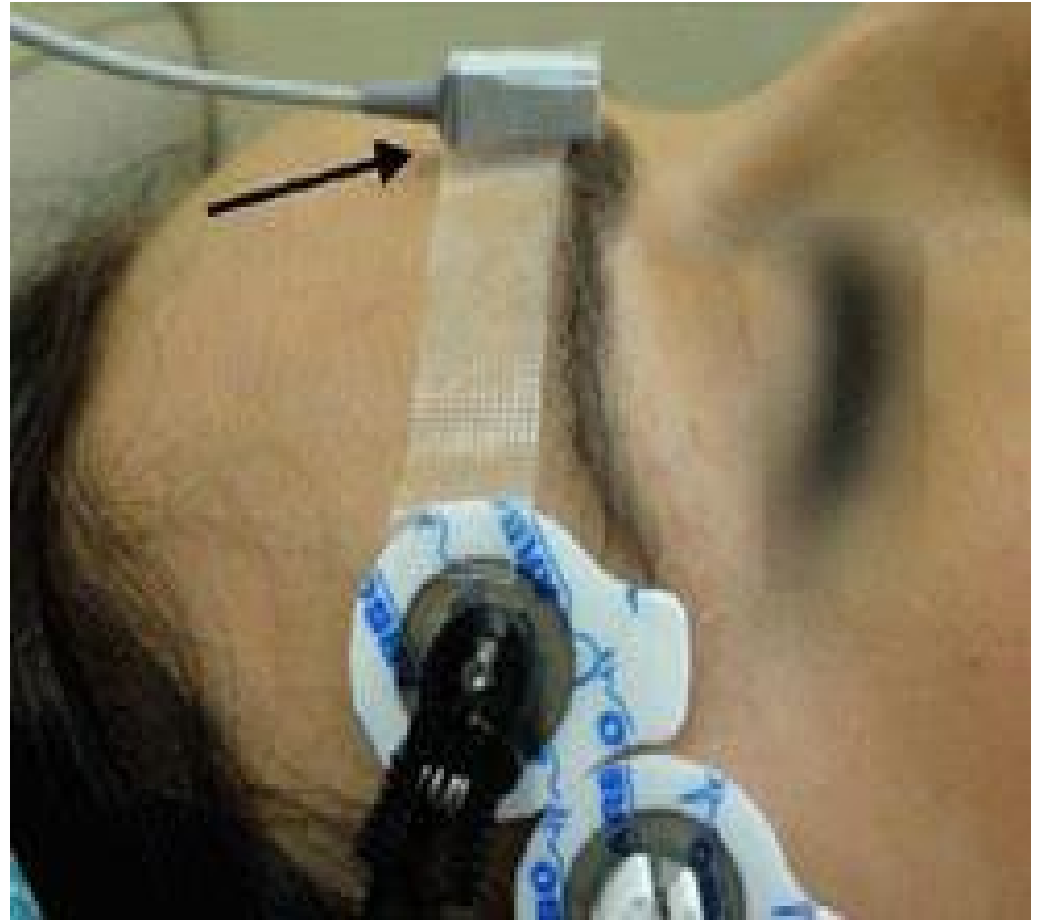


n. ischiadicus

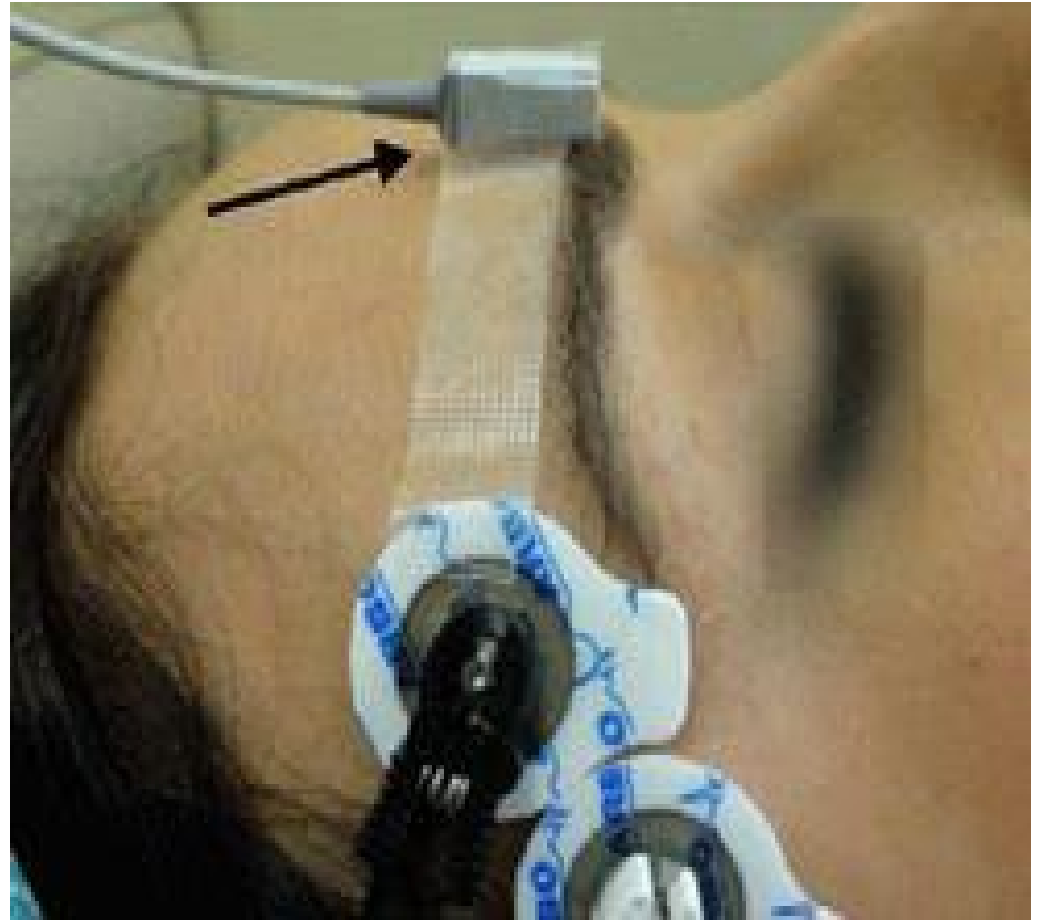
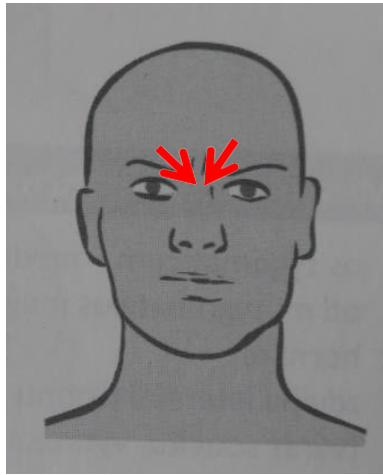
→ n. tibialis post.

→ n. plantaris medialis

→ m. flexor hallucis brevis



n. facialis → m. corrugator supercilii
(sval svrašťovač obočí)



n. facialis → m. corrugator supercilii
(sval svrašťovač obočí)

5. Monitorovat jinde, ale

K vyloučení reziduální kurarizace je **nejbezpečnější** po skončení přemístit monitorování na ruku (n. ulnaris – m. adductor pollicis)!

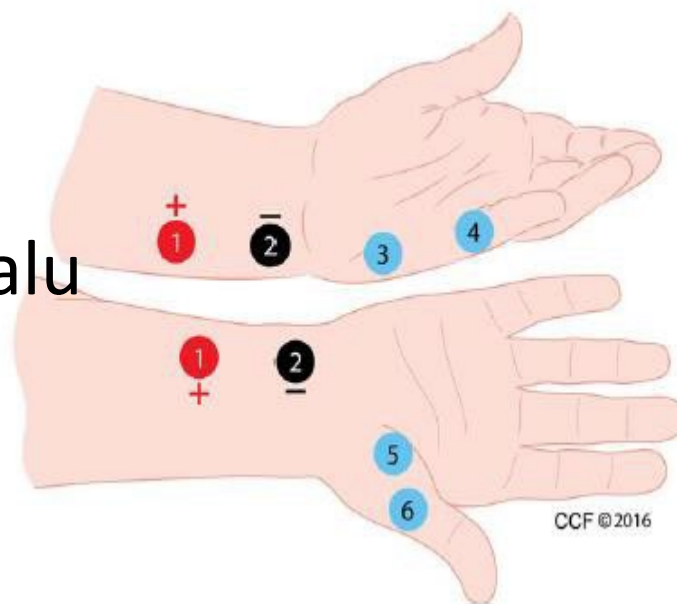
Naguib M, Brull SJ, Johnson KB.: Conceptual and technical insights into the basis of neuromuscular monitoring.

Anaesthesia. 2017 Jan;72 Suppl 1:16-37.

Brull SJ, Kopman AF.: Current Status of Neuromuscular Reversal and Monitoring: Challenges and Opportunities. Anesthesiology. 2017 Jan;126(1):173-190

6. Monitorovat NSB jinak

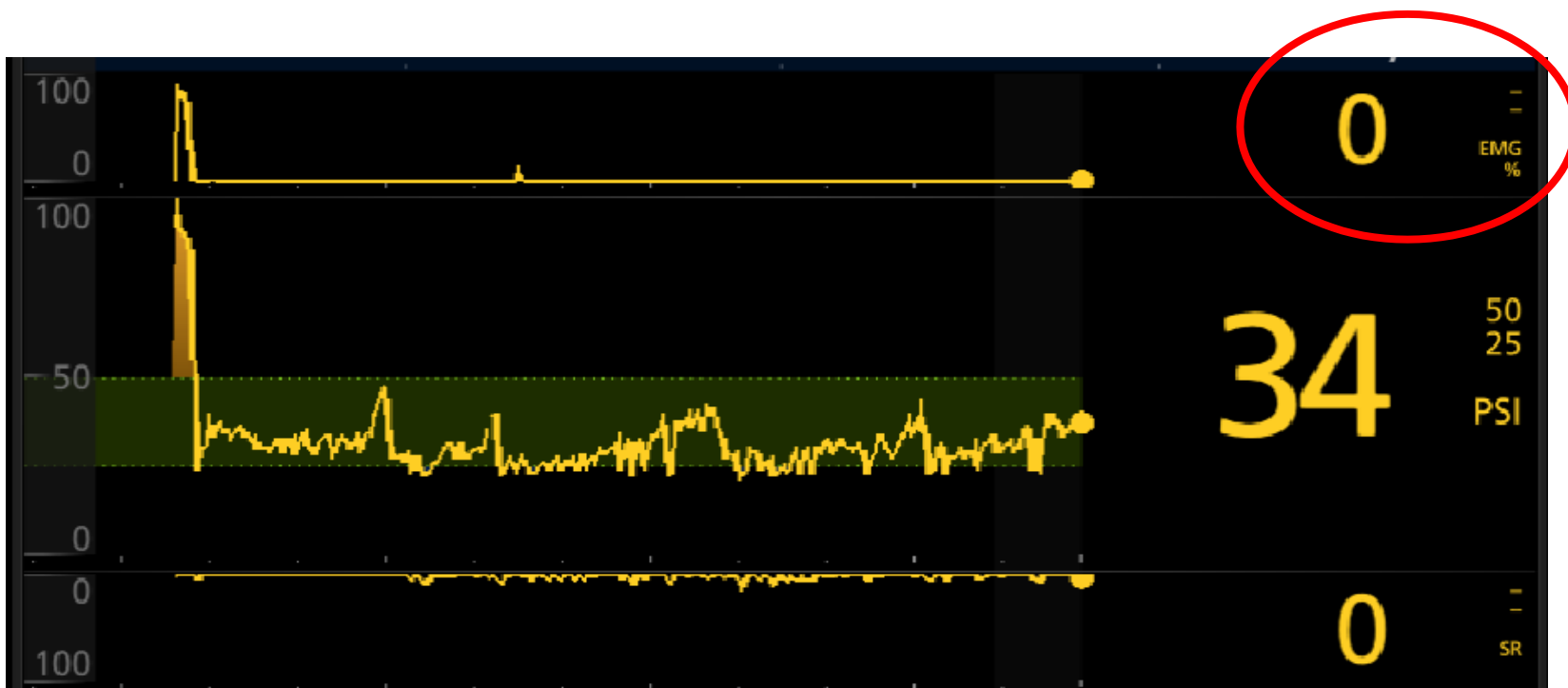
- **elektromyografie**
snímá složený elektrický
potenciál stimulovaného svalu
 - stimulace n. ulnaris
 - snímání:
 - m. abductor digiti minimi 3 a 4
 - m. abductor pollicis 5 a 6



Naguib M, Brull SJ, Johnson KB.: Conceptual and technical insights into the basis of neuromuscular monitoring.
Anaesthesia. 2017 Jan;72 Suppl 1:16-37.

6. Monitorovat NSB jinak

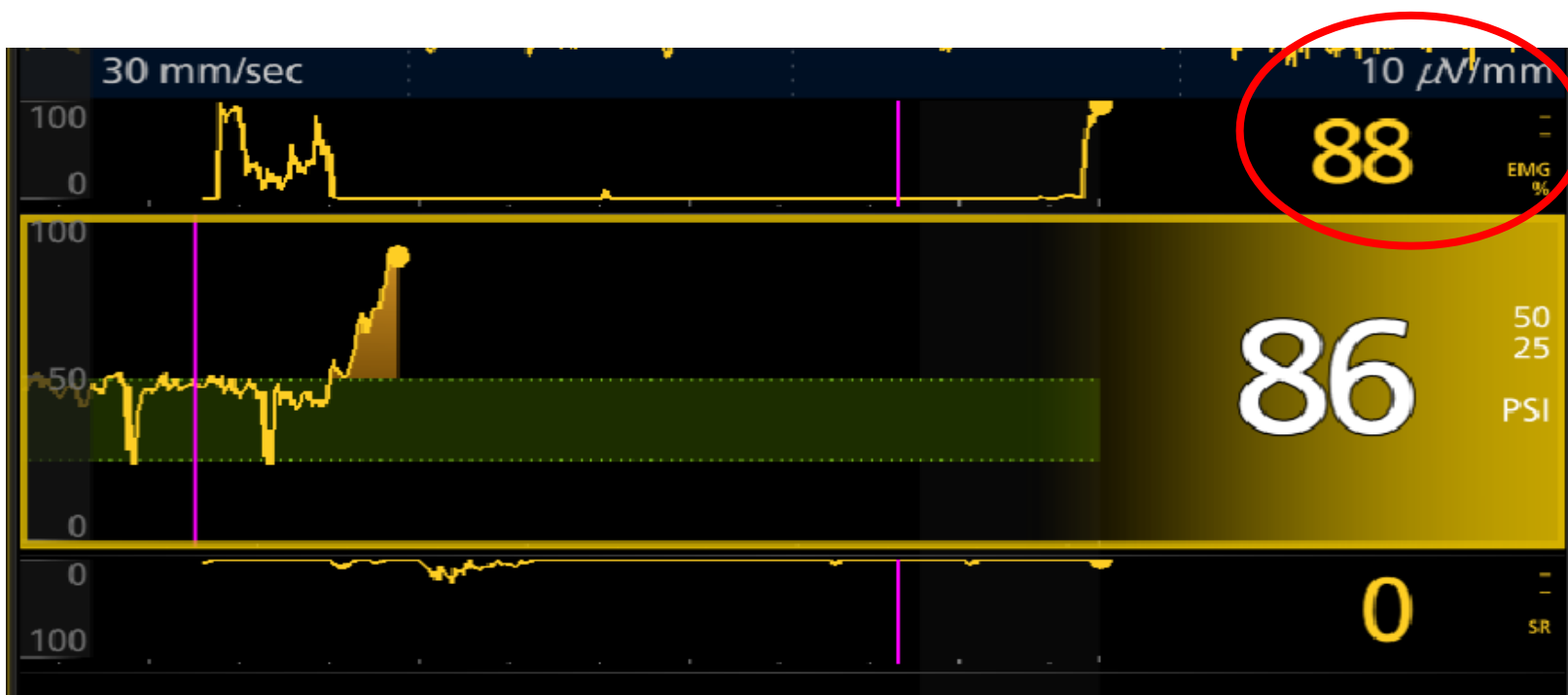
- počítačem zpracované EEG ukazuje EMG



monitor SEDline, aorto-bifemorální bypass 31. 8. 2017

6. Monitorovat NSB jinak

- počítačem zpracované EEG ukazuje EMG



monitor SEDline, 13. 7. 2017

Závěr: Co dělat, když ...?

1. nemonitorovat vůbec (nyní odporuje doporučením)
2. nepoužít svalová relaxancia
3. použít rocuronium a podat sugammadex
- 4. je-li důvodem nemožnost přístupu k ruce:**
 - „smlouvat“ s chirurgem o poloze ruky
 - „chránit“ ruku pod rouškami
- 5. monitorovat během výkonu jinde než na ruce, po operaci pak na ruce**
6. monitorovat NSB jinak
 - EMG
 - EMG z počítačem zpracovaného EEG (BIS, entropie, PSI aj.)

Doporučení

Clinicians should only administer NMBAs when clinically necessary.

If NMBAs are needed intraoperatively:

- the lowest dose required for surgical relaxation should be used,
- the depth of neuromuscular blockade should be monitored
- and NMBA administration should be minimized during the last hour of the procedure.

Murphy GS, Kopman AF.: "To Reverse or Not To Reverse?": The Answer Is Clear!
Anesthesiology **2016 Oct**;125(4):611-4