PHYSICS, MONITORING, AND ANESTHESIA DELIVERY DEVICES

Quantitative Neuromuscular Monitoring

Intraoperative teaching · CA-2

THE QUESTION

Where the evidence disagrees

This topic was selected because an evidence synthesis beats a textbook on it: the trials disagree, or the guidance has moved recently.

THE EVIDENCE

What each source contributes, and how strong it is

Study design first — a cohort and a randomised trial do not carry the same weight.

Design	Year	Journal	What it found
Meta-analysis	2025	British journal of anaesthesia	Where quantitative monitoring and sugammadex are readily available, residual block
Randomised trial	2008	Anesthesiology	Randomising to acceleromyography rather than qualitative train-of-four cut residual
Cohort	2015	Anesthesia and analgesia	Despite qualitative monitoring and neostigmine, 63.5% of patients still had a
Review	2018	Anesthesia and analgesia	Absence of fade on a peripheral nerve stimulator does not exclude residual block —
Guideline	2018	Anesthesia and analgesia	Whenever a neuromuscular blocker is given, monitor at the hand with a quantitative
Randomised trial	2011	Anesthesiology	Acceleromyography reduced residual block from 50% to 14.5% and left patients with

6 resolved citations behind this deck; every point above traces to one of them.

WHERE THE GUIDANCE SITS

What the guidelines and pooled evidence say

2 findings, each on the slide that follows.

BRITISH JOURNAL OF ANAESTHESIA 2025

Where quantitative monitoring and sugammadex are readily available, residual block

Where quantitative monitoring and sugammadex are readily available, residual block in recovery fell to 2.2%, against published incidences ranging…

ANESTHESIA AND ANALGESIA 2018

Whenever a neuromuscular blocker is given, monitor at the hand with a quantitative

Whenever a neuromuscular blocker is given, monitor at the hand with a quantitative device: documenting a train-of-four ratio of at least 0.90 is the…

WHERE THE GUIDANCE SITS

Where quantitative monitoring and sugammadex are readily available, residual block

Meta-analysis · British journal of anaesthesia

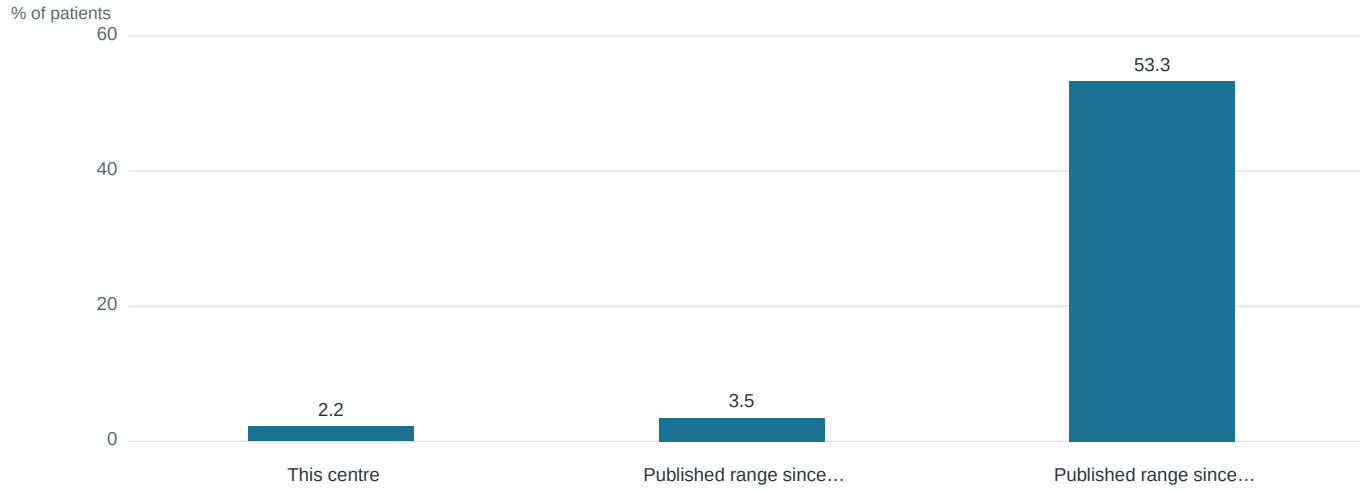
Where quantitative monitoring and sugammadex are readily available, residual block in recovery fell to 2.2%, against published incidences ranging from 3.5% to 53.3% since 2000.

Residual Neuromuscular Block in the Postanaesthesia Care Unit: A Single-Centre Prospective Observational Study and Systematic Review, British journal of anaesthesia 2025 · PMID 39443187

THE NUMBERS

Where quantitative monitoring is routine, the problem nearly disappears

500 patients, Dutch centre with monitors and sugammadex available.



2.2% in a centre where quantitative monitoring and sugammadex were routinely available, against published incidences up to 53%. Cross-study comparison, not a controlled one.

Residual Neuromuscular Block in the Postanaesthesia Care Unit: A Single-Centre Prospective Observational Study and Systematic Review, British journal of anaesthesia 2025 · PMID 39443187

WHERE THE GUIDANCE SITS

Whenever a neuromuscular blocker is given, monitor at the hand with a quantitative

Guideline · Anesthesia and analgesia

Whenever a neuromuscular blocker is given, monitor at the hand with a quantitative device: documenting a train-of-four ratio of at least 0.90 is the only way to confirm satisfactory recovery, and the 5-second head lift should be abandoned.

Consensus Statement on Perioperative Use of Neuromuscular Monitoring, Anesthesia and analgesia 2018 · PMID 29200077

WHAT THE TRIALS FOUND

Where randomised evidence moved the question

2 findings, each on the slide that follows.

ANESTHESIOLOGY 2008

Randomising to acceleromyography rather than qualitative train-of-four cut residual

Randomising to acceleromyography rather than qualitative train-of-four cut residual blockade in recovery from 30% to 4.5%

ANESTHESIOLOGY 2011

Acceleromyography reduced residual block from 50% to 14.5% and left patients with

Acceleromyography reduced residual block from 50% to 14.5% and left patients with fewer symptoms of weakness, even though visible signs of weakness…

WHAT THE TRIALS FOUND

Randomising to acceleromyography rather than qualitative train-of-four cut residual

Randomised trial · Anesthesiology

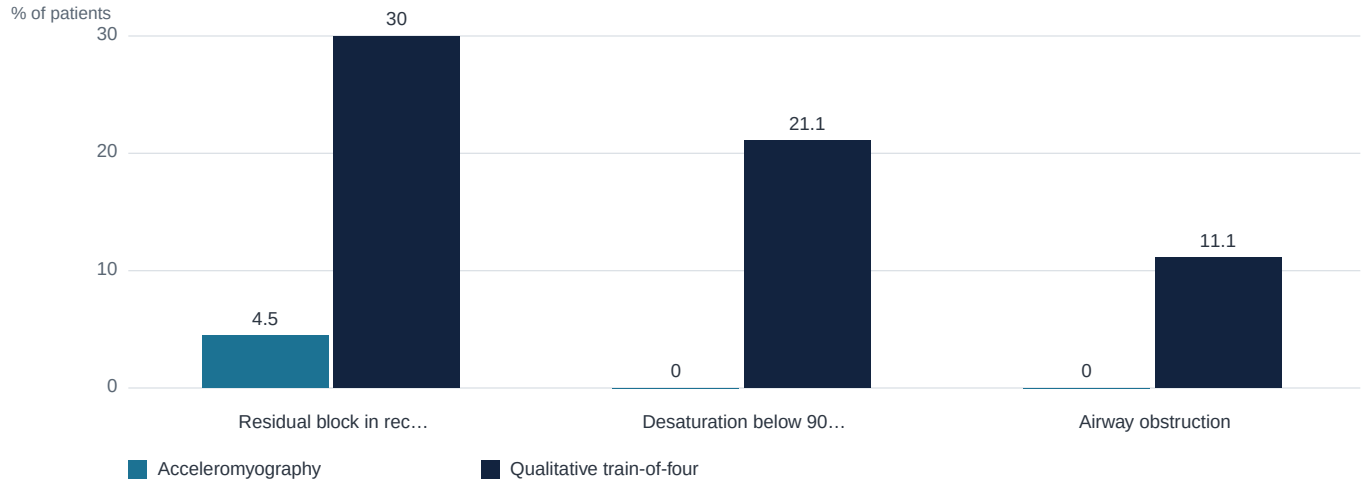
Randomising to acceleromyography rather than qualitative train-of-four cut residual blockade in recovery from 30% to 4.5%, and no acceleromyography patient desaturated below 90% or obstructed during transport.

Intraoperative Acceleromyographic Monitoring Reduces the Risk of Residual Neuromuscular Blockade and Adverse Respiratory Events in the Postanesthesia Care Unit, Anesthesiology 2008 · PMID 18719436

THE NUMBERS

Acceleromyography cut residual block sevenfold

185 patients randomised to quantitative or qualitative monitoring.



No acceleromyography patient desaturated or obstructed during transport. None.

Intraoperative Acceleromyographic Monitoring Reduces the Risk of Residual Neuromuscular Blockade and Adverse Respiratory Events in the Postanesthesia Care Unit, Anesthesiology 2008 · PMID 18719436

WHAT THE TRIALS FOUND

Acceleromyography reduced residual block from 50% to 14.5% and left patients with

Randomised trial · Anesthesiology

Acceleromyography reduced residual block from 50% to 14.5% and left patients with fewer symptoms of weakness, even though visible signs of weakness were rare in both groups.

Intraoperative Acceleromyography Monitoring Reduces Symptoms of Muscle Weakness and Improves Quality of Recovery in the Early Postoperative Period, Anesthesiology 2011 · PMID 21946094

IN PRACTICE

What the cohorts and reviews add

2 findings, each on the slide that follows.

ANESTHESIA AND ANALGESIA 2015

Despite qualitative monitoring and neostigmine, 63.5% of patients still had a

Despite qualitative monitoring and neostigmine, 63.5% of patients still had a train-of-four ratio under 0.9 at extubation — clinical judgement plus a…

ANESTHESIA AND ANALGESIA 2018

Absence of fade on a peripheral nerve stimulator does not exclude residual block —

Absence of fade on a peripheral nerve stimulator does not exclude residual block — train-of-four ratios as low as 0.4 to 0.6 can be present when no…

IN PRACTICE

Despite qualitative monitoring and neostigmine, 63.5% of patients still had a

Cohort · Anesthesia and analgesia

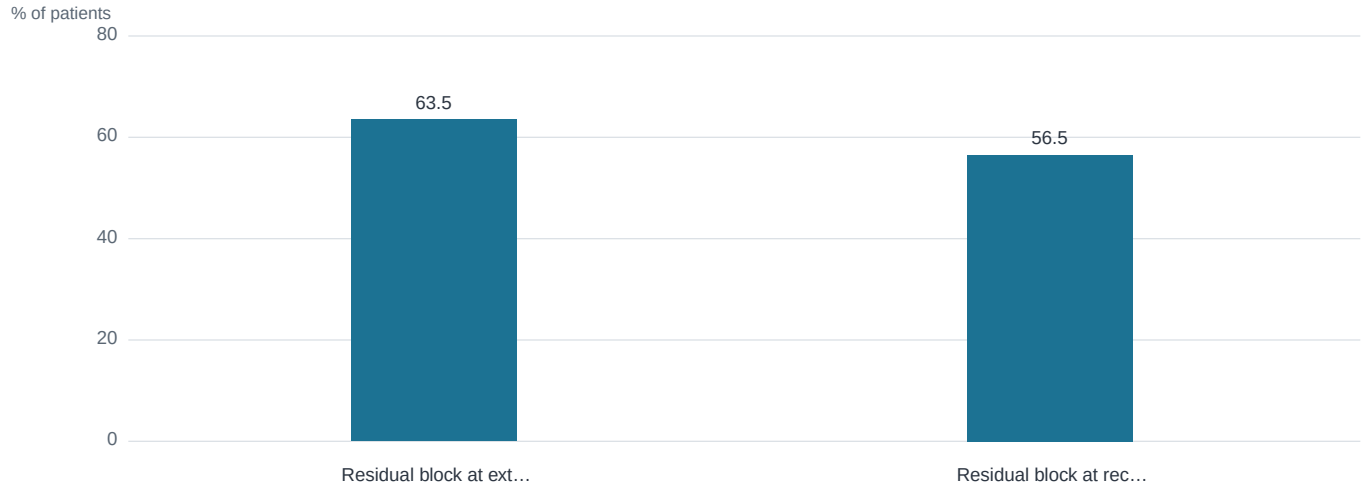
Despite qualitative monitoring and neostigmine, 63.5% of patients still had a train-of-four ratio under 0.9 at extubation — clinical judgement plus a nerve stimulator does not detect residual block.

The RECITE Study: A Canadian Prospective, Multicenter Study of the Incidence and Severity of Residual Neuromuscular Blockade, Anesthesia and analgesia 2015 · PMID 25902322

THE NUMBERS

Neostigmine plus a nerve stimulator is not enough

RECITE, 302 patients, blinded acceleromyography.



Two-thirds still had residual block at extubation despite routine reversal and qualitative monitoring.

The RECITE Study: A Canadian Prospective, Multicenter Study of the Incidence and Severity of Residual Neuromuscular Blockade, Anesthesia and analgesia 2015 · PMID 25902322

IN PRACTICE

Absence of fade on a peripheral nerve stimulator does not exclude residual block —

Review · Anesthesia and analgesia

Absence of fade on a peripheral nerve stimulator does not exclude residual block — train-of-four ratios as low as 0.4 to 0.6 can be present when no fade is visible.

Neuromuscular Monitoring in the Perioperative Period, Anesthesia and analgesia 2018 · PMID 28795964

IN THE ROOM

What this changes about the next case

Colour is the strength of the evidence behind each step, not the urgency.

1. **1**
   Whenever a neuromuscular blocker is given, monitor at the hand with a quantitative device: documenting a train-of-four ratio of at least 0.90 is the only way to confirm satisfactory recovery, and the 5-second head lift should be abandoned.
2. **2**
   Where quantitative monitoring and sugammadex are readily available, residual block in recovery fell to 2.2%, against published incidences ranging from 3.5% to 53.3% since 2000.
3. **3**
   Randomising to acceleromyography rather than qualitative train-of-four cut residual blockade in recovery from 30% to 4.5%, and no acceleromyography patient desaturated below 90% or obstructed during transport.
4. **4**
   Acceleromyography reduced residual block from 50% to 14.5% and left patients with fewer symptoms of weakness, even though visible signs of weakness were rare in both groups.
5. **5**
   Despite qualitative monitoring and neostigmine, 63.5% of patients still had a train-of-four ratio under 0.9 at extubation — clinical judgement plus a nerve stimulator does not detect residual block.

KEY TAKEAWAYS

What to carry into the next case

> **Where quantitative monitoring and sugammadex are readily available, residual block**
> British journal of anaesthesia 2025

> **Randomising to acceleromyography rather than qualitative train-of-four cut residual**
> Anesthesiology 2008

> **Despite qualitative monitoring and neostigmine, 63.5% of patients still had a**
> Anesthesia and analgesia 2015

> **Absence of fade on a peripheral nerve stimulator does not exclude residual block —**
> Anesthesia and analgesia 2018

Where quantitative monitoring and sugammadex are readily available, residual block

QUESTIONS I'LL ASK YOU IN THE ROOM

1. How does your plan change if the patient is not optimised?
2. What is the physiology behind what we just did?
3. Talk me through the trade-off you made there.
4. What would make you abandon this plan and do something else?

ORAL BOARDS STEM

> *A CA-1 has judged reversal adequate on a peripheral nerve stimulator by eye and wants to extubate. The quantitative monitor is in the drawer and would take a minute to set up.*

BOARD QUESTIONS

1. State the core recommendations of the 2018 consensus statement on perioperative use of neuromuscular monitoring: when monitoring is indicated, where on the body and with what type of device, the numeric endpoint that confirms satisfactory recovery, and which traditional bedside test the statement says to abandon.

2. A resident sees no fade in the train-of-four response on a peripheral nerve stimulator and concludes that residual neuromuscular block has been excluded. State what range of train-of-four ratios can be present when no fade is visible, and say whether the resident's conclusion holds.

3. In the RECITE study, patients were managed with qualitative neuromuscular monitoring and neostigmine reversal. State the proportion who still had a train-of-four ratio under 0.9 at extubation, and what the study establishes about clinical judgement combined with a nerve stimulator.

4. A single-centre prospective observational study, published alongside a systematic review, found residual neuromuscular block in the recovery unit in 2.2% of patients in a setting where quantitative monitoring and sugammadex were readily available, against published incidences ranging from 3.5% to 53.3% since 2000. State what this comparison does and does not establish.

ANSWER KEY

1. Whenever a neuromuscular blocker is given, monitor at the hand with a quantitative device; documenting a train-of-four ratio of at least 0.90 is the only way to confirm satisfactory recovery, and the 5-second head lift should be abandoned.

The consensus is unambiguous: any neuromuscular blocker means a quantitative device at the hand and a documented train-of-four ratio of at least 0.90, and the 5-second head lift is no longer acceptable as proof.

Consensus Statement on Perioperative Use of Neuromuscular Monitoring, Anesthesia and analgesia 2018 · PMID 29200077

2. The conclusion does not hold: absence of fade on a peripheral nerve stimulator does not exclude residual block, because train-of-four ratios as low as 0.4 to 0.6 can be present when no fade is visible.

Your eye saturates well before the neuromuscular junction recovers, so a ratio anywhere from 0.4 to 0.6 can hide behind a train-of-four that looks fade-free.

Neuromuscular Monitoring in the Perioperative Period, Anesthesia and analgesia 2018 · PMID 28795964

3. Despite qualitative monitoring and neostigmine, 63.5% of patients still had a train-of-four ratio under 0.9 at extubation, which shows that clinical judgement plus a nerve stimulator does not detect residual block.

Nearly two thirds of RECITE patients reached extubation with a train-of-four ratio under 0.9, which is why judgement plus a qualitative stimulator cannot be your detection strategy.

The RECITE Study: A Canadian Prospective, Multicenter Study of the Incidence and Severity of Residual Neuromuscular Blockade, Anesthesia and analgesia 2015 · PMID 25902322

4. It establishes that in a setting where quantitative monitoring and sugammadex were readily available the observed incidence of residual block in recovery was 2.2%, at or below the bottom of the 3.5% to 53.3% range published since 2000. It does not establish that those two practices caused the low rate: the comparator is a wide range of incidences from other studies over 25 years rather than a concurrent randomized control group.

This is an observed incidence in one setting benchmarked against a very wide historical range, so treat it as consistent with the practice, not as proof that the monitor and sugammadex produced the number.

Residual Neuromuscular Block in the Postanaesthesia Care Unit: A Single-Centre Prospective Observational Study and Systematic Review, British journal of anaesthesia 2025 · PMID 39443187

Where quantitative monitoring and sugammadex are readily available, residual block

SOURCES

[1] Residual Neuromuscular Block in the Postanaesthesia Care Unit: A Single-Centre Prospective Observational Study and Systematic Review, British journal of anaesthesia 2025 · PMID 39443187

[2] Intraoperative Acceleromyographic Monitoring Reduces the Risk of Residual Neuromuscular Blockade and Adverse Respiratory Events in the Postanesthesia Care Unit, Anesthesiology 2008 · PMID 18719436

[3] The RECITE Study: A Canadian Prospective, Multicenter Study of the Incidence and Severity of Residual Neuromuscular Blockade, Anesthesia and analgesia 2015 · PMID 25902322

[4] Neuromuscular Monitoring in the Perioperative Period, Anesthesia and analgesia 2018 · PMID 28795964

[5] Consensus Statement on Perioperative Use of Neuromuscular Monitoring, Anesthesia and analgesia 2018 · PMID 29200077

[6] Intraoperative Acceleromyography Monitoring Reduces Symptoms of Muscle Weakness and Improves Quality of Recovery in the Early Postoperative Period, Anesthesiology 2011 · PMID 21946094