NEUROMUSCULAR MONITORING
To observe onset of NM Blockade
To determine level of muscle relaxation during surgery
To minimize risk of residual paralysis
Residual post-op NM Blockade

- Impairment of pharyngeal and upper esophageal muscles
- Impaired ability to maintain the airway
- Increased risk for post-op pulmonary complications
- Difficult to exclude clinically significant residual curarization by clinical evaluation

WHY DO WE MONITOR
Residual Neuromuscular Blockade and Critical Respiratory Events in the Postanesthesia Care Unit

Glenn S. Murphy, MD
Joseph W. Szokol, MD
Jesse H. Marymont, MD
Steven B. Greenberg, MD
Michael J. Avram, PhD
Jeffery S. Vender, MD

(Anesth Analg 2008;107:130 – 7)
<table>
<thead>
<tr>
<th>No.</th>
<th>Intraoperative</th>
<th>Critical event group</th>
<th>Control group</th>
<th>Difference (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Potent volatile anesthetic</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Sevoflurane</td>
<td>29 (69.1%)</td>
<td>26 (61.9%)</td>
<td>7.1% (−14 to 28)</td>
<td>0.513*</td>
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<tr>
<td></td>
<td>Desflurane</td>
<td>4 (9.5%)</td>
<td>7 (16.7%)</td>
<td>−7.1% (−23 to 9)</td>
<td>0.366*</td>
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<tr>
<td></td>
<td>Isoflurane</td>
<td>9 (21.4%)</td>
<td>9 (21.4%)</td>
<td>0% (−17 to 17)</td>
<td>1.000*</td>
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<tr>
<td></td>
<td>Dose fentanyl (µg)</td>
<td>200 (0–800)</td>
<td>200 (0–400)</td>
<td>−25 (−50 to 25)</td>
<td>0.357†</td>
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<td></td>
<td>Hydromorphone (No. pts.)</td>
<td>7 (16.7%)</td>
<td>4 (9.5%)</td>
<td>7.1% (−8 to 22)</td>
<td>0.317*</td>
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<tr>
<td></td>
<td>Total OR time (min)</td>
<td>159 ± 81</td>
<td>157 ± 90</td>
<td>2 (−6 to 33)</td>
<td>0.903‡</td>
</tr>
<tr>
<td></td>
<td>Estimated blood loss (mL)</td>
<td>50 (0–840)</td>
<td>50 (0–700)</td>
<td>50 (−15 to 150)</td>
<td>0.111†</td>
</tr>
<tr>
<td></td>
<td>PRBCs (No. units)</td>
<td>2 (7.1%)</td>
<td>3 (7.1%)</td>
<td>0% (−13 to 12)</td>
<td>1.000*</td>
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<tr>
<td></td>
<td>Fluid (L)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Urine output (mL)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>NM blockade</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Receiving dose</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Dose rocuronium (µg)</td>
<td></td>
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<tr>
<td></td>
<td>Redosed (µg)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>No. redoses</td>
<td></td>
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<tr>
<td></td>
<td>Last dose to end (min)</td>
<td>80 ± 37</td>
<td>82 ± 31</td>
<td>−2 (−16 to 12)</td>
<td>0.746‡</td>
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<tr>
<td></td>
<td>Other NMBDs used</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Succinylcholine*</td>
<td>11 (26.2%)</td>
<td>10 (23.8%)</td>
<td>2.4% (−18 to 23)</td>
<td>0.819*</td>
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<td>Cisatracurium</td>
<td>1 (2.4%)</td>
<td>1 (2.4%)</td>
<td>0% (−10 to 10)</td>
<td>1.000*</td>
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<td></td>
<td>Dose neostigmine (mg)</td>
<td>4.0 (2.5–5.0)</td>
<td>4.0 (2.0–5.0)</td>
<td>0.25 (−0.25 to 0.5)</td>
<td>0.499‡</td>
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<tr>
<td></td>
<td>Postanesthesia care unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>PACU temperature (°C)</td>
<td>36.34 ± 0.50</td>
<td>36.26 ± 0.37</td>
<td>0.08 (−0.10 to 0.27)</td>
<td>0.377‡</td>
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<tr>
<td></td>
<td>Morphine sulfate equivalent dose (mg)</td>
<td>5 (0–20)</td>
<td>8.75 (0–40)</td>
<td>−2.5 (−5 to 0)</td>
<td>0.048†</td>
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<tr>
<td></td>
<td>Train-of-four ratio</td>
<td>0.62 ± 0.20</td>
<td>0.98 ± 0.07</td>
<td>−0.36 (−0.43 to −0.30)</td>
<td>&lt;0.0001†</td>
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<tr>
<td></td>
<td>Degree of NM blockade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acceptable</td>
<td>4 (9.5%)</td>
<td>38 (90.5%)</td>
<td>−81.0% (−90 to −66)</td>
<td>&lt;0.0001*</td>
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<tr>
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<td>Mild-to-moderate</td>
<td>7 (16.7%)</td>
<td>4 (9.5%)</td>
<td>7.1% (−9 to 24)</td>
<td>0.366*</td>
</tr>
<tr>
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<td>Severe</td>
<td>31 (73.8%)</td>
<td>0 (0%)</td>
<td>73.8% (59 to 85)</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

TOF 0.62 in critical respiratory events group
VS
TOF 0.98 in control group
Review Article

Conceptual and technical insights into the basis of neuromuscular monitoring

M. Naguib,1 S. J. Brull2 and K. B. Johnson3

1 Professor, Cleveland Clinic Lerner College of Medicine of Case Western Reserve University, Department of General Anesthesia, Cleveland Clinic, Cleveland, Ohio, USA, 2 Professor, Department of Anesthesiology, Mayo Clinic College of Medicine, Jacksonville, Florida, USA, 3 Professor, Department of Anesthesiology, University of Utah, Salt Lake City, Utah, USA

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Anaesthesia 2017, 72 (Suppl. 1), 16-37
Table 2 Selected reports of postoperative residual paralysis, 2006–2016.

<table>
<thead>
<tr>
<th>Study</th>
<th>Intermediate-acting NMBA</th>
<th>Reversal</th>
<th>TOF Threshold</th>
<th>Monitoring modality</th>
<th>Residual paralysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cammu et al. [26]</td>
<td>Atrac/Cis/Miv/Roc</td>
<td>In 26%</td>
<td>0.9</td>
<td>Clinical (49% of cases)</td>
<td>38%</td>
<td>One of 320 inpatients required re-intubation in PACU; Subjective assessment did not decrease incidence of residual paralysis</td>
</tr>
<tr>
<td>Outpatients</td>
<td></td>
<td>In 25%</td>
<td></td>
<td></td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>Inpatients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Maybauer et al. [88]</td>
<td>Cis</td>
<td>None</td>
<td>0.9</td>
<td>AMG</td>
<td>57%</td>
<td>Variability in duration of action of Roc greater than Cisatrac</td>
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<tr>
<td>Roc</td>
<td></td>
<td></td>
<td></td>
<td>AMG</td>
<td>44%</td>
<td>AMG lowers RNMB risk</td>
</tr>
<tr>
<td>Murphy et al. [89]</td>
<td>Roc</td>
<td>Yes</td>
<td>0.9</td>
<td>AMG</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Subjective</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30%</td>
<td></td>
<td></td>
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<tr>
<td>Butterly et al. [14]</td>
<td>Vec/Cis</td>
<td>Yes</td>
<td>0.9</td>
<td>Subjective</td>
<td>22%</td>
<td>Less RNMB with Cis</td>
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<tr>
<td>Yip et al. [90]</td>
<td>Atrac/Vec/Roc</td>
<td>In 65%</td>
<td>0.9</td>
<td>Not reported</td>
<td>31%</td>
<td>21% of patients with RNMB required airway support</td>
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<td>Murphy et al. [7]</td>
<td>Roc</td>
<td>Yes</td>
<td>0.9</td>
<td>AMG</td>
<td>15%</td>
<td>AMG monitoring lowers RNMB</td>
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<tr>
<td>Cammu et al. [91]</td>
<td>Atrac/Roc/Miv</td>
<td>None</td>
<td>0.9</td>
<td>Subjective (38% of cases)</td>
<td>15%</td>
<td>Body mass index we an independent predictor of desaturation in PACU</td>
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<tr>
<td></td>
<td></td>
<td>Neo</td>
<td></td>
<td></td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SGX</td>
<td></td>
<td></td>
<td>2%</td>
<td></td>
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<tr>
<td>Kumar et al. [92]</td>
<td>Vec</td>
<td>Yes in 100%</td>
<td>0.9</td>
<td>Not performed</td>
<td></td>
<td>RNMB resulted in reductions in forced vital capacity and peak expiratory flow</td>
</tr>
<tr>
<td></td>
<td>Atrac</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roc</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Norton et al. [93]</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td></td>
<td>CRE present in 51% with RNMB</td>
</tr>
</tbody>
</table>
Incidence of post-op residual neuromuscular blockage following the use of intermediate-acting neuromuscular blocking drugs was ~41%.

Incidence of critical respiratory events in the PACU is approximately 0.8%.
WHO SHOULD BE MONITORED

- Severe pulmonary disease
- Severe renal, liver disease
- Neuromuscular disorders
  - Myasthenia gravis
  - Myopathies
- Critically ill
WHO SHOULD BE MONITORED

- Marked obesity
- Continuous infusion of NMBs
- Surgeries requiring elimination of sudden movement
- Surgeries requiring profound NM blockade
A prospective, randomized, controlled evaluation of peripheral nerve stimulation versus standard clinical dosing of neuromuscular blocking agents in critically ill patients.

M I Rudis; C A Sikora; E Angus; E Peterson; J Popovich; R Hyzy; B J Zarowitz
Use of PNS in continuously paralyzed critically ill patients

- Lower doses of vecuronium to maintain a desired depth of paralysis
- Faster recovery of neuromuscular function and spontaneous ventilation
THE PERIPHERAL NERVE STIMULATION
EQUIPMENTS REQUIRED

- The nerve stimulator
- The stimulating electrodes
- The recording equipment
TYPES OF PERIPHERAL NERVE STIMULATION

- Electrical
  - Most commonly used in clinical practice

- Magnetic
  - Less painful and doesn’t require physical contact with body
  - Bulky and heavy
  - Difficult to achieve supramaximal stimulation
Electrical impulses are transmitted to the nerve:
- By means of surface or needle electrodes.

Conducting area should be small:
- 7 - 11 mm diameter.

If tissue resistance occurs:
- Needle electrodes can be used.
ESSENTIAL FEATURES OF PNS

- Shape of stimulus
  - Monophasic and rectangular
    - Square wave stimulus
- 0.2 - 0.3 msec duration
- Constant current up to 80 mA
- Variable voltage
- Battery operated
Threshold current
- Lowest current required to depolarize the fibers to detect muscle response

Maximal current
- Generates response through all nerves fibers
- Maximal muscle contraction
Supramaximal current
- Electrical stimulus at least 15% - 20% greater than that necessary for a maximal response
- Intensity 2-3 times higher than threshold current
PATTERNS OF NERVE STIMULATION
PATTERNS OF NERVE STIMULATION

- Single twitch stimulation
- Train-of-four stimulation
- Tetanic stimulation
- Post-tetanic count stimulation
- Double burst stimulation
SINGLE-TWITCH STIMULATION

- Single supramaximal stimuli
- Frequencies ranging from 1.0 Hz (once every second) to 0.1 Hz (once every 10 seconds)
- Depressed in twitch response when NMB agents occupies 75% of receptors
Good conditions for abdominal surgery need twitch depression > 90%

Useful time to apply is at the onset of neuromuscular block

Using 1 Hz to establish the level at supramaximal stimulus
SINGLE-TWITCH STIMULATION

- **Stimulation:**
  - Frequency: 0.1–1.0 Hz.

- **Response:**
  - Non-dep. block:
  - Dep. block:
Four supramaximal twitch stimuli
- Every 0.5 second (2 Hz)

TOF ratio = \( \frac{T4}{T1} \)
TRAIN-OF-FOUR STIMULATION

- During a partial non-depolarizing block
  - The ratio decreases (fades)
TRAIN-OF-FOUR STIMULATION

- During a partial non-depolarizing block
  - The ratio decreases (fades)
During onset of non-depolarizing block
- T4 disappears $\rightarrow$ 75% depression of T1
- T3 disappears $\rightarrow$ 80-85% depression of T1
- T2 disappears $\rightarrow$ 90% depression of T1
- During a partial non-depolarizing block
  - TOF count correlates with the degree of neuromuscular block
  - Twitch suppression of 90% = TOF count 1 or less
During a depolarizing block
- No fade occurs, TOF ratio is 1.0
- Fade in the TOF response
  - Phase II block
TETANIC STIMULATION

- Rapid delivery of supramaximal stimuli
  - 30, 50 or 100-Hz
  - Most commonly used 50-Hz stimulation given for 5 seconds
Tetanic stimulation
- Ach in synaptic cleft $\rightarrow$ positive feedback on presynaptic receptors
- Greater amount of Ach $\rightarrow$ tetanic contraction
- Response will be fade in nondepolarizing block
- Effect of non depolarizing agent
  - Presynaptic receptors decreases Ach mobilized and released → Fade
The response will be sustained

- Depolarizing block
TETANIC STIMULATION

- Very painful
  - Not acceptable to an unanesthetized patient
5 seconds Tetanic stimulation at 50 Hz
Follow 3 sec by single twitches at 1 Hz
Tetanic stimulation

Ach synthesis and mobilization continue for a short period

Increased in available store of Ach

Enhanced response to Single twitch stimulation
POST-TETANIC COUNT STIMULATION

**Stimulation:**
- Intense block (A)
- Deep block (B)
- Surgical block (D)

**Response:**
- PTC and no. of TOF responses:
  - 0, 0, 0, 0, 3, 1, 8
Interfere with neuromuscular block
- Not be performed more often than every 6 minutes

Clinically used
- Ophthalmic surgery, surgery in the airways
Two short bursts of tetanus at 50-Hz at a supramaximal stimulation
- Separated by 750 msec
- Each square wave impulse duration is 0.2 msec
Nonparalyzed muscle
- Equal strength of two short muscle contractions

Paralyzed muscle
- Second response is weaker than the first (fades)
SITES OF NERVE STIMULATION AND DIFFERENT MUSCLE RESPONSES
ULNAR NERVE
Response: Adductor pollicis muscle → thumb adduction
FACIAL NERVE

Response: Orbicularis occuli muscle
→ Eyelid twitching
POSTERIOR TIBIAL NERVE
POSTERIOR TIBIAL NERVE

Response: Flexor hallucis brevis muscle → Plantar flexion of big toe
RECORDING OF EVOKED RESPONSES
RECORDING OF EVOKE RESPONSES

- Mechanomyography [MMG]
- Electromyography [EMG]
- Kinemyography [KMG]
- Acceleromyography [AMG]
- Phonomyography [PMG]: new method
Figure 53-12. The setup for mechanomyography. The response to nerve stimulation is measured using a force transducer (TD-100; Biometer, Odense, Denmark) placed at the proximal phalanx of the thumb.
Figure 53-13. The setup for electromyography (NMT ElectroSensor, Datex-Ohmeda, Helsinki, Finland) for recording the compound action potential from the adductor pollicis muscle.
Figure 53-17. The setup of kinemyography (NMT MechanoSensor, Datex-Ohmeda, Helsinki, Finland). The response to nerve stimulation is measured by the bending of a small piezoelectric sensor positioned between the index finger and the thumb.
Figure 53-15. The setup of acceleromyography without preload (TOF Watch, Biometer, Odense, Denmark). The response to nerve stimulation is measured with a small piezoelectric acceleration transducer placed distally on the volar site of the thumb.

Figure 53-16. The setup of acceleromyography with preload (TOF Watch with Hand Adapter, Biometer, Odense, Denmark). The piezoelectric acceleration transducer is placed in the Hand Adapter. The stretching wing ensures that the thumb does not touch the palm of the hand.
Based on Newton’s second law:

\[ \text{Force} = \text{Mass} \times \text{Acceleration} \]
EVALUATION OF RECORDED EVOKED RESPONSES

NONDEPOLARIZING NEUROMUSCULAR BLOCK
- Intense Neuromuscular Block
- Deep Neuromuscular Block
- Moderate or Surgical Neuromuscular Block
- Recovery from Neuromuscular Block

DEPOLARIZING NEUROMUSCULAR BLOCK (PHASE I AND II BLOCKS)
INTENSE NEUROMUSCULAR BLOCK

Sug 16 mg/kg
Intense Neuromuscular Block

- Within 3 to 6 minutes of injection
- “Period of no response”
- Cannot be antagonized with a cholinesterase inhibitor
- Can be antagonize an intense block
  - Given a high dose of sugammadex (16 mg/kg)
Sug 4 mg/kg
Deep Neuromuscular Block

- Reverse a deep block with neostigmine is usually impossible.

- Can be antagonized completely within a few minutes.
  - Using a dose of sugammadex of 4 mg/kg.
MODERATE NEUROMUSCULAR BLOCK

**Injection of NMBA**
- Level of block
  - Response to TOF
    - TOF count ≥1
- Onset
  - TOF count 0
  - PTC 0

**PTC stimulation during deep block**
- Intense block
  - TOF count 0
  - PTC ≥1
- Deep block
  - TOF count 0
  - PTC ≥1

**Moderate block**
- TOF count 1-3

**Sug 2 mg/kg**

---

MODERATE OR SURGICAL NEUROMUSCULAR BLOCK

- Begins when the first response to TOF stimulation appears

- Sufficient relaxation for most surgical procedures
MODERATE OR SURGICAL NEUROMUSCULAR BLOCK

- Antagonism with neostigmine
  - Should not be initiated before at least two to four responses

- Antagonism of moderate block can be achieved
  - Small dose of sugammadex (2 mg/kg)
Controversies in Anesthesia
Dose depth neuromuscular blockage matter?

Modulator Scott Groudine, MD
From Medscape
Deep neuromuscular block to optimize surgical space conditions during laparoscopic surgery: a systematic review and meta-analysis

M. H. Bruintjes	extsuperscript{1,*}, E. V. van Helden	extsuperscript{1}, A. E. Braat	extsuperscript{2}, A. Dahan	extsuperscript{3}, G. J. Scheffer	extsuperscript{4}, C. J. van Laarhoven	extsuperscript{1} and M. C. Warlé	extsuperscript{1}

	extsuperscript{1}Department of Surgery, Radboud University Medical Center, Geert Grooteplein 10-zuid, 6525 GA, Nijmegen, The Netherlands, \textsuperscript{2}Department of Surgery LUMC, \textsuperscript{3}Department of Anaesthesiology LUMC, Albinusdreef 2, 2333 ZA, Leiden, The Netherlands and \textsuperscript{4}Department of Anaesthesiology, Radboud University Medical Center, Geert Grooteplein 10-zuid, 6525 GA, Nijmegen, The Netherlands
Deep VS moderate NMB

- OR
  - IAP 9.3 vs 12 mm.Hg

- PACU
  - Abdominal pain score 2.3 VS 2.9
  - Incidence of shoulder pain 3.3 % VS 25.8 %

- Generally better ratings for quality of surgical field

Conclusion
- Insufficient evidence to conclude that deep NM improve Sx condition
- Decreasing Post-op PFT is not difference in two group
RECOVERY PHASE

Level of block
Response to TOF
Response to PTC

Onset
TOF count ≥1

Intense block
TOF count 0
PTC 0

Deep block
TOF count 0
PTC ≥ 1

Moderate block
TOF count 1-3

Recovery phase
TOF ratio measurable

## Clinical Sign and Symptoms of Residual Paralysis

<table>
<thead>
<tr>
<th>Train of Four Ratio</th>
<th>Signs and Symptoms</th>
</tr>
</thead>
</table>
| 0.4 or less         | - Unable to lift the head or arm  
                        - Tidal volume may be normal  
                        - Reduced vital capacity and inspiratory force |
| 0.6                 | - Able to lift their head for 3 seconds  
                        - Open their eyes widely  
                        - Tick out their tongue  
                        - Still reduced vital capacity and inspiratory force |
## CLINICAL SIGN AND SYMPTOMS OF RESIDUAL PARALYSIS

<table>
<thead>
<tr>
<th>Train of Four Ratio</th>
<th>Signs and Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7 to 0.75</td>
<td>- Cough</td>
</tr>
<tr>
<td></td>
<td>- Lift the head at least 5 sec, grip strength 60%</td>
</tr>
<tr>
<td>0.8 and higher</td>
<td>- Normal vital capacity and inspiratory force</td>
</tr>
<tr>
<td></td>
<td>- Diplopia, blurred vision, and facial weakness</td>
</tr>
</tbody>
</table>
RECOVERY FROM NEUROMUSCULAR BLOCK

- The TOF ratio
  - MMG or EMG → exceed 0.9
  - AMG → 1.0 (or normalized to 0.9)
EVALUATION OF RECORDED EVOKED RESPONSES

NONDEPOLARIZING NEUROMUSCULAR BLOCK

- Intense Neuromuscular Block
- Deep Neuromuscular Block

DEPOLARIZING NEUROMUSCULAR BLOCK (PHASE I AND II BLOCKS)

- Moderate or Surgical Neuromuscular Block
- Recovery from Neuromuscular Block
Phase I block

- Normal plasma cholinesterase activity
- Moderate dose of succinylcholine (0.5 to 1.5 mg/kg)
- The response
  - TOF $\rightarrow$ No fading
  - Tetanic stimulation $\rightarrow$ No posttetanic facilitation
Phase II block

- Succinylcholine
  - 7-10 mg/kg
  - 30-60 min of exposure
- Determined abnormal plasma cholinesterase activity
- Fade in the response to TOF and tetanic stimulation and the occurrence of post-tetanic facilitation of transmission
Normal patients can be antagonized by administering a cholinesterase inhibitor a few minutes → extreme caution

Patients with abnormal plasma cholinesterase activity is unpredictable

- Inhibits acetylcholinesterase and plasma-cholinesterase
### How to Use Nerve Stimulators in Daily Clinical Practice?

<table>
<thead>
<tr>
<th></th>
<th>During induction</th>
<th>During surgery</th>
<th>In the recovery room</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thiopental/propofol</td>
<td>Supramaximal stimulation</td>
<td>Tracheal intubation</td>
</tr>
<tr>
<td>Single twitch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0 Hz</td>
<td>0.1 Hz</td>
<td></td>
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<td>TOF</td>
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<td>PTC</td>
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<td>DBS</td>
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- Single twitch: 1.0 Hz, 0.1 Hz
- TOF: Reversal
- PTC: Reversal
- DBS: Reversal
Reversal when neuromuscular monitoring is available

**Sugammadex**
- No response to TOF
  - PTC 0
    - SUG 16 mg/kg
  - PTC 1-15
    - SUG 4 mg/kg
    - SUG 2 mg/kg
    - SUG 2 mg/kg
- TOF count 1-4
- TOF<1.0
  - TOF<0.9
  - TOF>=0.9
- TOF>=0.9
- TOF<0.4 or TOF count 2-3
- Delay reversal

**Neostigmine**
- TOF>=0.9
- TOF 0.4-0.9
  - NEO 0.02 mg/kg
  - NEO 0.05 mg/kg
- TOF count 0-1
- No reversal
TAKE HOME MESSAGE

- Use of NM monitoring $\rightarrow$ decrease residual post-op NM Blockade

- Definition for ‘adequate recovery’ from NM block is the return of the TOF ratio to $\geq 0.9$

- Residual NMB may predispose to postoperative complication, anesthetists should utilise clinical monitoring to assess NMB

- Although the use of neuromuscular monitoring has many advantages, but the main thing is to take care of by the whole team
THANK YOU