

Drug Formulary Form

Drug formularies are lists of drugs that are created and used in a variety of ways. Some drug formularies are general guidance documents, listing acceptable uses, dosages, and routes of administration of a wide variety of drugs that may be administered to animals. As a guidance to changes in anesthesia, analgesia, sedation or euthanasia that can be covered by the VVC, the Brown veterinarians have developed a drug formulary that includes drug regimens that investigators can refer to in their IACUC animal use protocols. The VVC process may be used to change the dose, route, concentration, volume, and/or duration of an approved anesthetic, analgesic, or sedative. Should an investigator wish to use an anesthesia, analgesia, euthanasia or sedation protocol that is not represented in the Brown University Animal Care Formulary, published references must be submitted at the time of the request supporting the use of the requested drug or drug combination in the species of interest.

Changes in experimental substances may include use of a different drug, pharmacological agent, peptide inhibitor or antibody etc. that will be used to address the stated overall objective of the approved study. A published reference showing efficacy and the proposed dose/route of administration must be included for this to be considered by VVC.

Brown University Lab Animal Formulary

Subject
Mouse
Rat
Swine
Nonhuman Primates (Rhesus macaques)
Sheep
Avian
Reptile
Bats
References

Disclaimer: If you are writing a new protocol or are writing an amendment adding anesthesia or painful/distressful procedures, you MUST consult a veterinarian before submitting.

The Ideal Anesthetic/Analgesic Regimen

- It should provide **Pre-emptive Analgesia** so that animal pain is already being treated as the general anesthetic is wearing off, to prevent sensitization (“ramp-up”) of pain sensory mechanisms, and to lower the overall amount of general anesthetic required for the procedure.
- It should be precisely titratable to assure that animals receive adequate anesthesia to block pain sensation, to produce unconsciousness, and to produce immobility without experiencing hemodynamic instability or life-threatening anesthetic overdoses.
- It should not interfere with the study that the animals are on.
- It should not result in unhealthy post-operative side-effects.

- It should not cause pain or distress on induction or recovery
- It should be compatible with available equipment and available medications

Mouse Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Ketamine + Xylazine*	70-100 (K) 5-10 (X) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Xylazine + Acepromazine	70-100 (K) 10-15 (X) 2-3 (A) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Dexmedetomidine	50-75 (K) 1 (Me) IP in the same syringe	As needed	If redosing, use ketamine alone. May be partially reversed with Atipamezole
Ketamine + Midazolam	70-100 (K) 4-5 (Mi) IP in the same syringe	As needed	May not produce surgical-plane anesthesia for major procedures, but may be useful for restraint
Anesthetic Reversal Agents			
Atipamezole	0.5-1 SC or IP	Any time dexmedetomidine or xylazine has been used	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	1-2 SC or IP	For reversal of xylazine effects	
Opioid Analgesia Agents			

Buprenorphine*	0.05-0.1 SC or IP	Use for preemptive analgesia and post-operatively every 4-12 hours	Consider Multi-modal Analgesia with an NSAID and/or Local Analgesic
Buprenorphine-SR* (sustained release)	0.5-1 SC	Single dose prior to or at the end of surgery; must give a pre-operative analgesia if giving at the end of surgery	Provides 72 hours of analgesia with single dose; veterinary license required to purchase
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	2-5 SC or PO	Use for preemptive analgesia and post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen*	2-5 SC or PO	Use for preemptive analgesia and post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	2-5 SC	Use for preemptive analgesia and post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	Dilute to 0.5%, do not exceed 7 mg/kg total dose SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Faster onset (2 minutes) 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, or before final skin closure	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent. IP: intraperitoneally; into the peritoneal cavity SC: subcutaneously; under the skin
PO: per os; by mouth

Rat Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Ketamine + Xylazine*	70-100 (K) 5-10 (X) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Xylazine + Acepromazine	70-100 (K) 5-10 (X) 1-2 (A) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Dexmedetomidine	75-90 (K) 0.5 (Me) IP in the same syringe	As needed	If redosing, use ketamine alone. May be partially reversed with Atipamezole
Ketamine + Midazolam	70-100 (K) 4-5 (Mi) IP in the same syringe	As needed	May not produce surgical-plane anesthesia for major procedures, but may be useful for restraint
Anesthetic Reversal Agents			

Atipamezole	0.5-1 SC or IP	Any time dexmedetomidine or xylazine has been used	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	1-2 SC or IP	For reversal of xylazine effects	
Opioid Analgesia Agents			
Buprenorphine*	0.01-0.05 SC or IP	Use for preemptive analgesia and post-operatively every 4-12 hours	Consider multi-modal analgesia with an NSAID and/or local analgesic
Buprenorphine-SR* (sustained release)	1-1.2 SC	Single dose prior to or at the end of surgery; must give a pre-operative analgesia if giving at the end of surgery	Provides 72 hours of analgesia with single dose; veterinary license required to purchase
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	1-2 SC or PO	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen*	2-5 SC or PO	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	5 SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	Dilute to 0.5%, do not exceed 7 mg/kg total dose SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Faster onset (2 minutes) 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, or before final skin closure	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent. IP: intraperitoneally; into the peritoneal cavity SC: subcutaneously; under the skin
PO: per os; by mouth

Swine Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine*	20 (K) 1.1-2.2 (X) IM in the same syringe	For sedation or pre-anesthesia	Can result in large volumes
Telazol®* (tiletamine and zolazepam)	6-8 IM	For sedation or pre-anesthesia	Must be reconstituted with sterile water and refrigerated after
Ketamine + Dexmedetomidine	10 (K) 0.05-0.1 (Me) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	10-15 (K) 0.5-2 (Mi) IM in the same syringe	For sedation or pre-anesthesia	

Telazol® + Xylazine	4-6 (T) 2.2 (X) IM	For sedation or pre-anesthesia	Reconstitute Telazol® with 5 ml of 100 mg/ml xylazine instead of water; must be refrigerated.
Propofol	3-5 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone
Anesthetic Reversal Agents			
Atipamezole	0.5-1 SC or IM	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	0.05-1 SC or IM	For reversal of xylazine effects	
Opioid Analgesia Agents			
Buprenorphine*	0.05-0.1 SC or IM	Use for preemptive analgesia and post-operatively every 8-12 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Buprenorphine-SR* (sustained release)	0.12-0.2 SC	Single dose at the end of surgery	Provides up to 72 hours of pain relief; consider multi-modal analgesia; veterinary license required to purchase
Butorphanol	0.1-0.5 SC	Use for preemptive analgesia and post-operatively every 4-6 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Oxymorphone	0.15-0.2 IM	Use for preemptive analgesia and post-operatively every 3-4 hours, or for 'rescue analgesia' when buprenorphine is not potent enough	More potent but shorter duration than buprenorphine or butorphanol
Fentanyl transdermal patch	2.5-5 µg/kg/hr	Place 8-12 hours before surgery if possible	Variable absorption; provides 48-72 hours of pain relief
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			

Meloxicam*	0.2-0.4 PO, IM, or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen*	2-4 PO, SC, or IM	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	1-3 SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-4 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	1-2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.

IM: intramuscularly; into a muscle (the neck or rump) SC: subcutaneously; under the skin (behind the ear)

IV: intravenously; into a vein (must have a patent catheter) PO: per os; by mouth

Nonhuman Primate Formulary (Macaques)

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine*	10 (K) 0.5 (X) IM in the same syringe	For sedation or pre-anesthesia	

Ketamine	10-15 IM	For sedation or pre-anesthesia	To be used only for chemical restraint, any invasive procedures require additional drugs
Ketamine + Dexmedetomidine	3-5 (K) 0.03-0.1 (M) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	8-10 (K) 0.05-0.15 (Mi) IM in the same syringe	For sedation or pre-anesthesia	Midazolam may slightly prolong recovery time, but also makes for smoother recovery
Telazol® (tiletamine and zolazepam)	3-6 IM	For sedation or pre-anesthesia	Must be reconstituted with sterile water and refrigerated after
Propofol	2.5-5 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone
Anesthetic Reversal Agents			
Atipamezole	0.15-0.2 SC or IM	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	0.2 SC or IM	For reversal of xylazine effects	
Opioid Analgesia Agents			
Buprenorphine*	0.01-0.03 SC or IM	Use for preemptive analgesia and post-operatively every 6-12 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Buprenorphine-SR* (sustained release)	0.2 SC	Single dose at the end of surgery	Provides 3-5 days of pain relief; consider multi-modal analgesia; veterinary license required to purchase
Oxymorphone	0.15 SC or IM	Use for preemptive analgesia and post-operatively every 4-6 hours	More potent but shorter duration than buprenorphine
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			

Meloxicam*	0.1-0.2 PO, IM, or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen	2-4 PO or IM	Use post-operatively every 12 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	2 IM or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-4 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	1-2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.

IM: intramuscularly; into a muscle (quadriceps or hamstring muscles) SC: subcutaneously; under the skin (anywhere there's loose skin)

IV: intravenously; into a vein (must have a patent catheter) PO: per os; by mouth

Sheep Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia

Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine*	4 (K) 0.1 (X) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Dexmedetomidine	1 (K) 0.025 (Me) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	4 (K) 0.5 (Mi) IM in the same syringe	For sedation or pre-anesthesia	
Propofol	4-5 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone.
Anesthetic Reversal Agents			
Atipamezole	0.1-0.2 IM or IV	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	0.2 SC or IM	For reversal of xylazine effects	
Opioid Analgesia Agents			
Buprenorphine*	0.005-0.01 SC or IM	Use for preemptive analgesia and post-operatively every 8 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Butorphanol	0.1-0.5 IM	Use for preemptive analgesia and post-operatively every 2-4 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Fentanyl transdermal patch	2.-3 µg/kg/hr	Place 8-12 hours before surgery if possible	Provides 48-72 hours of pain relief
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Flunixin*	1-2 IV or IM	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Meloxicam*	1 IM or PO	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid

Carprofen	2-4 SC or IM	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-4 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	1-2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.

IM: intramuscularly; into a muscle (rump or epaxial muscles)

SC: subcutaneously; under the skin (anywhere there's loose skin) IV: intravenously; into a vein (must have a patent catheter)

PO: per os; by mouth

Avian Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
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Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine	10-15 (K) 2 (X) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	10-40 (K) 0.2-2 (Mi) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Acepromazine	10-25 (K) 0.5-1.0 (A) IM in the same syringe	For sedation or pre-anesthesia	Use higher end of dose range for birds <250g
Ketamine + Dexmedetomidine	2-6 (K) 0.04-0.15 (D) SC in the same syringe	For sedation or pre-anesthesia	
Anesthetic Reversal Agents			
Atipamezole	0.5 SC	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Opioid Analgesia Agents			
Butorphanol*	0.5-4 IM	Use for preemptive analgesia and post-operatively every 4-6 hours	Recommend analgesic for most species of birds; consider multi-modal analgesia with an NSAID or local anesthetic.
Buprenorphine	0.01-0.05 IM	Use for preemptive analgesia and post-operatively every 8-12 hours	Consider multi-modal analgesia with an NSAID or local anesthetic
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	0.2-0.3 SC	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Carprofen	1 SC	Use post-operatively every 4 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			

Lidocaine	1-3 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.

IM: intramuscularly; into a muscle (rump or epaxial muscles)

SC: subcutaneously; under the skin (anywhere there's loose skin)

Reptile Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Ketamine	10-30 (K) SC or IM	As needed	Lower doses may be used to sedate animals for Inhalant anesthesia intubation
Ketamine + Dexmedetomidine	5-10 (K) 0.05-0.1 (D) IM in the same syringe	As needed	
Telazol® (tiletamine and zolazepam)	5-10 IM	As needed	Must be reconstituted with sterile water and refrigerated after
Propofol	10 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone.
Anesthetic Reversal Agents			
Atipamezole	SC	For reversal of dexmedetomidine	Dose at the same volume as dexmedetomidine
Opioid Analgesia Agents			
Buprenorphine	0.01-0.05 IM	Use for preemptive analgesia and post-operatively every 24-48 hours	Consider multi-modal analgesia with an NSAID or local anesthetic
Butorphanol	0.5-2 SC or IM	Use for preemptive analgesia and post-operatively every 24 hours	Consider multi-modal analgesia with an NSAID or local anesthetic
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam	0.1-0.5 PO or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid

Ketoprofen	2 SC or IM	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen	1-4 SC or IM	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-5 Dilute to 0.5-1% (=10mg/ml). SC or intra-incisional	Use locally before making surgical incision	Fast onset (2 minutes) but short (<1 hour) duration of action

IMPORTANT: All injected medications must be given in the anterior third of the body for snakes, or the front limbs of other reptiles.

* Denotes the recommended/preferred agent.

IM: intramuscularly; into a muscle (epaxial muscles in snakes, upper leg muscles in others) SC: subcutaneously; under the skin (anywhere there's loose skin)

IV: intravenously; into a vein (must have a patent catheter) PO: per os; by mouth

Bat Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Dexmedetomidine + Midazolam + Fentanyl (MMF)*	0.4 (D) 4 (Mi) 0.04 (F) IM in the same syringe	As needed	
Ketamine + Xylazine	10-15 (K) 2 (X) IM in the same syringe	As needed	
Opioid Analgesia Agents			
Buprenorphine*	0.1 PO	Use for preemptive analgesia and post-operatively every 12 hours	May be applied to the gums to be absorbed through mucous membranes
Tramadol	3.75 PO	Use for preemptive analgesia and post-operatively every 8 hours	Dissolve one 50 mg tablet in 20 mls distilled water
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	3 PO	Use post-operatively every 12 hours	May be used as multi-modal analgesia with opioid

* Denotes the recommended/preferred agent.

IM: intramuscularly; into a muscle (thigh muscle) PO: per os; by mouth