Subject: Peripheral Nerve Stimulator Use

Policy: The Registered Nurse may utilize the Peripheral Nerve Stimulator, PNS, when neuromuscular blocking agents, NMBA, are used with mechanically ventilated patients in the ICU setting. Results of PNS use can guide the physician and registered nurse in determining appropriate NMBA titration dosage for optimal paralysis.

Purpose: The PNS may be used with neuromuscularly blocked ventilator patients to determine level of paralysis to diminish avoidable side effects of NMBA use such as prolonged paralysis, ventilator dependence, unwanted movements and delayed muscle recovery from drug or metabolite accumulation.

Additional Information:

The PNS provides a burst of electrical impulses which stimulates muscle contraction innervated by a selected nerve. Train of four (TOF) testing gives the registered nurse data relating to percentage of muscle receptor blockade of the nerve indicated by twitches during the TOF impulses.

1. The PNS includes other settings of “single twitch,” “tetany,” and “double burst.” The Train of Four (TOF) setting is preferable due to a greater degree of quantification of block and less discomfort than other settings.
2. Sedation and analgesia are desirable before NMBA use of TOF testing.
3. If possible, TOF assessment should begin before NMBA use to obtain a threshold level and proper pad placement.
4. Initially and after NMBA dosage changes, nerve stimulation should be assessed every 15 minutes until a steady state is achieved then every 30 – 60 minutes thereafter.
5. Pharmacology:
   a. NMBA include the compounds: cisatracurium, pancuronium, succinylcholine, mivacurium, rocuronium, vecuronium, atracurium, pipcuronium, doxacurium.
   b. Sedatives include: barbiturates, benzodiazepines.
   c. Analgesics include: all narcotics-morphine, meperidine, hydromorphone, fentanyl. These also have sedative properties.
6. Alternate electrode placement may be necessary due to forearm dressings, edema, invasive lines, open wounds or pre-existing paralysis.
   a. Facial nerve related to orbicularis oculi muscle: eyelid twitching.
   b. Sural nerve related to flexor hallucis brevis muscle: plantar flexion (curl) of the 3, 4, 5 toes.
7. Because of the nature of ulnar nerve and diaphragmatic innervation similarities, ulnar nerve testing is preferable for indication of potential ventilator weaning.
8. Clinical decisions of NMBA titration should be based TOF data as well as assessment of oxygenation, ventilation, neurologic function and tissue perfusion.
9. The physician will determine desired level of paralysis, ie. numbers of twitches desired on TOF.
10. The physician will be notified if the level of paralysis differs greatly or if patient is 100% paralyzed.
11. The TOF stimulus is low frequency 50-100 Hz for 2 seconds at 0.5 second intervals for 4 pulses.
12. The number of twitches to TOF stimuli indicates degree of neuromuscular blockade.

<table>
<thead>
<tr>
<th>TOF Response</th>
<th>Approximate Percentage of Receptors Blocked by Agent</th>
<th>Clinical Significance</th>
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<tbody>
<tr>
<td>Four Twitches</td>
<td>0 to 75</td>
<td>May be able to move although may experience weakness. Amenable to reversal of blockade with antagonist.</td>
</tr>
<tr>
<td>Three Twitches</td>
<td>75</td>
<td>May need to administer additional drug to prolong relaxation. Short or intermediate acting agents may be reversible.</td>
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<tr>
<td>Two Twitches</td>
<td>80</td>
<td>Suitable for short term relaxation as well as long term mechanical ventilation.</td>
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<tr>
<td>One Twitch</td>
<td>90</td>
<td>Usually gives conditions suitable for short term procedures including intubation and long term mechanical ventilation.</td>
</tr>
<tr>
<td>Twitches Absent</td>
<td>100</td>
<td>Conditions for intubation. Long term saturation may lead to prolonged effects.</td>
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</table>

13. Use PNS with caution in patients with external pacing catheters or pacing lead wires as microshocks could stimulate myocardium to dysthymia.
14. Specific reversal agents should be readily available: Neostigmine and glycopyrolate.

**Equipment:**
- PNS with 2 lead wires.
- 2 fresh small or infant electrode pads.
- Ball electrode attachment may be substituted for electrodes and lead wires.
- Suitable batteries.
**Ulnar Nerve:** The electrodes are placed on the wrist in line with the smallest digit.

**Response:** 4\textsuperscript{th} and 5\textsuperscript{th} finders twitch

![Placement of electrodes along the Ulnar Nerve](image1.png)

**Facial Nerve:** Electrodes are placed along the facial nerve inferior and lateral to the eye.

**Response:** Orbicularis occuli muscle – eyelid twitching.

![Placement of electrodes along the Facial Nerve](image2.png)
**Sural Nerve:** Electrodes are placed over the inferolateral aspect of the medial malleolus

**Response:** Fexor hallucis brevis muscle – planter flexion (curl) of 3, 4, 5 toes.

![Diagram of Sural Nerve](image)

**Procedure**

1. Explain purpose of PNS test to patient and family. Assemble equipment.

2. Wash hands.

3. Extend arm, palm up, in a relaxed position.

4. Attach electrodes in wristline of little finger; attach lead wires proximately and distally and plug into PNS.

**Key Points**

1. Anxiety associated with equipment and sensation of test may be decreased by knowing what to expect.

2. Ulnar nerve is superficial and easy to locate. If facial nerve is used, place one lead at the outer canthus of the eye and the second lead approx. 2cm below and parallel with the tragus of the ear.

3. Preferable use of infant electrodes 2 to 3 inches apart. If poor twitch response, polarity can be reversed by switching wires.
5. Turn on PNS and select low mA. Adjust to obtain initial twitch threshold level.

6. Depress the TOF key and observe twitching of the fingers, counting the number of twitches. Placing a hand over fingers may reduce artifact of finger movements.

5. Excess stimulation may result in repetitive nerve firing.

6. Expected outcomes:
   a. slight discomfort during TOF.
   b. Desired 1-2 twitches of 4th and 5th fingers during TOF.
   c. NMBA dosage titrated according to twitching level.

Unexpected outcomes
   a. moderate to severe discomfort during TOF stimulation, IP mA too high.
   b. Injury to skin with electrode removal.
   c. Resumption of 4 twitching does not occur within 2 hours of NMBA discontinuation.
   d. Patient movement despite acceptable TOF.

7. If absence of twitching, check connections, electrodes and batteries.

7. Absence of twitching may mean 100% blockade if device working. Notify physician.

8. Turn off PNS between uses.

9. Wash hands.

Documentation:
1. Date of the test.
   a. time
   b. mA
   c. TOF twitch response
   d. nerve site used
   0/4 1/4 2/4 3/4
   100 90 (recommended level) 85 (recommended level) 80

2. Patient and family education
   4/4 75 or less

3. Unexpected outcomes, trouble shooting attempts and additional interventions.

4. Contact with physician and change of NMBA infusion.

References:
3) Rudis Mi, Sekora CA, anges E, it al. A perspective, randomized, controlled evaluation of peripheral nerve stimulation versus standard clinical dosing of neuromuscular blocking agents in critically ill patients.
4) Aacn.org http://pedsccm.wustl.edu/clinical/NMB_monitoring.html