POLICY

1. Patients receiving Neuromuscular Blockade (NMB) infusions or those who have received NMB bolus/infusion require ongoing respiratory assessment/support. {See CC 45-070 Mechanical Ventilation Initiation maintenance and Weaning and Care of the Patient using Oscillator Ventilation (pending)}

1.1. In cases where NMB has been given and no mechanical ventilator is available, mechanical ventilation may be carried out using a bag/valve/ mask

2. Train-of-four (TOF) is the most commonly used test to assess the degree of NMB.

3. Refer to Learning Supplement (Appendix A) for additional information on NMB and TOF.

DEFINITIONS

Neuromuscular blockade (NMB) The intentional paralysis of skeletal muscle using drug therapy.

Neuromuscular Blockade Agents (NMBA):

There are two types of NMBA, depolarizing and non-depolarizing.

- **Depolarizing agents** - Agents that combine with receptors resulting in persistent depolarization. **Succinylicolone is the only depolarizing agent currently in clinical use.** Succinylicolone has a rapid onset and short duration making it useful in procedures such as endotracheal intubation.

- **Non-depolarizing agents** - Agents that compete with acetylcholine at the receptor site. The degree of paralysis
increases with the number of receptors occupied by the NMBA. NMBA currently used to manage critically ill patients in the ICU are primarily non-depolarizing. Non—depolarizing agents include Pancuronium, Cisatracurium, and Rocuronium

GUIDING PRINCIPLES

1. Metabolism and elimination of NMBAs differs, accounting for variations in level of blockade particularly in renal or hepatic compromised patients.

2. Critically ill patients may require temporary chemical paralysis to optimize clinical goals when maximal doses of sedation and analgesia have not been adequate to reach the desired goal.

3. NMBA’s exert their primary effects at the neuromuscular junction (NMJ) of the motor neuron by interfering with the release of acetylcholine. The effectiveness of any medication is a function of volume of distribution, ability to bind receptors and the efficiency of the breakdown/elimination processes. Nursing assessment of the degree of blockade is required to provide optimal patient outcome without compromising long-term recovery (Train of Four Assessment--TOF)( Corso,2008)

4. Most critically ill patients have some degree of multi-organ dysfunction/failure and this may influence drug levels as well as blood work results.

5. A core temperature of less than 36 degrees C and peripheral cooling may decrease twitch response and prolong blockade. In these situations facial nerve TOF monitoring is most appropriate.

PROCEDURE

Equipment:
- 2 EKG electrodes
- alcohol swabs
- razor for shaving area if required
- peripheral nerve stimulator

<table>
<thead>
<tr>
<th>Number of twitches</th>
<th>Approximate % or receptors blocked</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>90</td>
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<tr>
<td>2</td>
<td>75-80</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
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<tr>
<td>4</td>
<td>0</td>
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</tbody>
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From Critical Care Nurse Vol 28(3) June 2008. 32.
1. Assess for Indications in Critical Care as follows:
   1.1. Procedures including intubation, tracheostomy and complex dressing changes.
   1.2. Facilitate mechanical ventilation
   1.3. Decrease oxygen consumption and address oxygen supply/demand imbalances
   1.4. Management of status asthmaticus
   1.5. Management of hypothermia post cardiac arrest
   1.6. Adjunct to management of tetanus
   1.7. Treatment of muscle spasm
   1.8. Adjunct to management of increased ICP
   1.9. Transport of an unstable patient including those with unstable fractures and head injuries

2. Monitor the degree of NMB using visual, tactile and electronic assessments of muscle tone.

   **Visual**
   Observation of skeletal muscle movement and/or respiratory effect may indicate inadequate NMB.

   **Tactile**
   Tactile evaluation of motor response to a stimulus is more reliable than visual evaluation with TOF stimulator. Tactile evaluation involves touching the area being stimulated to assess response instead of relying on vision.

   Complete paralysis is not always required or desired. The degree of muscle paralysis should be ordered, assessed and drugs and/or drips titrated depending on the clinical circumstances.

   **Electronic**
   A peripheral nerve stimulator (PNS) is used to assess the depth of NMB by delivering an electrical stimulus to a peripheral motor nerve. The electrode closest to the nerve is the positive (red). The other electrode is negative (black). It is imperative that you understand how the PNS that you are using works as there are many types available at CDHA.

Information from references complied into this diagram summer 2010 by DW at CDHA

3. **Assess for factors that interfere with the TOF:**
   3.1. Obesity
   3.2. Edema
   3.3. Dry skin
   3.4. Perspiration
   3.5. Sepsis

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3.6. Medications that antagonize or potentiate the blockade

4. **Facilitate TOF assessment:**
   
   4.1. Change electrode pads daily. Label date and time
   
   4.2. Reapply electrode to same site for consistency
   
   4.3. Clean and dry skin well to increase contact
   
   4.4. Assess core temperature, which should be greater than 36 degrees C. Peripheral cooling can decrease the twitch response
   
   4.5. Keep in mind factors that potentiate and antagonize NMB
   
   4.6. Check the battery and wires of the PNS
   
   4.7. Assess TOF prior to initiating NMB if possible.
      
      4.7.1. Assess depth of blockade frequently (at least q1h) depending on patient status and response to blockade agent.

5. **Titrating the Drip**
   
   5.1. If the depth of blockade is greater than ordered, stop the drip and assess:
      
      5.1.1. TOF q15 minutes with Cisatracurium
      
      5.1.2. TOF q 30 minutes with Rocuronium and Pancuronium
   
   5.2. When one twitch/two twitches (as ordered) return, restart infusion at one half previous dose.
   
   5.3. If TOF indicates more twitches than ordered increase the infusion increased by 25%.
   
   5.4. If required, use a Bispectral Index (BIS) monitor as an adjunct to sedation evaluation (not NMB evaluation).
      
      **Note:** A BIS monitor processes EEG data that measures hypnotic effect of anesthetics and sedation on the brain. It is expressed as a number of 0-100. (0=no brain activity, 100 = awake). Typical “ideal “sedation is 50. The use of BIS Monitor has not yet been extensively validated in the ICU setting although use in the OR is becoming common.
   
   5.5. Do not rely on the BIS alone. Use clinical judgment when interpreting the BIS. (Refer to CC 07-095 BIS (Bispectral Index) Monitoring)

6. **Train-of-four (TOF) Responses**

   **Measure Train-of-four (TOF) responses at one of the following three common sites:**

6.1 **Facial Nerve**

   6.1.1. Place the negative electrode over the lateral forehead where the temporal branch of the facial nerve lies.
   
   6.1.2. Place the positive electrode elsewhere on the forehead. (A response in eyelid or cheek will be seen, depending on positioning)
6.1.3. Assess for a response to Train-of-four stimulation as detected by palpitation or visible twitch.

**Note:** Using the facial nerve may underestimate the degree of neuromuscular blockade.

### 6.2. Ulnar Nerve

6.2.1. Select left or right forearm
6.2.2. Use two electrodes-black or negative lead and red or positive lead
6.2.3. Shave excessive hair, wipe sites with alcohol swab
6.2.4. Date the electrodes; change daily
6.2.5. Make sure the unit is off before connecting the stimulator
6.2.6. Connect the electrical source with the negative lead (black) attaching to the electrode closest to the hand (see pictures)
6.2.7. Turn power on, turn up voltage. Start low and increase the voltage; be aware that this is a painful procedure for the patient.
6.2.8. Position the arm with the palm up, press the train-of-four button, which will deliver four stimulations in two seconds
6.2.9. Observe thumb and fingers. Count the number of twitches

**Note** - One to two twitches indicate a block of 90%.

6.2.10. Measure neuromuscular blockade q1h when meds are being titrated or q2h if a stable infusion rate has been established.

### 6.3. Posterior Tibial Nerve

6.3.1. Apply the negative electrode between the medical malleolus and the Achilles tendon
6.3.2. Place the positive electrode 1 to 3 cm. further up the ankle
6.3.3. Assess for flexion of the great toe which can be detected by palpation when stimulus is delivered.

7. **Assess for the need for the following Nursing Therapies Related To NMBA:**

7.1. Sedation and pain control
7.2. Mechanical ventilation (Refer to CC 45-070 Mechanical Ventilation Initiation maintenance and Weaning)
7.3. Regular ROM exercises and repositioning
7.4. Exercise caution against overextensions when repositioning or performing ROM exercises as muscle resistance is lost
7.5. Frequent turning to avoid skin breakdown and atelectasis
7.6. Frequent suctioning to remove secretions from lungs
7.7. Ophthalmic lubricant to decrease risk of corneal abrasion( taping lids closed may be required)
7.8. DVT prophylaxis and antiembolic hoses or Pneumatic Stockings (Authorized Prescriber’s order required).

7.9. Family and patient explanations related to purpose of Neuromuscular blockade

REFERENCES


RELATED DOCUMENTS

Policies

CC 07-095  BIS (Bispectral Index) Monitoring

CC 45-070  Ventilation Initiation Maintenance and Weaning

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CC xx-xxx  Care of the Patient using Oscillator Ventilation (pending)

Appendices

Appendix A - Learning Supplement – Neuromuscular Blockade Agents and Train of Four Monitoring

Other

CDHA online IV Drug Manual

* * *
Appendix A
Learning Supplement – Neuromuscular Blockade Agents and Train of Four Monitoring

1. Associated side effects and complications:
   1.1. the patient is awake and paralyzed
   1.2. airway mishaps – accidental ventilation disconnection or extubation
   1.3. accumulation of drugs and metabolites
   1.4. cardiovascular response – tachycardia, bradycardia and hypotension
   1.5. skin breakdown
   1.6. peripheral nerve injury
   1.7. continued paralysis
   1.8. DVT
   1.9. Acute neuropathy – an uncommon but not rare major complication demonstrated as diffuse, persistent weakness long after NMBA discontinued. It is unclear if certain drug combinations carry an increased risk of myopathy but it maybe prudent to avoid possible adverse combinations such as steroids and NMBA’S.

2. The choice of neuromuscular blocking agent depends on:
   2.1. Onset of action
   2.2. Duration of action
   2.3. Side effects
   2.4. Renal and hepatic function (mechanism of elimination)
   2.5. Hemodynamic stability
   2.6. Cost
   2.7. Clinical experience

(Mehra et al, 2009)

3. Analgesic or amnesic effects
   3.1. Neuromuscular blocking agents (NMBA) do not have analgesic or amnesic properties. It is impossible to accurately assess pain and anxiety in a paralyzed patient. The clinical signs of pain or anxiety may be alterations in heart rate and blood pressure in response to interventions or verbal stimulus but these parameters are also affected by other physiologic processes. Medication for pain and anxiety must be administered prior and concurrently with neuromuscular blockade. Communication with the patient must be maintained with explanation of environment, procedure and presence of staff.

4. Reversal Agents
4.1. The newest drug on the horizon is sugammadex being used for rocuronium and vecuronium induced NMB (presently being trialed clinically in Europe.) The exact amount of dose required and the cost are unknown. (Kopman, p18.). The drug presently in use for reversal is neostigime.

5. Complications

5.1. Acute Quadriplegic Myopathy Syndrome (AQMS), floppy man syndrome, critical illness polyneuropathy (CIP), and acute myopathy. Regardless of the term used, profound immobility results causing skeletal muscle atrophy and functional alterations in very major organs (Foster & Clark, p 3.)

6. Patterns of Weakness

6.1. Two patterns of weakness have been identified.

6.1.1. Prolonged Recovery Time as determined by pharmacologic parameter such as duration of action and accumulation of metabolites.

6.1.2. AQMS - a devastating diffuse weakness lasting from days to months (Foster & Clark, p 3.). It has been proven that the concurrent administration of corticosteroids and vecuronium or Pancuronium may precipitate muscle fiber degeneration resulting in AQMS. Corticosteroids do not directly interfere with impulse transmission at the neuromuscular junction. These cause direct muscle tissue damage. Atrophy, necrosis, architectural disarray, myosin loss with degeneration of fibers, lipid accumulation, and multiple metabolic alterations can occur (Whetstone & Clark, p.8.)

7. Assessment of Effectiveness of Blockade

7.1. The risk associated with inadequate or excessive blockade warrants monitoring the degree of blockade.

7.2. Peripheral Nerve Monitoring can be an unreliable indicator of NMB due to problems with patient, operator, or equipment. Short term delay in the recovery of neuromuscular activity, evident in the hours to days after termination of NMB, most likely results from slow return of neuromuscular transmission (NMT). This may be attributed to prolonged blockade at the NMJ resulting from an accumulation of drug or metabolites. (Whetstone & Clark, 2006.)

8. Peripheral Nerve Stimulator (PNS)

8.1. The peripheral nerve stimulator provides four possible patterns of nerve stimulus: single twitch, post tetanic, double-burst and train-of-four (TOF).

8.2. Train-of-four is the most commonly used test. There are four stimuli 0.5 seconds apart and delivered over 2 seconds. Visualizing or palpating the number of twitches determines the degree of blockade. (When there is no twitch, greater than 90% of the receptors are blocked. Tactile evaluation of motor response to a stimulus is more reliable than visual evaluated alone.

The optimal degree of blockade is 85-90%.

8.3. The degree of blockade correlates with the ratio of T4/T1. Four Twitches can still be present with substantial (75%) blockade. It is uncommon that degree of blockade needs to be down to 0 or 1 twitch. “There is evidence that TOF values less
than 80% result in measurable decreases in mechanical respiratory reserve, decreased ventilatory responses to hypoxia, an impaired ability to swallow, and protect the airway from aspiration. (Kopman, p15.)