NEUROMUSCULAR BLOCKADE AGENTS (NMBA) - CICU - SCH

PRACTICE GUIDELINE ©

DOCUMENT SUMMARY/KEY POINTS

- NMBAs are high-risk medications used to manage critically ill patients for uncontrolled agitation, to prevent respiratory dyssynchrony, to stop spontaneous respiratory efforts and muscle movement, to improve gas exchange and to facilitate ventilation.[1]
- To promote patient safety and inform clinical decision making when applying these medications to practice, staff should be familiar with pharmacology, dosing, drug interactions, required monitoring and adverse effects.[2]
- Crucial considerations for optimisation of treatment with NMBAs include frequent reassessment of treatment goals, titration of the agents to objective parameters (using clinical assessment and Peripheral Nerve Stimulation (Train-of-Four)monitoring), use of intermittent therapy when possible, implementation of interruption strategies and daily assessment for the need of continuous therapy.[3]
- Only registered nurses who have satisfactorily completed Clinical Competency - Care of the Paediatric Intensive Care Patient and the additional component *Provides care for a stable ventilated infant /child* may independently care for the patient receiving NMBA. This includes staff members undertaking break relief.
- Additional learning and assessment competency plans must be successfully completed.
- The completion of these prior to caring for the CICU patient is not a pre-requisite but should be undertaken as appropriate opportunities arise.
- Nurses caring for patients receiving NMBAs should know the indications, mechanism of action (depolarising or non-depolarising), duration of action, safe management and how to evaluate drug effects [5]
- **Muscle relaxed patients must be nursed 1:1 and never left unattended.**
- Since NMBA agents are devoid of analgesic and sedative properties, they should be used in conjunction with appropriate sedation and/or analgesia to decrease awareness, ease fear and provide comfort. [6] There is no ideal sedation scale for the critically ill child receiving NMBAs. Subsequently, the level of sedation must be adapted to the disease

Approved by:	SCHN Policy Procedure and Guideline Committee	
Date Effective:	1st October 2017	**Review Period:** 3 years
Team Leader:	Clinical Nurse Consultant	**Area/Dept:** CICU SCH

Date of Publishing: 27 September 2017 11:08 AM Date of Printing: 27 September 2017

and clinical state. (Reference 1)

- Daily interruption of the NMBA can allow a window of opportunity to minimize drug accumulation, assess adequacy of sedation and analgesia, and determine ongoing requirements for chemical paralysis.[3]

  The decision to interrupt NMBA on a daily basis will be made on an individual patient basis by the CICU Consultant with exact process and parameters outlined.

- Staff must always be aware of the potential for the use of inadvertent jargon. The use of the word "paralysed / paralysis" when the actual meaning is muscle relaxed can cause extreme distress to both the patient and/or their family.
- Neuromuscular blockade assessment requires not only clinical observation but also Peripheral Nerve Stimulation *(*PNS) monitoring which must be undertaken a minimum of 12-hourly (refer Peripheral Nerve Stimulation (Train of Four) Monitoring in CICU Guideline) [7] and documented accordingly on the CICU flow chart.
- The lowest effective dose should be used to avoid drug accumulation and prolonged neuromuscular blockade and to minimize the risk of adverse events.[3]
- If a non-depolarising NMBA is in use, the reversal agents neostigmine or sugammadex must always be readily available in the unit and it is the responsibility of the bedside nurse to ensure its availability. ***See Reversal for further information***
- Suxamethonium is a depolarising NMBA and its use in CICU is limited to short-term muscle relaxation for facilitation of intubation.

READ ACKNOWLEDGEMENT

- CICU staff are required to read and acknowledge they understand the content of the document.

CHANGE SUMMARY

- This SCH Practice Guideline replaces a previous version of the document.
- More detailed information re PNS and requirement for 12hrly monitoring
- References updated

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Definition

Neuromuscular blockade is the intentional paralysis of a patient using drugs that paralyse skeletal muscle but don't affect cardiac or smooth muscle. Non-depolarising Neuromuscular blocking agents (NMBAs) bind with the nicotinic Acetylcholine (Ach) receptor at the neuromuscular junction and act as competitive antagonists, causing the muscle cell to become insensitive to motor-nerve impulses.[3, 4]

General Information

- NMBAs are high-risk medications used to manage critically ill patients for uncontrolled agitation, to prevent respiratory dyssynchrony, to stop spontaneous respiratory efforts and muscle movement, to improve gas exchange and to facilitate ventilation.[1]
- NMBAs blunt or abolish the neuromuscular protective reflexes of coughing, gagging and blinking.[2]
- Non-depolarising NMBAs e.g. rocuronium, atracurium, pancuronium are competitive antagonists competing with acetylcholine for binding at motor end plate receptors. They are more frequently used as they have much fewer side effects and a longer half-life than depolarising NMBAs. Because of their slower onset and offset, they should not be used in circumstances where a rapid onset and offset is required.
- Motor weakness progresses to flaccid paralysis in the following sequence: [2]
    - **i.** Eyes and fingers
    - **ii.** Limbs, neck and trunk
    - **iii.** Intercostal muscles, abdomen
    - **iv.** Diaphragm.

  The recovery of these muscles occurs in the reverse order.
- Rocuronium is the preferred neuromuscular blocking agent used in CICU:
    - Rocuronium is supplied in a pH 4 solution [9]
    - IV injection of rocuronium can cause pain and withdrawal movements, especially in children [9]
    - As with all muscle relaxants, rocuronium should only be used in patients who are (or are about to be) intubated and ventilated.
- Multiple factors may affect the pharmacokinetics of NMBAs in critically ill patients. Age-related changes (i.e., reduction in total body water, lean body mass, and serum albumin concentration) may result in a reduction in the volume of distribution of NMBAs. [6,10]
- The temperature of blood that is perfusing muscles must be normothermic to restore respiratory mechanics. Hypothermia can profoundly influence pharmacokinetics of a number of medications, including NMBAs. [6]

- Many medications can interact with NMBAs. Interactions can increase or decrease the efficacy of an NMBA within the neuromuscular junction. Use of aminoglycosides and some other antibiotics as well as diuretics can increase the efficacy. Previous chronic administration of phenytoin, corticosteroids and carbamazepine can reduce efficacy. [6]

Standard

- **A muscle-relaxed patient should be nursed under a 1:1 patient / nurse ratio and not left unattended. There will be occasions when patients will be under the supervision of a nurse with a 2:1 patient / nurse ratio. This should only occur following discussion with the Team Leader and ICU Director. The supervising nurse must have the appropriate skill level.**

> **NOTE: Muscle relaxed patients with a 'critical airway' (e.g. newly placed tracheostomy, subglottic stenosis) must be nursed 1:1 and never left unattended.**

- Careful clinical monitoring of patients receiving NMBAs for signs and symptoms suggesting inadequate sedation-analgesia, such as tachycardia, hypertension, lacrimation, or sweating is required.
- Clinical monitoring includes detection of spontaneous breathing through observation of ventilator triggering and end-tidal CO_2 waveforms, as well as trends in vital signs. [3]
- Hourly assessment of pupillary reaction to light stimuli must be performed and documented on the CICU flow chart. Assess pupils immediately if there are any other significant changes in vital signs. *Complete neurological observations cannot be evaluated*.
- Neuromuscular blockade assessment requires not only clinical observation but also Peripheral Nerve Stimulation *(*PNS) monitoring which must be undertaken a minimum of 12-hourly (refer Peripheral Nerve Stimulation (Train of Four) Monitoring in CICU Guideline) [7] and documented accordingly on the CICU flow chart.
- With intermittent bolus doses of NMBA there should be some noted recovery of muscle activity between doses. *Peripheral Nerve Stimulation (PNS) is not required when patient is receiving intermittent doses of NMBA*.

Eye Care

- NMBAs increase the risk of corneal abrasions in critically ill patients. Paralysis abolishes eyelid closure and the blink reflex, which may result in cornea drying, scarring, ulceration, and infection and scarring that can possibly affect the patient's visual acuity. [6, 8] Please refer to the Practice Guideline – Paediatric Intensive Care Patient-Patient Care in CICU – SCH
- Frequent (2-4hrly) eye lubrication with diligent attention to eyelid closure, if needed, is as effective as eye lubrication and moisture chamber therapy in preventing corneal abrasions in critically ill children requiring NMB. [8]
- As corneal abrasions may develop if these therapies are not maintained and monitored, evaluations of the eyes are to be undertaken every 2 - 4 hours to ensure eyelid closure and the application of prophylactic eye protection with artificial ointments undertaken.[8]

Special Considerations

- Risks of NMB include the potential devastating effect of hypoxemia secondary to inadvertent extubation and risks of masking seizures. [11]
  ****RESPOND TO ALL ALARMS IMMEDIATELY****
- Ensure ETT is secured as per CICU practice.
- Suctioning is to be assessed and performed according to the individual needs of the patient.
- Clinicians should evaluate the reason for (at least daily) and depth of neuromuscular blockade (continuously) so that mobility may be achieved faster, which may decrease the prevalence of delirium, increase functional independence, and increase ventilator-free days.[6]
- If the recovery time from the infusion cessation is prolonged it is suggestive of excessive blockage of the neuromuscular junction therefore the NMBA infusion should be reduced according to the consultant.
- Strict and close attention to anatomical positioning is vital due to the absence of skeletal muscle tone. [8] Please refer to the Practice Guideline – Paediatric Intensive Care Patient-Patient Care in CICU – SCH
- Keep head and neck in alignment taking special care when moving the patient to protect spinal cord due to induced muscle relaxation. Repositioning should be undertaken 2 – 4 hourly dependent on patient condition.
- Patient may still be able to hear and feel. Communicate with the patient whenever undertaking any procedure and whenever possible reorientate the patient to time and place.
- Ensure families understand the rationale for use of NMBAs and encourage touch and talking with the patients. Attempt to alleviate parental stress with explanations and reassurance. Involve parents in patient care wherever possible.
- One of the most widely reported potential adverse effects associated with the administration of neuromuscular blocking agents is ***ICU Acquired Weakness*** (ICUAW) [1, 12]
- ICUAW occurs as a result of complex pathophysiological processes involving the nerves and muscles that determine the functional property of skeletal muscle and in whom there is no plausible aetiology other than critical illness. [12, 13]
  - The clinically detected weakness of ICUAW is classified into those with critical illness polyneuropathy (CIP), critical illness myopathy (CIM), or critical illness neuromyopathy (CINM)[13] The aetiology of these is uncertain and almost certainly multifactorial. [13]
  - Prolonged bed rest and inactivity are harmful; they contribute to skin ulceration, compression neuropathies, deep venous thrombosis and produce deconditioning (reduced muscle size, strength, coordination, balance, endurance and functioning) with an associated low mood. [13]
- Physical activity, mobilisation and exercise therapy have been consistently shown to be safe and achievable within the ICU once patients have stabilized and in accordance with a

protocol. Pressure area care and skin assessments must be undertaken as per policy. [13] Refer to Guideline– Paediatric Intensive Care Patient-Patient Care in CICU – SCH

Neuromuscular Blockade Reversal

- Anticholinesterase reversal agents (neostigmine) are only effective for non-depolarising blockers. [6]
- Neostigmine cannot reverse profound blockade and has a relatively slow onset of action. [14]
- Recommended to use neostigmine with atropine to reverse the neuromuscular blockade in neonates and small infants even if they have shown clinical signs of recovery. [7]
- Drugs such as aminoglycosides may interfere with neuromuscular transmission and could decrease the efficacy of neostigmine. [7]
- Sugammadex can reverse rocuronium effectively and quickly and will reverse even deep rocuronium blockade within 3 minutes.[20] Should only be used when emergency reversal is required.
- Recommended dose of sugammadex depends on depth of NMB at time of reversal. [15]
- Initially dosing is 2mg/kg of sugammadex to reverse a rocuronium-induced moderate NMB in infants, children and adolescents but dose may need to be repeated. [10, 15]
- Binding affinity between sugammadex and other medicinal products indicate that some medications(e.g. flucloxacillin) may displace rocuronium from the sugammadex-relaxant complex and thus delay the neuromuscular recovery. [15]
- Rocuronium should not be administered within 24 hours of sugammadex. [15]

Complications

- Loss of artificial airway (accidental extubation).
- Inadequate analgesia and sedation. (Pain and anxiety in critically ill children, predisposing them to physiological and psychological stress – Post traumatic stress disorder).
- Prolonged immobility can produce muscle atrophy and joint contractures, thrombotic or embolic events.
- Prolonged muscle weakness/paralysis after NMBAs discontinuation especially in the setting of prolonged infusions (accumulation of the drug or its active metabolite).
- Bronchospasm increasing airway pressures and predisposing patients to barotrauma (histamine release).

Outcome

The muscle relaxed patient will be cared for in a manner that optimises their management whilst attempting to minimise and prevent complications associated with the administration of neuromuscular blocking agents.

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