



## *Nursing Professional Development*

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# *Peripheral Nerve Stimulation/Train of Four (TOF) Monitoring*

## *Resource Manual*

*Quality, Patient Safety & Interprofessional Practice  
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*Together...supporting quality care*



## Table of Contents

Objectives .....	2
Continuing Competency.....	2
Introduction.....	3
Physiology of Neuromuscular Impulse Transmission.....	4
Neuromuscular Blocking Agents (NMBAs) .....	4
Depolarizing NMBAs .....	5
Non-depolarizing NMBAs .....	5
Indications for the Use of NMBAs .....	7
Reversal of NMBAs .....	7
Contraindications/Complications for the Use of NMBAs.....	8
Principles of Neurostimulation/Train of Four Monitoring.....	9
Procedure .....	10
Troubleshooting .....	11
Nursing Care and Considerations.....	12
Documentation.....	13
References .....	14
Appendix A: Peripheral Nerve Stimulation – Train of Four Certification Test.....	15
Appendix B: Certification Checklist.....	17

## Objectives

Train of Four (TOF) monitoring is a competency requirement for critical care nurses. Registered Nurses at Quinte Healthcare Corporation (QHC) who have a current theoretical and practical knowledge of neuromuscular blocking agents (NMBAs), and an understanding of neuromuscular blocking monitoring procedures, equipment and assessment may provide care to patients who are receiving NMBAs in the Intensive Care Unit (ICU). Nurses will utilize their understanding of NMBA administration and TOF monitoring to ensure proper dosing of NMBA medications and to prevent untoward side effects. This manual will provide a review of NMBA administration and monitoring including the therapeutic uses and the nursing responsibilities associated with caring for the patient who is receiving an NMBA.

## Continuing Competence

It is strongly recommended that critical care nurses review all skills related to caring for patients who require Train of Four (TOF) monitoring on an ongoing basis to ensure continued competence. If at any time the nurse feels additional review/retraining is required, it is the responsibility of that nurse to seek additional education/resources from the manager, or clinical educator/delegate to ensure continued competence related to TOF monitoring procedures, assessments, and equipment use. Nurses are professionally responsible for ensuring that they have the requisite knowledge, skill and judgment necessary to provide safe and effective patient care and for maintaining competence and refraining from performing activities that she/he is not competent in (CNO, 2002).

## Introduction

What are NMBAs and what is Train of Four (TOF) monitoring?

1. **Neuromuscular Blocking Agents (NMBAs)** are medications which block the binding of acetylcholine to its receptors (non-depolarizing agents) or by depolarizing the plasma membrane of the muscle (depolarizing agents) in order to produce muscle paralysis.
2. NMBAs are administered in the critical care setting mainly for facilitating endotracheal intubation and mechanical ventilation in patients with severe lung injury (i.e. ARDS).
3. For rapid sequence intubation, short acting, rapid onset NMBAs such as succinylcholine (depolarizing agent) are used, as rapid paralysis is required. However, there are potentially severe side effects associated with depolarizing NMBAs and therefore they are only used for short procedures. Side effects can include hypertension, hyperkalemia, arrhythmia, increased intracranial pressure and malignant hyperthermia.
4. Non-depolarizing NMBAs such as pancuronium, rocuronium and cisatracurium have a slow onset and long duration of action. Cisatracurium (Nimbex) is the agent of choice due to its low incidence of nephrotoxicity and hepatotoxicity. These longer action NMBAs will be utilized for most patients in ICU who are being therapeutically paralyzed to achieve mechanical ventilation, to prevent shivering during targeted temperature management (induction of hypothermia), as an adjunct to reducing intracranial pressure or occasionally in conjunction with anti-seizure medications for the treatment of status epilepticus.
5. NMBAs cause paralysis of the muscles; therefore the patient will be unable to move or to take spontaneous respirations. All patients who receive an NMBA **must** have an advanced airway and mechanical ventilation in place before administration of an NMBA infusion. The exception is the short acting NMBA utilized to perform rapid sequence intubation.
6. NMBAs **do not** provide analgesic, sedative or amnesic effects. Therefore, the nurse must continually assess the need for pain control (CPOT assessment) and ensure continuous and sufficient sedation (RASS score) for all patients receiving an NMBA.
7. Train of Four (TOF) testing is a method of measuring the degree of neuromuscular blockade through the use of a peripheral nerve stimulator. The goal of TOF monitoring is to ensure the minimum amount of NMBA is administered to adequately paralyze the patient.

## Physiology of Neuromuscular Impulse Transmission

### The Neuromuscular Junction

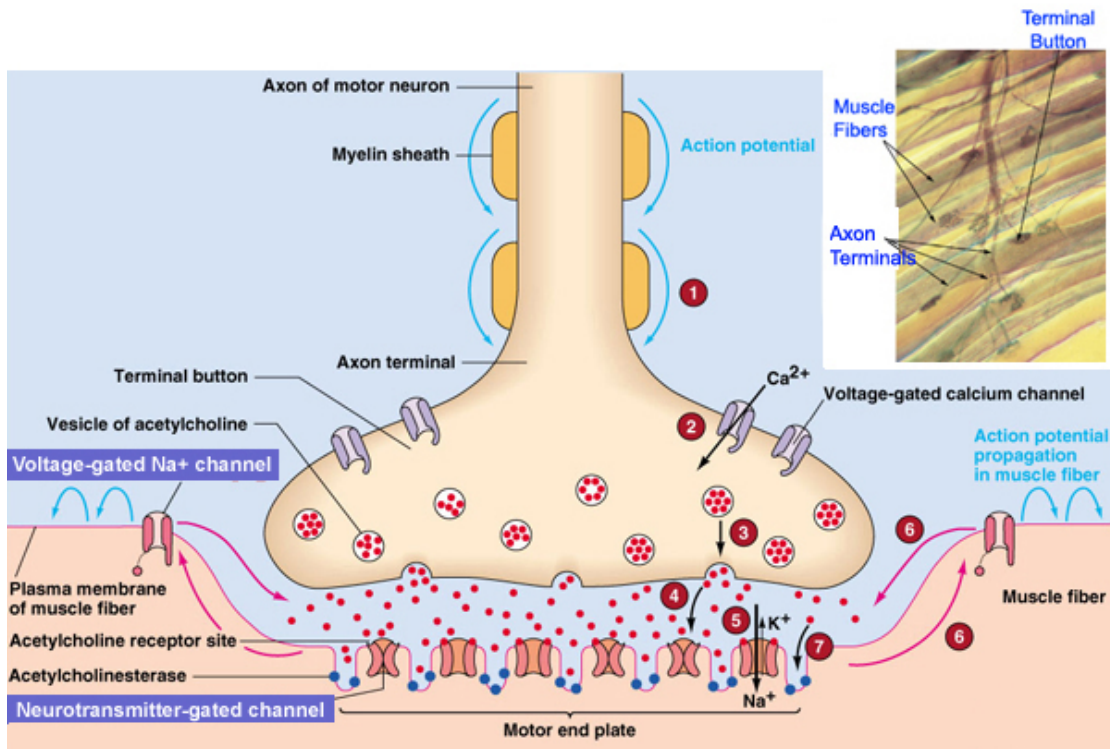


Image obtained from: <http://www.colorado.edu>

Action potentials are electrical impulses generated by neurons that originate from the central nervous system and are responsible for skeletal muscle contraction. These action potentials travel down the body of the neuron (axon), which conduct and transmit signals causing contraction. The synapse, or connection, of this engagement is called the **neuromuscular junction**. When a nerve impulse travelling from the brain or spinal cord reaches the motor end plate, some synaptic vesicles release a neurotransmitter called acetylcholine (ACh) into the synaptic cleft. When the ACh binds to the muscle membrane, it will depolarize the muscle resulting in muscular contraction. The force of the resultant contraction is related to the number of cells depolarized.

### Neuromuscular Blocking Agents (NMBAs)

NMBAs are medications that prevent the transmission of an impulse, thus preventing muscle contraction. Various muscle groups have different sensitivities to NMBAs, the diaphragm being the most resistant. NMBAs have **NO** analgesic, sedative or amnesic properties so it is imperative that the patient **receive a simultaneous infusion** of analgesia +/- sedative.

There are two types of NMBAs:

- Depolarizing NMBAs
- Non-Depolarizing NMBAs

### Depolarizing NMBAs

The depolarizing NMBAs act on the receptors at the motor end plate of the neuromuscular junction (NMJ). This action makes the motor end plate refractory to the action of ACh. An example of non-depolarizing NMBA is succinylcholine. **Succinylcholine** has a quick onset of action and rapidly metabolizes via the enzymatic action of pseudocholinesterase. The continued disruption of the effect of ACh causes muscular fasciculation and twitching. The onset of action is about 1 minute, and the duration is about 6 minutes. It is the only depolarizing NMBA in clinical use. Depolarizing agents have a rapid onset of action and short duration and are therefore usually selected for short procedures and intubation. Depolarizing NMBAs are also associated with more serious and life-threatening side effects and complications requiring the administering physician to be knowledgeable of the contraindications, diagnosis, and treatment of these complications (e.g. malignant hyperthermia).

#### **Adverse Effects of Depolarizing NMBAs**

Succinylcholine administration correlates to a significant rise in the serum potassium. Therefore, it is recommended to avoid use succinylcholine in patients with chronic renal disease, burn patients, patients with crush injuries and rhabdomyolysis. Elevated potassium level can lead to fatal arrhythmia.

Succinylcholine is also associated with bradycardia especially in the pediatric population. The stimulation of the nicotinic receptor activates a muscarinic receptor that produces bradycardia. The effect can be blunted by administering atropine or glycopyrrolate.

The use of succinylcholine carries associations with increased intracranial pressure and intraocular pressure. The administration of adequate age-appropriate sedation can minimize this unwanted side effect. Other side effects of succinylcholine include jaw rigidity, hypersalivation, and hypersensitive reaction.

Another side effect of succinylcholine is malignant hyperthermia; this is a pharmacogenetic disorder that occurs with the use of volatile inhalation anesthetic agents and succinylcholine. Clinically it can manifest with hypercarbia, hyperventilation hyperthermia, rhabdomyolysis, and metabolic acidosis.

### Non-depolarizing NMBAs

The non-depolarizing NMBA works by a different mechanism. When administered, instead of causing depolarization of the motor plate at the NMJ, they block acetylcholine from binding to the motor plate at the NMJ, an action achieved by competing for the binding site on the alpha subunit of the nicotinic receptors. As the concentration of non-depolarizing NMBA builds up at the junction, relative to ACh, it establishes a neuromuscular blockage. Non-depolarizing NMBAs bind competitively to the receptor at the motor end plate to antagonize the action of ACh which results in a blockage of the neuromuscular transmission. Onset of action is generally slower than depolarizing agents and the duration of action is longer. **Rocuronium** is an example of a non-depolarizing agent.

## Adverse Effects of Non-depolarizing NMBAs

Benzylisoquinolinium, mivacurium, atracurium, cisatracurium, and doxacurium can cause histamine release when administered, which can cause bronchospasm, hypotension, and tachycardia from peripheral vasodilation. Vecuronium, and rocuronium are known as amino steroid NMBAs. Prolonged infusion of amino steroids with concurrent administration of steroids can lead to profound muscular weakness which is otherwise known as critical illness polyneuropathy.

Certain conditions can prolong the effects of neuromuscular blocking agents:

- Hypothermia
- Metabolic derangements
- Hypercalcemia
- Hypermagnesemia
- Hypokalemia
- Hypothermia
- Respiratory acidosis
- Metabolic alkalosis

Close observation of the patient receiving NMBAs is critical to ensuring the targeted level of neuromuscular blockade is achieved.

The choice of NMBA is dependent on the situation or the need for paralysis. NMBAs have various lengths of neuromuscular block and therefore are chosen patient specific, depending on their onset and duration of action (Table 1). Complications are usually directly related to the effects of the medications themselves.

**Table 1**

<b>Drug (Type)</b>	<b>Route of Elimination</b>	<b>Onset of Action</b>	<b>Duration of Action</b>	<b>Adverse Effects</b>
Rocuronium (Non-depolarizing)	Hepatic and Renal	30-60 seconds	30 minutes	Anaphylaxis. Little cardiac effect
Succinylcholine (Depolarizing)	Plasma cholinesterase and Renal excretion (10%)	30-60 seconds	4-6 minutes	hyperkalemia , malignant hyperthermia Increased intraocular, gastric, and intracranial pressure Hypotension and Bradycardia
Cisatracurium (Non-depolarizing)	Hoffman Degradation (no renal or hepatic excretion)	2-3 minutes	25-45 minutes	Hemodynamic instability, bronchospasm, rash
Pancuronium (Non-depolarizing)	Renal and Hepatic	2-3 minutes	60-100 minutes	Tachycardia, hypo/hypertension, bronchospasm, rash

**Indications for use of NMBAs****Table 2**

Indication	Rationale
Facilitate endotracheal intubation	Relaxation of laryngeal muscles facilitates passage of endotracheal tube
Facilitate mechanical ventilation and improve gas exchange when management cannot be done with sedation, analgesia and ventilator parameter manipulation alone.	The discomfort caused by high levels of PEEP, prolonged inspiratory time, and inverse I:E ratio required to treat certain types of illness (poor chest wall and lung compliance) cause asynchrony between the patient and ventilator i.e. ARDS, Status Asthmaticus
Struggling, “bucking”, coughing or hiccupping despite adequate sedation	There is increased risk of poor oxygenation and barotrauma resulting from asynchrony thus requiring relaxation of respiratory muscles.
Reduce intracranial pressure (ICP) peaks associated with muscular effort in patients with elevated ICP	Paralysis lowers ICP and increases perfusion to brain.
Transient control of shivering i.e. during induction of therapeutic hypothermia	Prevents increased oxygen consumption and hypercarbia
Reduce the metabolic demands of breathing	NMBAs decrease the metabolic rate preventing hypercarbia, hypoxia, acid-base imbalance, and myoglobinuria
Tetanus	NMBAs relax muscles, and prevent autonomic nervous system disturbances, sympathetic over activity, and high levels of catecholamines.
Status Epilepticus	Helps to control the cerebral metabolic rate which decrease the bodies oxygen demand and can prevent bodily injury, <b>BUT NMBAs do not suppress seizure activity.</b>
Control of movement during certain procedures or when certain types of lines are in situ (e.g. Intra-Aortic Balloon Pump)	Maintain patient safety and minimize interruption of care and treatment.

Adapted from Sudbury Regional Hospital’s Train of Four monitoring self-learning program (2006).

**Reversal of NMBAs**

For all NMBAs (except succinylcholine) reversal is achieved by the administration of an acetylcholinesterase inhibitor (e.g. Neostigmine or Edrophonium) with concurrent administration of antimuscarinic agents (Atropine or Glycopyrrolate) which prevent the cholinergic effects produced by the acetylcholinesterase inhibitors (e.g. bradycardia).

Reversal of NMBAs is required for cases of over-blockade or when recovering a patient post-operatively.

After the completion of a surgical procedure or when a patient is weaning toward extubation, the NMBA might be reversed pharmacologically to prevent unwanted side effects and facilitate quick extubation. Traditionally neostigmine reverses NMBAs. The mechanism of action of neostigmine is inhibition of acetylcholine esterase (AChE), the enzyme responsible for the breakdown of

acetylcholine (ACh). The increased level of ACh will compete with NMBA and stimulate the nicotinic receptors at the neuromuscular junction enhancing signal transmission.

Recent advances in anesthesia have seen the introduction of a new drug Sugammadex, which is the cyclodextrin which selectively binds to plasma NMBA. By the process of encapsulation, it rapidly nullifies the effect of the NMBA as it is unavailable to act at the neuromuscular junction.

Sugammadex produces a safe and quick reversal of commonly used NMBA like rocuronium, vecuronium and pancuronium. Sugammadex can quickly reverse both moderate and deep neuromuscular blockage.

### **Contraindications to the Use of NMBAs**

**Table 3**

Contraindication	Rationale
NO advanced airway in place	Cessation of respiration will cause patient to die without airway and respiratory support.
CPAP mode	Ventilator must be set on a mode that includes a set frequency as the patients respiratory effort will cease with paralytic agents.
Inability to administer sedation	Sedation must be administered concurrently with paralytic agents to reduce the potential for post-traumatic stress syndrome.
Unstable bone fractures	Loose bony fragments may further damage surrounding tissues, organs, and blood vessels as the muscles surrounding the fragments relax.
Lack of knowledge regarding potential complications	The patient is at increased risk for the development of complications if staff unaware of the risks associated with NMBAs

Adapted from Sudbury Regional Hospital's Train of Four monitoring self-learning program (2006).

### **Complications of NMBAs**

- Ventilator- associated pneumonia: Perform routine frequent oral care and suctioning (VAP protocol)
- DVT/VTE – patient should be on VTE prophylaxis and/or pneumatic compression device to prevent formation of venous thromboembolism
- Peptic Ulcer disease – patient should be on PPE medication
- Corneal Abrasion – dry eyes can be prevented by application of ophthalmic solution
- Foot Drop and/or Neuropathy - perform ROM exercises, consult Physiotherapy
- Pressure Injuries - prevent with frequent repositioning, use of prealon boots
- Over-blockade – no twitches observed = 100% blockade – hold infusion, notify physician and obtain further dosing orders, reassess TOF q30 min after each rate adjustment and q4h once stable 2/4 target reached



### Principles of Neurostimulation

Muscular contraction in response to peripheral nerve stimulation is reliant on the current delivered and by the amount of current required to elicit a response – this is called the **threshold current**.

*A baseline threshold current should be obtained prior to the initiation of neuromuscular blockade, when possible.*

Resistance is the force opposing the flow of energy between the electrodes.

$$\text{CURRENT} = \frac{\text{VOLTAGE}}{\text{RESISTANCE}}$$

An increase in tissue resistance must be compensated with a proportional increase in voltage in order to maintain a constant stimulating current. It is important to properly prepare the skin in the area to be stimulated in order to minimize resistance.

- Clean area
- Remove body hair
- If very edematous choose alternate location

### Train of Four Monitoring

Peripheral nerve stimulation helps to accurately monitor the patient receiving NMBAs and therefore decreases avoidable side effects related to the use of NMBAs such as unwanted movement, prolonged paralysis and delayed recovery from drug and/or metabolite accumulation. There are several methods of monitoring neuromuscular blockade. Train of Four (TOF) testing is the most commonly used method of peripheral nerve stimulation in ICU and is thought to be the least painful method for the patient. It is done by counting the number of twitches elicited through electrodes placed along the nerve pathway. In the absence of NMBAs, each impulse delivered will produce one contraction (twitch) of equal amplitude/acceleration. With increasing neuromuscular blockade this twitch response fades with the twitch resulting from the fourth impulse lost first, then the third, then the second and finally the first. The number of twitches observed indicates the degree of neuromuscular blockade achieved (Table 4). This allows for delivery of the minimum amount of NMBA required in order to achieve the desired effect, while preventing the likelihood of over-paralyzing the patient and causing prolonged muscular weakness.

**Table 4**

<b>TOF Response</b>	<b>Approximate Percentage of Receptors Blocked by Agent</b>	<b>Clinical Significance</b>
Four twitches	0-75%	May be able to move although may experience weakness.
Three twitches	75%	May need to administer additional drug to prolong relaxation
Two twitches	80%	Suitable for short term relaxation as well as long term ventilation
One twitch	90%	Suitable for short term procedures including intubation, and long term mechanical ventilation
No twitches	100%	Conditions for intubation. Long term saturation may lead to prolonged effects.

Adapted from Sudbury Regional Hospital's Train of Four monitoring self-learning program (2006).

Prior to the initiation of NMBA the **threshold current** should be determined and recorded. This may not always be possible, if the patient has had bolus doses of succinylcholine or rocuronium to facilitate rapid endotracheal intubation. However, it may be feasible to allow the initial dose of paralytic (NMBA) to wear off briefly to obtain the baseline threshold current, prior to initiating the loading and maintenance doses of NMBA.

On initiation of the NMBA infusion and after any dosing changes TOF monitoring is to be completed q30minutes until desired block is achieved then q4h. During NMBA infusion, the **target of \*80% to 90% blockade is recommended\* (correlates to 2/4 twitches).**

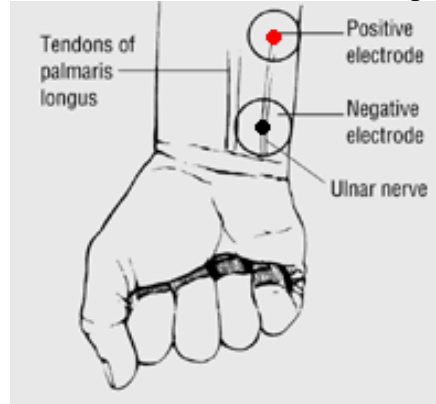
## Procedure

### **Obtaining threshold current – done prior to administering NMBA**

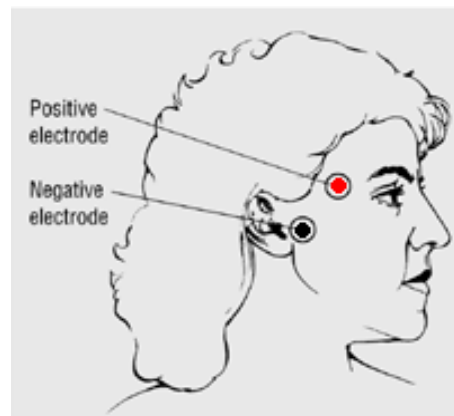
1. Apply leads to selected site. Optimal nerve stimulation occurs when the negative electrode is placed directly over the nerve and the positive electrode is placed 2-3 cm proximal to the negative electrode along the nerve path.
2. Turn on peripheral nerve stimulator.
3. Select the necessary current required to elicit a twitch when stimulus applied (usually 10-20 mA) using the stimulus amplitude control dial. If the patient is already chemically paralyzed, set the current at 50 mA. **Supramaximal stimulation (SMS)** is the level at which additional stimulation will not increase the intensity of the 4 twitches. The SMS is important as it is the baseline for further comparison and establishes what the adequate stimulating current is prior to NMBA therapy is initiated.
4. To determine supramaximal stimulation, start current at 20 milliamps.
5. Press the Train-of-Four button once and release.
6. Increase the current by 10 milliamps at a time until the greatest twitch response is observed. Allow 10-15 seconds between each attempt. This point marks the maximal stimulation.
7. A “train” of four impulses will be delivered 0.5 seconds apart and four twitches should be observed. Also the output indicator light will flash with each stimulus delivered.
8. The twitch response need not be equal in strength. In some cases muscle twitches may be felt by the PNS operator's fingers and not visually observed. An accurate response to the PNS for each location is as follows: **ULNAR NERVE** - only observe the thumb twitch. **FACIAL NERVE** - only observe facial twitch which includes more than just the eye area. The cheek and side of mouth on same side as stimulation also must twitch. **POSTERIOR TIBIAL NERVE** - only observe the great toe twitch.
9. If no twitches observed: recheck connections, electrodes and battery.
10. Retry, pressing TOF once at previous current.
11. If no twitches observed turn the stimulus amplitude control dial to increase amperage until twitches observed.
12. If still no twitching observed, report to MD **prior** to initiating NMBA.
13. **Turn off nerve stimulator between uses.**
14. The **supramaximal** threshold should be determined **each time electrodes are changed** or repositioned, and **following boluses or rate adjustments of the NMBA.**
15. For periodic, on-going assessments, the current should be set at the supramaximal threshold determined as above. Monitor the twitch response, i.e., number of twitches seen out of four stimuli administered. The degree of block may be estimated by counting the number of twitch response seen from Train of Four (TOF) stimulation. As the depth of neuromuscular blockade increases, the number of elicited responses decreases.

### Sites and Lead Placement

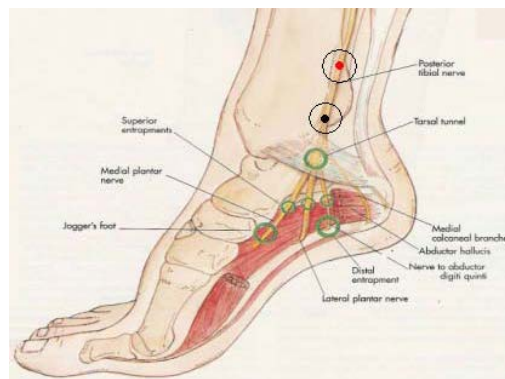
**Ulnar Nerve** (recommended site): place negative electrode (black) on wrist in line with the smallest digit and 1-2 cm below the skin crease. Place the positive electrode (red) 2-3 cm proximal to the negative electrode. Response: thumb adduction (adductor pollicis muscle)



**Facial Nerve**: place the negative electrode (black) by the ear lobe. Place the positive electrode (red) 2 cm from the eyebrow inferior and lateral to the eye. Response: eyelid twitching (orbicularis oculi muscle)



**Posterior Tibial nerve**: place the negative electrode (black) over inferolateral aspect of medial malleolus (over area of posterior tibial pulse palpation). Place positive electrode (red) 2-3 cm proximal to the negative electrode. Response: Plantar flexion (curling) of big toe (flexor hallucis brevis muscle)



### Troubleshooting

Potential patient problems:

- Edema of monitoring site
- Diaphoresis or skin moisture
- Thick skin or wrist
- Electrolyte abnormalities
- Previous nerve injury
- Neuromuscular diseases such as Myasthenia Gravis, Bell’s Palsy (may not respond normally to nerve stimulation)

Potential technical problems:

- Poor lead connection to machine
- Battery needs to be replaced
- Electrode placement and polarity
- Electrodes need to be replaced (should be replaced q24h)

### Nursing Care and Considerations

Nursing Consideration	Rationale
Ensure advanced airway and mechanical ventilation with fixed rate (SIMV, CMV) prior to initiation of NMBA	NMBAs paralyze the diaphragm thus removing the patient’s ability to breath independently
Obtain physician order for: <ul style="list-style-type: none"> <li>➤ Sedation/analgesia</li> <li>➤ Eye lubrication</li> <li>➤ DVT prophylaxis</li> <li>➤ Physiotherapy</li> </ul>	<ul style="list-style-type: none"> <li>➤ NMBAs have no sedative or analgesic properties</li> <li>➤ Inability to blink can result in damage to the cornea</li> <li>➤ Inability to constrict leg muscles increases risk for DVT development</li> <li>➤ Passive ROM can reduce the risk of developing skin breakdown, muscle atrophy, and DVT</li> </ul>
Administer sedation and analgesic prior to initiating TOF and NMBA	Reduce risk of post-traumatic stress syndrome. Common signs of pain and anxiety may not be evident under the effect of neuromuscular blockade
Initiate pressure ulcer prevention strategies	Patients who are paralyzed with NMBA are unable to position themselves and are at increased risk for developing skin breakdown and pressure ulcers.
Regular tracheal suctioning	Patients are unable to cough and are at increased risk of developing pneumonia.
Acknowledge all ventilator alarms promptly, continuous monitoring of oxygen saturation	Able to respond quickly to any respiratory issues.
Reassess TOF supramaximal stimulus threshold and ensure target of 2/4 twitches following any NMBA rate adjustment or boluses	Ensure paralysis is being achieved with the minimal amount of NMBA necessary.

Keep ambu-bag at bedside	Enables immediate response in case of endotracheal tube displacement or ventilator malfunction.
Continuous monitoring of T, HR, RR, SpO2 and BP monitoring by arterial line	Some NMBAs can cause bradycardia, tachycardia, hypotension, hyperthermia (malignant), hypothermia
Perform pain assessment (CPOT) q2h and PRN – watch for signs of pain in response to turning, suctioning, wound care, etc.	Patients receiving NMBAs cannot express pain scale verbally – use a validated non-verbal pain tool
Perform pupillary assessment q4h minimum during paralysis and apply ophthalmic ointment to maintain eye moisture and prevent corneal abrasions	All other means of assessing neurological functioning (response to painful stimuli, voluntary limb movement) are absent when NMBAs are being administered and pupillary response to light is the only method of identifying possible neurologic problems.
Visual and clinical assessment of the patient's response to NMBAs in conjunction with TOF monitoring	Watch for signs of voluntary breathing or other movement when assessing patient, or changes in vital signs which may indicate lack of sedation
Maintain sedation as paralytics being weaned, until TOF reaches 4/4 twitches of equal acceleration/amplitude	Further decrease the risk of post-traumatic stress.
Communicate with patient prior to performing interventions and during provision of care	Providing psychological support to the patient by orienting patient to time, care activities taking place will help to lessen post-traumatic stress reaction – patient cannot move and is sedated but may be able to hear and have sensation to touch
Perform teaching with patient's family related to the use of NMBAs	Explain the reason for administering an NMBA. Explain how the peripheral nerve stimulation (TOF testing) will help guide the medication dosing. Describe the experience of the stimuli as a slight prickly feeling that the patient may or may not feel to help reduce anxiety and knowledge deficit
Place sign at the head of patient bed indicating *NMBA in Use*	Ensures any health professional entering the room is aware of neuromuscular blockade.



### **Documentation**

Train of four testing is to be completed q30minutes on initiation and after dosing changes until the desired number of twitches is achieved and then testing is completed q4h.

Documentation consists of:

1. Train of Four testing site
2. Threshold current
3. Train of Four response
4. Any required interventions i.e. holding or rate change of the NMBA infusion, alerting physician

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## Appendix A

### Peripheral Nerve Stimulation – Train of Four Certification Test

1. Neuromuscular blocking agents may be used in the critical care setting for the following reasons:
  - a) Facilitation of endotracheal intubation
  - b) To facilitate mechanical ventilation
  - c) To reduce the metabolic demands of breathing
  - d) All of the above
2. When using neuromuscular blocking agents in the critical care setting, patients are identified as receiving an NMBA by:
  - a) Placing a sign in the patient records
  - b) Placing a sign at the head of the bed
3. Neuromuscular blocking agents have no analgesic properties.
  - a) True
  - b) False
4. Peripheral nerve stimulation is defined as:
  - a) The application of energy
  - b) The application of electrical energy
  - c) A method to objectively monitor the degree of neuromuscular blockade
  - d) A method to objectively monitor the degree of sedation
5. Peripheral nerve stimulation – Train of Four testing helps to decrease avoidable side effects of neuromuscular blocking agents such as:
  - a) Prolonged paralysis
  - b) Delayed recovery from drug and/or metabolite accumulation
  - c) Both of the above
  - d) None of the above
6. The stimulus for the Train of Four is delivered as a total of 4 pulses. The number of responses (twitches) to the TOF stimuli indicates the degree of blockade. A patient who is receiving a continuous infusion of a non-depolarizing neuromuscular blocking agent has 2 responses (twitches) to TOF testing. The approximate percentage of receptors blocked by the agent is:
  - a) 0 to 75 %
  - b) 75%
  - c) 80%
  - d) 90%

- 
7. A patient who is receiving a continuous infusion of a non-depolarizing neuromuscular blocking agent has 0 responses (twitches) to TOF testing. The appropriate nursing response is:
- a) Notify physician
  - b) Reassess in 1 hour
  - c) Reassess in 2 hours
  - d) Document response, discuss on next set of rounds
8. Any nurse floating into ICU for a shift may access the Peripheral Nerve Stimulation -Train of Four Procedure from the Nursing Policy and Procedure Manual and perform this test on a patient.
- a) True
  - b) False
9. Documentation of Peripheral Nerve Stimulation – Train of Four testing should include:
- a) Date and response level of blockade
  - b) Date, time and site
  - c) Date, time, site, response level of blockade and any required rate adjustments or interventions
10. A patient is receiving a continuous infusion of a neuromuscular blocking agent. The therapeutic goal for this client is 2 responses (twitches) to TOF testing. The physician order reads “Train of Four testing q 4 hours and prn at the ulnar nerve with goal of 2 twitches”. This is an appropriate order.
- a) True
  - b) False
11. Troubleshooting measures may include:
- a) Re-checking connections and battery
  - b) Checking electrodes for correct placement
  - c) Checking leads for correct polarity
  - d) All of the above



### Appendix B Certification Checklist

Skill Steps	Yes	No
1. Confirms physician order		
2. Gathers appropriate equipment: ➤ Peripheral nerve stimulator ➤ 2 electrode pads ➤ Alcohol wipes ➤ Razor (if needed)		
3. Ensures sign at head of bed		
4. Remove hair at site if needed and cleanse area with alcohol and allow to dry before applying electrodes		
5. Identifies correct nerve		
6. Places electrodes in correct position over nerve		
7. Attaches black lead to distal electrode pad and red lead to proximal electrode pad		
8. Turn the nerve stimulator on to threshold current level		
9. Performs TOF testing		
10. Observes for and counts the number of twitches elicited		
11. Identifies the percentage of block indicated by number of twitches observed		
12. Identifies next steps based on objective finding		
13. Turns off the nerve stimulator between uses		
14. Documents site, threshold and response to TOF stimulation in chart.		

Nurse's Name: \_\_\_\_\_ Date: \_\_\_\_\_

Certified by: \_\_\_\_\_

\*Please provide the signed copy of this certification checklist to your Manager/Professional Practice Specialist or ICU Clinical Resource Nurse