

NEUROMUSCULAR BLOCKING AGENTS

1 Policy statement

Neuromuscular blocking agents must not be used without adequate general anaesthesia or an appropriate surgical procedure that eliminates sensory awareness and must be justified. Few indications exist for the use of neuromuscular blocking agents in research involving animals. Therefore, their proposed use must be reviewed by IACUC on a case-by-case basis. These drugs must not be used alone to provide restraint and immobilization and may only be used in conjunction with drugs producing surgical anesthesia, and hence, unawareness of the paralytic state. Due to the inherent difficulties in assessing the level of surgical anesthesia in paralyzed animals, the use of these drugs will be approved only if it is clearly established that (1) neuromuscular blockers are essential for the proposed research, and (2) that the investigator is able to monitor the animals appropriately for signs of pain and distress.

2 Definitions

Animal	All live fish, amphibians, reptiles, birds, non-human mammals and cephalopods.
Neuromuscular blocking agents/ Neuromuscular blockers	Drugs that cause skeletal muscle paralysis by disrupting transmission at the neuromuscular junction. They have no sedative, amnestic, or analgesic properties and therefore do not prevent the perception of pain.
Paralytic state	A condition characterized by the loss or impairment of the ability to move in part or all of the body.
Institutional Animal Care and Use Committee (IACUC)	The Committee, constituted by an institution, responsible for the oversight and evaluation of all aspects of the institution's animal care and use programme.
Nitrous oxide	A gas with a faint sweet smell that can be breathed in with oxygen to reduce pain.
Surgical plane of anesthesia	A depth of general anesthesia at which an animal is sufficiently unconscious to undergo surgical procedures without experiencing pain or distress.
Controlled ventilation	A technique in which an external device (e.g., mechanical ventilator or manual resuscitator) is used to actively regulate the animal's breathing during anesthesia or surgery.
Electroencephalography (EEG)	A non-invasive technique used to record electrical activity of the brain through electrodes placed on the scalp or directly on the brain surface.

3 Scope

This policy applies to all animals' work covered under NUS Animal Care and Use Programme.

4 Guidelines

4.1 Safe and Ethical Administration of Neuromuscular Blocking Agents

- 4.1.1 A surgical plane of anesthesia (i.e. absence of toe pinch/pedal withdrawal reflex) must be induced and the animal intubated prior to administration of the neuromuscular blocking drug; furthermore, special care must be taken to ensure the maintenance of an adequate plane of anaesthesia, until the effects of the neuromuscular blocking agent have fully subsided.
- 4.1.2 A surgical plane of anesthesia must be maintained during the entire time the neuromuscular blocking drug is present and active in vivo.
- 4.1.3 Neuromuscular blockers must not be administered until after the initiation of the surgical procedure (i.e. the skin incision) to ensure that the depth of anesthesia is adequate and the animal does not feel pain.
- 4.1.4 Use of neuromuscular blocking agents should be confined solely to that phase of the procedure for which they are indicated.
- 4.1.5 Neuromuscular blocking agents must not be used as a matter of convenience or to substitute for poor control of anesthesia.
- 4.1.6 Controlled ventilation must be initiated prior to administration of the neuromuscular blocking drug.
- 4.1.7 Nitrous oxide in most animal species is not an anesthetic and cannot provide a surgical plane of anesthesia. As a result, it must not be used alone with neuromuscular blocking agents during surgical procedures. Electro-immobilisation must not be used as an alternative to analgesia or anaesthesia.
- 4.1.8 The use of a pre-operative analgesic is recommended in addition to the general anesthetic during surgical procedures where neuromuscular blockers are being used.

4.2 Monitoring of Physiological Parameters

- 4.2.1 Baseline measurements of physiological parameters under anesthesia must be established at the initiation of the procedure or surgery (i.e. at the time of skin incision) and before administering any neuromuscular blocking agents. This is to ensure that the depth of anesthesia is adequate.
- 4.2.2 Continuous or frequent intermittent monitoring of physiological variables, such as heart rate, blood pressure, oxygen saturation, pupil size and brain activity, must be conducted. An increase of 20% or more in any one or combination of the parameters compared to the baseline measurement without other explanation is an indicator that pain/stress may be present. The depth of anesthesia should be deepened. For rodent surgeries, please ensure that either the [NUS CM Rodent Surgical Record](#) is completed or that the laboratory's own surgical records—containing all parameters listed in the [Rodent Surgical Record Checklist](#)—are fully documented.
- 4.2.3 Monitoring of electroencephalography (EEG) may also be helpful. However, the normal EEG appearance differs with different types of anesthetics, and confirmation of an anesthetized state may not always be possible based on the EEG. Therefore, the investigator should be thoroughly familiar with the expected EEG pattern for the particular anesthetic used.
- 4.2.4 Core temperature, blood gases, and fluid and electrolyte balance should be maintained within normal levels during the period of paralysis. If animals have to be paralyzed for long periods of time (e.g. greater than 4 hours), provision must be made for periodic voiding of the urinary bladder.

- 4.2.5 Respiration and corneal and flexor withdrawal reflexes must not be used to judge the level of anaesthesia when neuromuscular blocking agents are used.

4.3 Verification of Adequate Anesthesia Prior to Neuromuscular Blocker Use

The appropriate amount of anesthetic should first be defined on the basis of results of a similar procedure using the anesthetic without a blocking agent.

5 References

1. Drummond, J. C., M. M. Todd, and L. J. Saidman. 1996. Use of neuromuscular blocking drugs in scientific investigations involving animal subjects: The benefit of the doubt goes to the animal. *Anesthesiology* 85:697-699.
2. Hammond, P. 1978. Inadequacy of nitrous oxide/oxygen mixtures for maintaining anaesthesia in cats: satisfactory alternatives. *Pain* 5:143-151.
3. Mahmoudi, N. W., D. J. Cole, and H. M. Shapiro. 1989. Insufficient anesthetic potency of nitrous oxide in the rat. *Anesthesiology* 70:345-349.
4. Marsch, S. C. U. and W. Studer. 1999. Guidelines to the use of laboratory animals: what about neuromuscular blocking agents? *Cardiovascular Research* 42:565-566.

6 Related Documents/SOPs

1. CM SOP 101 [Anesthetic regimens for mice, rats and guinea pigs](#)
2. CM SOP 102 [Pig Anesthesia](#)
3. CM SOP 103 [Rabbit Anesthesia](#)
4. CM SOP 104 [Rodent Analgesia](#)
5. CM SOP 106 [Fish Anaesthesia](#)
6. CM SOP 107 [Frog Anaesthesia and Analgesia](#)
7. CM SOP 108 [Rabbit Analgesia](#)
8. CM SOP 116 [Non-human primate \(NHP\) Anaesthesia](#)
9. CM SOP 117 [Non-human primate \(NHP\) analgesia](#)
10. CM SOP 201 [Rodent Surgery](#)
11. CM SOP 202 [Non-Rodent Surgery \(Pre-, Peri-, and Post-Operative Procedures\)](#)

Revision	Author	IACUC approval date
Last reviewed.	Dr Foo Tet Wei, John	13 August 2013
P213.01. Reviewed to:	Dr Chew Li Li	3 January 2023
1. ensure policies are in compliance with the NACLAR Guidelines 2022 and the updated Animals and Birds (Care and Use of Animals for Scientific Purposes) Rules 2004; and	IACUC	
2. up-to-date with current practices		
Changes made:		
1. under "Guidelines on Neuromuscular Blocking Agents" to update to "Neuromuscular blocking agents must not be used without adequate general anaesthesia or an appropriate surgical procedure that eliminates sensory awareness and must be justified."; and		
2. under "Procedures" to add "special care must be taken to ensure the maintenance of an adequate plane of anaesthesia, until the effects of the neuromuscular blocking agent have fully subsided", "Electro-immobilisation must not be used as an alternative to analgesia or anaesthesia." and "Respiration and corneal and flexor withdrawal reflexes must not be used to judge the level of anaesthesia when neuromuscular blocking agents are used"; and		
3. under "Procedures" updated to "Continuous or frequent intermittent monitoring of physiological variables such as heart rate, blood pressure, oxygen saturation, pupil size and brain activity must be conducted."		
P213.02. Revisions to:	Dr Chew Li Li	19 January 2026
1. update policy format.	Ms Keh Lee Hwei	
2. change the policy title from 'Guidelines on Neuromuscular Blocking Agents' to 'Neuromuscular Blocking Agents'.	IACUC Designated Reviewers	

3. revise policy statement.
4. include "i.e. absence of toe pinch/pedal withdrawal reflex" in Section 4.1.1.
5. switch Section 4.2.1 and 4.2.2.
6. include the download link for the Rodent Surgical Record Form and Rodent Surgical Record Checklist in Section 4.2.2.
7. revise Section 4.3 according to the Guide for the Care and Use of Laboratory Animals, 8th Edition

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Approved