ASA 2023 Guidelines for Reversing Neuromuscular Blockade

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May 18, 2023

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No Disclosures

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2023 ASA NMB Guidelines can grouped into 2 categories

Categories of 2023 NMB Recommendations

- How to assess depth of neuromuscular blockade
- What to do with the information obtained from the assessment.

Stephan R. Thiles, Wade A. Weigel, Michael M. Todd, Richard P. Dutton, Cynthia A. Lien, Stuart A. Grant, Joseph W. Szokol, Lars I. Eriksson, Myron Yaster, Mark D. Grant, Madhulika Agarkar, Anne M. Marbella, Jaime F. Blasco, Karen B. Domino; 2023 American Society of Anesthesiologists Practice Guidelines for Monitoring and Antagonism of Neuromuscular Blockade: A Report by the American Society of Anesthesiologists Task Force on Neuromuscular Blockade. Anesthesiology 2023; 138:13–41 doi: https://doi.org/10.1097/ALN.0000000000004372

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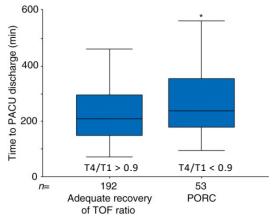
Residual Neuromuscular Blockade is associated with delayed PACU discharge



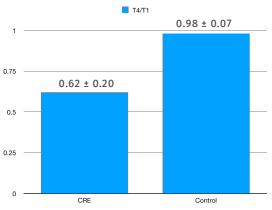
It takes longer for patients with residual NMB to leave the PACU

- Observational Study (n= 246)
- PACU discharge readiness longer (224 min vs 149 min)
- Incidence of residual NMB= 22%.

Butterly A, Bittner EA, George E, Sandberg WS, Eikermann M, Schmidt U. Postoperative residual curarization from intermediate-acting neuromuscular blocking agents delays recovery room discharge. Br J Anaesth. 2010 Sep;105(3):304-9. doi: 10.1093/bja/aeq137. Epub 2010 Jun 24. PMID: 20576622.

4

Critical Respiratory Events in the PACU are associated with residual NMB



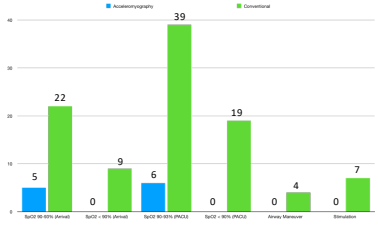
73.8% of cases had TOF ratios < 0.7

- Case Control Study
  - 42 Matched Cases (7459 total)
- Severe Hypoxemia 52% (22/42)
- Airway Obstruction 38% (15/42)

Murphy GS, Szokol JW, Marymont JH, Greenberg SB, Avram MJ, Vender JS. Residual neuromuscular blockade and critical respiratory events in the postanesthesia care unit. Anesth Analg. 2008 Jul;107(1):130-7. doi: 10.1213/ane.0b013e31816d1268. PMID: 18635478.

5

Quantitative Monitoring reduces risk of adverse respiratory events in the PACU



Incidence of significant respiratory events was virtually non-existent in prospective randomized trial of 185 patients.

Higher incidence of:

- SpO2 < 90% (PACU and Arrival)
- Airway Maneuvers
- Stimulation

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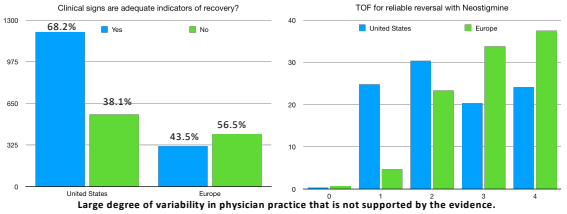
The need for these guidelines has been apparent for over a decade.



Large degree of variability in physician practice that is not supported by the evidence.

Naguib M , Kopman AF , Lien CA , Hunter JM , Lopez A , Brull SJ . A survey of current management of neuromuscular block in the United States and Europe. Anesth Analg. 2010 Jul;111(1):110-9. doi: 10.1213/ANE.0b013e3181c07928. Epub 2009 Nov 12. PMID: 19910616.

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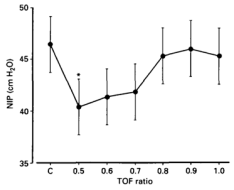
A 5 second head lift does not necessarily indicate T4/T1 > 0.9



7 out of 7 healthy volunteers were able to sustain a head lift at T4/T1 of 0.6

- NIP only showed a significant decrease at T4/T1 of 0.5
- Similar results for other pulmonary tests

El Mikatti N , Wilson A , Pollard BJ , Healy TE . Pulmonary function and head lift during spontaneous recovery from pipecuronium neuromuscular block. Br J Anaesth. 1995 Jan;74(1):16-9. doi: 10.1093/bja/74.1.16. PMID: 7880698.

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Recommendations:

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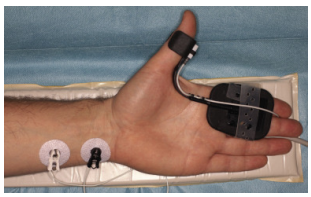
Baseline T4/T1 measurements in Acceleromyography can commonly exceed 1.0 and should be normalized.



Baseline values should be obtained in Acceleromyographic assessments.

- Example: 0.95/1.15 = 0.83
- Baseline > 1.01 may be present in more than half of patients.
- The goal should be a normalized T4/T1 > 0.9

Baykara, N., Hosten, T., Özdamar, D., Ellier, N., Solak, M., & Toker, K. (2010). High Incidence of Residual Curarization After Rocuronium Despite Administration of Neostigmine/Neostigmin Uygulamasına Rağmen Rokuronyum Sonrası Yüksek Rezidüel Kürarizasyon Oranları. *Türkiye Klinikleri. Tıp Bilimleri Dergisi*, 30(4), 1325.

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"Direct evidence from randomized trials that compare confirming or not confirming TOF ratios before extubation are lacking."

Supplemental Table 11. Strength of evidence for train-of-four ratio confirmation prior to extubation.

Outcome	Studies (pts)	Strength of Evidence GRADE	ACCF/AHA	Importance[1]	Summary
Sugammadex					
Residual neuromuscular blockade	21 (1556)	⊕⊕◯◯	B-NR	•••	A lower incidence of residual neuromuscular blockade (TOFR <0.9) was observed in study arms when TOFR ≥0.9 was confirmed prior to extubation. The estimated incidence of residual neuromuscular blockade with confirmation was 0.5 per 100 (95% CI, 0.0 to 6.0); without confirmation 2.2 per 100 (95% CI, 0.5 to 9.0).
Neostigmine					
Residual neuromuscular blockade	16 (1979)	⊕⊕◯◯	B-NR	•••	A lower incidence of residual neuromuscular blockade (TOFR <0.9) was observed in study arms when TOFR ≥0.9 was confirmed prior to extubation. The estimated incidence of residual neuromuscular blockade with confirmation was 5.3 per 100 (95% CI, 2.5 to 10.7); without confirmation 39.8 per 100 (95% CI, 23.5 to 58.8).

GRADE: Grading of Recommendations Assessment, Development and Evaluation; ACCF/AHA: American College of Cardiology Foundation/American Heart Association; TOFR: train-of-four ratio.
GRADE: strength of evidence: ⊕⊕⊕⊕ high, ⊕⊕⊕◯ moderate, ⊕⊕◯◯ low, ⊕◯◯◯ very low.
ACCF/AHA ratings: A: high-quality evidence from more than 1 RCT; B-R: moderate-quality evidence from more than 1 RCT; B-NR: moderate-quality evidence from more than one observational study; C-LD: randomized or non-randomized observational or registry studies with limited data; C-EO: consensus of expert opinion.
• = Limited, •• = Important, ••• = Critical.

- Effects are substantive and clinically meaningful for both neostigmine and sugammadex.

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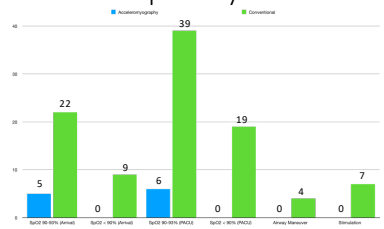

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"Disagreement exists between the degree of paralysis measured at the OO and the AP muscles."

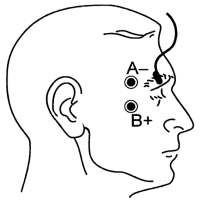

Fig. 1. Positions and polarity of stimulating electrodes and the acceleration transducer.

16 patients with vecuronium induced and neostigmine antagonized NMB

- Orbicularis Oculi had a faster recovery than the Adductor Pollicis

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Residual NMB is lower and recovery is faster with sugammadex compared to neostigmine

Depth of Blockade	Peripheral Nerve Stimulator and Qualitative Assessment	Quantitative Monitor
Complete	Posttetanic count = 0	Posttetanic count = 0
Deep	Posttetanic count ≥ 1; train-of-four count = 0	Posttetanic count ≥ 1; train-of-four count = 0
Moderate	Train-of-four count = 1–3	Train-of-four count = 1–3
Shallow*	Train-of-four count = 4; train-of-four fade present	Train-of-four ratio < 0.4
Minimal*	Train-of-four count = 4; train-of-four fade absent	Train-of-four ratio = 0.4–0.9
Acceptable recovery	Cannot be determined	Train-of-four ratio ≥ 0.9

*The quantitative threshold of train-of-four ratio of 0.4 cannot reliably be subjectively determined by the presence or absence of fade in the train-of-four ratio response. The absence of subjectively appreciated fade has been reported with a train-of-four ratio of less than 0.3, and the presence of fade has been reported with train-of-four ratio of greater than 0.7.[48]

With a peripheral nerve stimulator it is recommended that sugammadex be used if you can detect fade on TOF

- This corresponds to T4/T1 < 0.4
- If TOF has no fade or T4/T1 > 0.4 it is reasonable to use neostigmine.

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This table summarizes the data that supports recommending sugammadex over neostigmine

Outcome	Randomized Controlled Trials	Patients	Strength of Evidence	Effect (95% CI)
Less residual neuromuscular blockade				Risk ratio
Train-of-four ratio < 0.9	8	1,451	Moderate	0.18 (0.07 to 0.42)
				Risk difference
Train-of-four ratio < 0.9	8	1,451	Moderate	-21.6% (-33.8 to -9.4%)
Shorter time to train-of-four ratio ≥ 0.9 from				Mean difference, min
Deep block	4	308	Moderate	-33.6 (-59.3 to -7.9)
Moderate block	17	1,114	Moderate	-10.0 (-12.7 to -7.2)
Shallow block	5	153	Moderate	-3.9 (-6.1 to -1.6)
Minimal block	1	17	Very low	-1.4 (-2.0 to -0.8)

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The recommendations are linked to the strength of the data supporting them.

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Where the data is more robust the use of sugammadex is supported.

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For minimal depth of block there is no evidence to support the use of either sugammadex or neostigmine.

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Outpatient · Office Based · Non-Operating Room
www.SAMBAhq.org

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7. **Neostigmine is a reasonable alternative to sugammadex at minimal depth of neuromuscular blockade.**
8. **For Atracurium and Cisatracurium:**
   a) **Quantitative monitoring: reverse with neostigmine at T4/T1 > 0.4 and confirm recovery to T4/T1 > 0.9 prior to extubation.**
   b) **Qualitative monitoring: Reverse with no detectable fade and then WAIT AT LEAST 10 minutes prior to extubation.**

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The dose of neostigmine when used for minimal depth of NMB should not exceed 40 mcg/kg

Quantitative Assessment

- Give lower doses at T4/T1 > 0.6
  - (15-30 mcg/kg)
- Confirm that adequate reversal was achieved.

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Quantitative Assessment

- Give lower doses at T4/T1 > 0.6
  - (15-30 mcg/kg)
- Confirm that adequate reversal was achieved.

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If adequate reversal is not achieved within 10 minutes of neostigmine administration, it is probably because insufficient time was given for spontaneous recovery.

Options:

- Wait for spontaneous recovery
- Give sugammadex
- Give additional neostigmine up to total dose of 50 mcg/kg

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Quantitative Assessment

- Give lower doses at T4/T1 > 0.6
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- Confirm that adequate reversal was achieved.

Qualitative Assessment

- Wait for 10 minutes and hope for the best.

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1. **Do not use clinical assessment alone to avoid residual neuromuscular blockade.**
2. **Quantitative Monitoring is recommended over qualitative monitoring to avoid residual neuromuscular blockade.**
3. **When using quantitative monitoring, confirm a T4/T1 ratio > 0.9 prior to extubation**
4. **Use the adductor pollicis muscle for neuromuscular monitoring**
5. **Avoid using the eye muscles for neuromuscular monitoring**
6. **Use sugammadex over neostigmine to reverse deep, moderate and shallow neuromuscular blockade induced by rocuronium or vecuronium**
7. **Neostigmine is a reasonable alternative to sugammadex at minimal depth of neuromuscular blockade.**
8. **For Atracurium and Cisatracurium:**
   a) **Quantitative monitoring: reverse with neostigmine at T4/T1 > 0.4 and confirm recovery to T4/T1 > 0.9 prior to extubation.**
   b) **Qualitative monitoring: Reverse with no detectable fade and then WAIT AT LEAST 10 minutes prior to extubation.**

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1. Do not use clinical assessment alone to avoid residual neuromuscular blockade.
2. Quantitative Monitoring is recommended over qualitative monitoring to avoid residual neuromuscular blockade.
3. When using quantitative monitoring, confirm a T4/T1 ratio > 0.9 prior to extubation
4. Use the adductor pollicis muscle for neuromuscular monitoring
5. Avoid using the eye muscles for neuromuscular monitoring
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   b) Qualitative monitoring: Reverse with no detectable fade and then WAIT AT LEAST 10 minutes prior to extubation.

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The benefits of complete recovery include increased patient satisfaction, decreased length of PACU stay, decreased postoperative pulmonary complications, and decreased mortality.

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Thank you.

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