



Institutional Animal Care and Use Committee

Effective Date: February 2022

Next Review Date: February 2025

Policy: Rodent Anesthesia and Analgesia Formulary

Purpose: To provide researchers suggested drug doses

Applicable To: UMass Boston Research Community

Depth of anesthesia must be monitored. Parameters would include response to noxious stimuli e.g., toe pinch, corneal reflex, response to scalpel/needle, elevated respiratory rate (and heart rate if monitoring).

Rat Formulary

Note that all the doses are approximations and must be titrated to the animal's strain, age, sex, and individual responses. Significant departures from these doses should be discussed with a veterinarian. Doses will also vary depending on what other drugs are being administered concurrently.

All doses are listed as milligrams per kilogram (mg/kg) unless otherwise noted. Dilution of injected drugs allows more precise dosing, but may shorten the shelf-life of the compound (general standard: diluted drugs should be labeled, then discarded after 1 month)

DRUG NAME	DOSE (mg/kg) & ROUTE	FREQUENCY	NOTES
Inhalation anesthetics			
Recommended: Isoflurane or Sevoflurane	1-3% inhalant to effect (up to 5% for induction). Up to 8% for Sevoflurane	Whenever general anesthesia is required	Survival surgery requires concurrent preemptive analgesia. Must use precision vaporizer
Methoxyflurane	To effect (cannot determine percentage)	Whenever general anesthesia is required	Survival surgery requires concurrent preemptive analgesia. Not currently available in USA
Ketamine combinations			
Ketamine alone	75-100 IP	As needed	Deep sedation, but not surgical anesthesia. Not often used alone.
Ketamine-Medetomidine	75-100 + ~0.5-1 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for major procedures. If redosing, use ketamine alone. May be partially reversed with Atipamezole or Yohimbine
Recommended: Ketamine-Xylazine	75-100 Ket + 5-10 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for major procedures, though more reliable than in mice. If redosing, use ketamine alone. May be partially reversed with Atipamezole or Yohimbine
Ketamine-Xylazine-Acepromazine	75 - 100 + 2 - 6 + 1 - 2 (in same syringe)	As needed	May not produce surgical-plane anesthesia for major procedures. If redosing, use ketamine alone. May be partially reversed with Atipamezole or Yohimbine
Ketamine-Midazolam	75-100 + 4-5 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for major procedures, but may be useful for
Reversal agents			
Atipamezole	0.1 - 1.0 subcutaneous or IP	Any time medetomidine or xylazine has been used	More specific for medetomidine than for xylazine (as a general rule, Atipamezole is dosed at the same volume as Medetomidine, though they are manufactured at different
Yohimbine	1.0 - 2.0 SC or IP	For reversal of xylazine effects	



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Other injectable anesthetics			
Sodium pentobarbital (Nembutal)	40 – 50 IP	Recommended for terminal/acute procedures only, with booster doses as needed. May occasionally be appropriate for survival procedures	Consider supplemental analgesia (opioid or NSAID) for invasive procedures, especially when used on a survival basis.
Tribromoethanol (avertin)	Not generally used in rats		
Propofol	12-26 IV	As needed	Only useful IV, so therefore limited usefulness in mice. Respiratory depression upon induction is possible.
Opioid analgesia			
Recommended: Buprenorphine	0.05 - 0.1 SC or IP	Used pre-operatively for preemptive analgesia and post-operatively every 6-12 hour	For major procedures, require more frequent dosing than 12 hour intervals. Consider multi-modal analgesia with a NSAID. High doses of buprenorphine may lead to pica behavior in rats.
Non-steroidal anti-inflammatory analgesia (NSAID) Note that prolonged use may cause renal, gastrointestinal, or other problems			
Recommended: Carprofen	4-5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Recommended: Meloxicam	1-2 PO, IM or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Recommended: Ketoprofen	2 – 5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Ketorolac	0.5 – 7.5 oral or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Flunixin meglumine	~ 2 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Local anesthetic/analgesics (lidocaine and bupivacaine may be combined in one syringe for rapid onset and long duration analgesia)			
Lidocaine hydrochloride	Dilute to 0.5%, do not exceed 7 mg/kg total dose, SC or intra- incisional	Use locally before making surgical incision	Faster onset than bupivacaine but short (<1 hour) duration of action
Bupivacaine	Dilute to 0.25%, do not exceed 8 mg/kg total dose, SC or intra- incisional	Use locally before making surgical incision	Slower onset than lidocaine but longer (~ 4-8 hour) duration of action



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Mouse Formulary

Note that all of these doses are approximations and must be titrated to the animal's strain, age, sex and individual responses. Significant departures from these doses should be discussed with a veterinarian. Doses will also vary depending on what other drugs are being administered concurrently. There can also be considerable variation in effect between different strains. Mice are prone to hypothermia, so a circulating water heating pad is recommended.

All doses are listed as milligrams per kilogram (mg/kg) unless otherwise noted. Dilution of injected drugs allows more precise dosing, but may shorten the shelf-life of the compound (general standard: diluted drugs should be labeled, then discarded after 1 month)

DRUG NAME	DOSE (mg/kg) & ROUTE	FREQUENCY	NOTES
Inhalation anesthetics			
Recommended: Isoflurane or Sevoflurane	1-3% inhalant to effect (up to 5% for induction). Up to 8% for Sevoflurane	Whenever general anesthesia is required	Survival surgery requires concurrent preemptive analgesia. Must use precision vaporizer with a scavenging system
Carbon dioxide	To effect (cannot determine percentage)	Once, at time of euthanasia	May be used for fast terminal procedure followed by euthanasia
Ketamine combinations			
Ketamine alone	100-200 IP	As needed	Deep sedation, but not surgical anesthesia. Not often used alone.
Ketamine-Medetomidine	50-75 + 0.5 -1 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for longer procedures (duration of effect 20-30 min). If redosing, use ketamine alone. May be partially reversed with Atipamezole
Recommended: Ketamine-Xylazine	80-100 + 5-10 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for major procedures (duration of effect 20-40 min). If redosing, use ketamine alone. May be partially reversed with Atipamezole or Yohimbine
Recommended: Ketamine-Xylazine-Acepromazine	50-100 + ~6 + ~1 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for longer procedures (duration of effect 20-30 min). If redosing, use ketamine alone. May be partially reversed with Atipamezole or Yohimbine
Ketamine- Midazolam	80-100 + 4-5 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for major procedures (duration of effect 20-30 min), but may be useful for restraint.
Ketamine-Acepromazine	100 + 2.5 IP (in same syringe)	As needed	May not produce surgical-plane anesthesia for major procedures (duration of effect 20-30 min), but may be useful for restraint.
Reversal agents			
Atipamezole	1-2 subcutaneous or IP	Any time medetomidine or xylazine has been used	More specific for medetomidine than for xylazine (as a general rule, Atipamezole is dosed at the same <i>volume</i> as Medetomidine, though they are manufactured at different concentrations).
Yohimbine	1.0 – 2.0 SC or IP	For reversal of xylazine effects	
Other injectable anesthetics			



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Sodium pentobarbital (Nembutal)	50 -90 IP	Recommended for terminal/acute procedures only, with booster doses as needed	Consider supplemental analgesia (opioid or NSAID) for invasive procedures
Tribromoethanol (Avertin)	200-250 IP	May be used for survival procedure (boosted as necessary during procedure)	Use fresh solution (<1 week of age). Lower concentration (1.25%) less likely to cause peritonitis. See recipe below.
Propofol	12-26 IV	As needed	Only useful IV, so therefore limited usefulness in mice. Respiratory depression upon induction is possible.
Opioid analgesia			
Recommended: Buprenorphine	0.05 - 0.1 SC or IP	Used pre-operatively for preemptive analgesia and post-operatively every 6-12 hour	For major procedures, require more frequent dosing than 12-hour intervals. Consider multi-modal analgesia with a NSAID
Butorphanol	1-5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 4 hours	Consider multi-modal analgesia with a NSAID
Non-steroidal anti-inflammatory analgesia (NSAID) Note that prolonged use may cause renal, gastrointestinal, or other problems			
Recommended: Carprofen	4-5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Recommended: Meloxicam	~ 0.2 PO, IM or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Recommended: Ketoprofen	2 – 5 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Ketorolac	5 – 7.5 oral or SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Flunixin meglumine	~ 2 SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hour	Depending on the procedure, may be used as sole analgesic, or as multi-modal analgesia with buprenorphine.
Local anesthetic/analgesics (lidocaine and bupivacaine may be combined in one syringe for rapid onset and long duration analgesia)			
Lidocaine hydrochloride	Dilute to 0.5%, do not exceed 7 mg/kg total dose, SC or intra- incisional	Use locally before making surgical incision	Faster onset than bupivacaine but short (<1 hour) duration of action
Bupivacaine	Dilute to 0.25%, do not exceed 8 mg/kg total dose, SC or intra- incisional	Use locally before making surgical incision	Slower onset than lidocaine but longer (~ 4-8 hour) duration of action

AVERTIN RECIPE



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100% stock avertin

Mix: add tribromoethanol to tertiary amyl alcohol and dissolve by heating and stirring. Add distilled water and continue until the solution is well mixed. Store wrapped in foil (light sensitive solution, ok to use brown glass bottle), 4 C

Solution may have to be warmed to dissolve. Mixture should be clear. 10g tribromoethyl alcohol (2, 2, 2 tribromoethanol), Aldrich T4, 840-2
10ml tertiary amyl alcohol (2 methyl-2-butanol), Aldrich 24, 048-6

Warning! Decomposition can result from improper storage.

2.5% working stock avertin (this solution should be prepared weekly)

For use in mice, dilute the 100% to 2.5% (1:40) using diluent, water or isotonic saline. Diluent recipe:

0.8% NaCl

1mM Tris (pH 7.4) 0.25mM EDTA

Check the pH. Adjust to pH 7.4.

To make 50 ml 2.5% avertin, add 1.25 ml 100% to 48.75 ml liquid (diluent, water or saline)

Filter .22 micron

Store 4 C, foil wrapped or brown bottle

Dosage for mice may vary with different preparations of avertin. Dosage should be redetermined each time a 100% stock is made up. Test for best effect in a few mice before choosing dose. Allow 5-10 min to take effect.