DCM Anesthetic and Analgesic Formulary
Reviewed by UCAR 7/17/24

This document contains recommendations for best practice use of sedatives/tranquilizers, anesthetics, and analgesics based on the current standard of care. While all of the drug combinations listed here are considered safe and effective, **the selections shaded in green represent the DCM best practice approach to anesthesia and analgesia in these species and should be followed whenever possible**. The drugs contained within this formulary are not exhaustive of all possible anesthetics and analgesics that can be used in laboratory animals, and investigators should consult with a DCM veterinarian if an alternative agent is desired to achieve the scientific goal. Veterinary staff continuously review outcomes of surgical and anesthetic procedures as well as the literature for refinements, and update their recommendations and clinical practice periodically to reflect the evolving standard of care.

Abbreviations	
IM	Intramuscular
IP	Intraperitoneal
IV	Intravenous
SQ	Subcutaneous
CRI	Constant rate infusion
PO	Per os (by mouth)

MULTIMODAL ANESTHESIA AND ANALGESIA

Multimodal anesthesia and analgesia, using multiple drugs that work by different mechanisms, are considered the gold standard and are strongly advised, unless there is scientific justification precluding a multimodal approach. This strategy harnesses the synergistic actions of different drugs to achieve balanced sedative, anesthetic and analgesic effects, achieving a better safety and efficacy profile with reduced drug doses. To relieve moderate to severe pain, a multimodal analgesic approach may include administration of both opioids and NSAIDs[1,2], and/or performing a nerve block or local infiltration using a local anesthetic such as bupivacaine.

PRECAUTIONS REGARDING INJECTABLE ANESTHETICS

MOUSE FORMULARY

DRUG NAME and DOSE	ROUTE & FREQUENCY	NOTES
Anesthetics		
Isoflurane Induction 4-5% Maintenance 1-3%	Inhalation	Generally first choice agent in rodents because it can be easily titrated to deliver dose required for anesthesia and allows for rapid recovery. Induce rodent in a chamber at 4-5%, then reduce to 1-3%. Adjust as needed based on patient assessment.
Ketamine 80-120 mg/kg + Xylazine 5-10 mg/kg	IP Once[a]	30-45 min of general anesthesia[b]
Ketamine 80-100 mg/kg + Xylazine 8-20 mg/kg + Acepromazine 1-3 mg/kg		

Analgesics –

BIRD FORMULARY

DRUG NAME and DOSE	ROUTE & FREQUENC	NOTES
Anesthesia		
Isoflurane, Induce 3-5%; Maintenance 2-3%	Inhalation	Bird can be placed in a chamber or induced via mask. Intubation in birds is relatively easy.
Ketamine 1.5-6 mg/kg + Dexmedetomidine 40-160mcg/kg	SQ	Can be used to maintain anesthesia delive

Analgesics		
Meloxicam 0.1mg/kg 0.5mg/kg	IM q24h PO q12h	NSAID
Carprofen 1mg/kg	SQq12-24h	NSAID
Buprenorphine 0.01-0.05mg/kg	IM q8-12h	Opioid agonist-antagonist
Butorphanol0.5-2mg/kg	IM q6h	Opioid agonist-antagonist

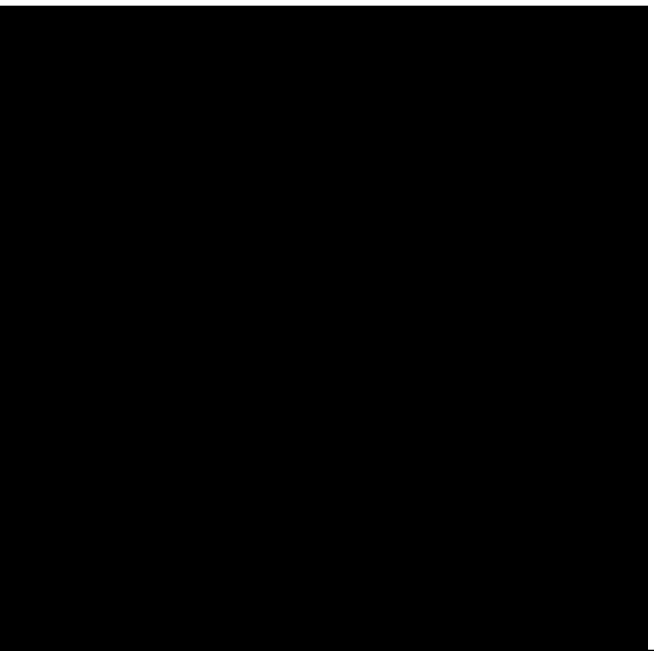
RABBIT FORMULARY

DRUG NAME and DOSE ROUTE &

NONHUMAN PRIMATE FORMULARY

DRUG NAME and DOSE	ROUTE & FREQUENC	NOTES
Sedation/Tranquilization		
Ketamine 8-10mg/kg + Midazolam 0.25mg/kg ± Glycopyrrolate 0.004mg/kg	IM	Diazepam causes pain on intramuscular injection and is not tissue soluble, so midazolam is preferred over diazepam for IM injections. Since midazolam is tissue soluble, it produces more reliable sedation that may allow int g -0.00.00.00 0 12 201.96()2 (ly1l)1

Propofol2-4mg/kg	IV	Used to induce general anesthesia for intubation; administer slowly to effect
Maintenance		
Isoflurane	1-2%	
Amiodarone 10mg/kg + 0.5mg/kg/hr	IV	Amiodarone is an anti



Fentanyl 5-20mcg/kg/hr	IV CRI	Short-acting opioid useful for intra-operative pain management during major invasive procedures; Required as balanced anesthesia for procedures such as sternotomies that are expected to cause severe pain

Analgesics

Lidocaine/Bupivacaine <2 mg/kg	Infiltrate or apply topically; Lasts 1-4 hours; Redose as needed	(not to exceed a total dose o 2 mg/kg)

REFERENCES

1. American College of Laboratory Animal Medicine. Formulary 2024.
2. Alamaw ED, Franco BD, Jampachaisri K, Huss BA, Karinsak C. (2022) Extended-release Buprenorphine, an FDA-Indexed Analgesic, Attenuates Mechanical Hypersensitivity in Rats (*Rattus norvegicus*). JAALAS 61(1): 81-88.
3. Anesthesia of Animals for Biomedical Research in British Journal of Anesthesia-1993;71:885-894
4. Arras M, Autenried P, Rettich A, Spaeni D, Rulicke T. 2001. Optimization of Intraperitoneal Injfection Anesthesia in Mice: Drugs, Dosages, Adverse Effects and Anesthesia Depth. JAALAS 51(5):443-456.
5. Association of Primate Veterinarians. 2021. Nonhuman Primate Formulary. Available at: https://www.primatevets.org/education--resources [Accessed 6/26/2024].
6. Authier S, Chaurand F, Legaspi M, Breault C, Troncy E. 2006. Comparison of three anesthetic protocols for intraduodenal drug administration using endoscopy in rhesus monkeys (*Macaca mulatta*). J Am Assoc Lab Anim Sci 45(6): 77-83
7. Bauer C, Frost P, Kirschner S. 2014. Pharmacokinetics of 3 formulations of meloxicam in cynomolgus macaques (*Macaca fasicularis*). J Am Assoc Lab Anim Sci 53: 501-512.
8. Buitrago S, Martin Te, Tetens V, Woodring J, Belich A, Villanueva A, Wilding GE. 2008. Safety and efficacy of various combinations of injectable anesthetics in BALB/c mice. JAALAS. 47:11-17.
9. Carney EL, Clark JB, Myers JL, Peterson R, Wilson RP, Weiss WJ. 2009. Animal Model Development for the Penn State Pediatric Ventricular Assist Device. Artif Organs 33(11):953-957.
10. Carpenter JW. (2018). Exotic Animal Formulary, 5th edition.
11.

17. Navarro1 KL, Huss M, Smith JC, Sharp P, Marx JO, Pacharinsak C. 2021. Mouse Anesthesia: The Art and Science. ILAR. 62(102):238-273.
18. Papich MG. 2007. Saunders Handbook of Veterinary Drugs. 2nd ed. Elsevier: St. Louis, MO.
19. Plumb DC. 2015. Plumb's Veterinary Drug Handbook. 8th ed. Blackwell: Ames, IA.
20. Oh SS & Narver HL. (2024). Mouse and rat anesthesia and analgesia. *Current Protocols, 4,* e995. doi: 10.1002/cpz1.995
21. Osborn I, Sebeo J. 2010. "Scalp block" during craniotomy: a classic technique revisited. J Neurosurg Anesthesiol 22(3):191-195.
22. Swindle MM. 2007. Swine in the Laboratory: Surgery, Anesthesia, Imaging, and Experimental Techniques. 2nd ed. CRC Press: Boca Raton, FL.
23. Thiede AJ, Garcia KD, Stolarik DF, Ma J, Jenkins GJ, Nunamaker EA. 2014. Pharmacokinetics of sustained-release and transdermal buprenorphine in Gottingen minipigs (*Sus scrofa domestica*). J Am Assoc Lab Anim Sci 53:687-692.
24. Unit for Laboratory Animal Medicine. Guidelines on Anesthesia and Analgesia in Mice. 2023.
25. Veterinary Guideline Rodent Anesthesia and Analgesia. 2022. Office of Research, Office of the Attending Veterinarian.
26. Waite ME, Tomkovich A, Quinn TL, Schumann AP, Dewberry LS, Totsch SK, Sorge RE. (2015) Efficacy of Common Analgesics for Postsurgical Pain in Rats. JAALAS, 54(4):420-
27. Williams A, Wyatt J. 2007. Comparison of Subcutaneous and Intramuscular Ketamine Medetomidine With and Without Rev(e)-(u)6 (4 (th[83 (0 Td (aj /TT1 1 (th[83 (0 Td (aj /TT1 1

For animals experiencing a craniotomy, a regional scalp block with 2mg/kg bupivacaine is recommended. The supraorbital nerves are blocked as they emerge from each orbit by palpating the supraorbital notch, inserting the needle along the upper orbital margin, perpendicular to the skin, just medial to the supraorbital foramen. The occipital nerve is then blocked as it exits the skull near the occipital protuberance. The occipital artery on the back of the skull is palpated, and bupivacaine is injected medially after careful aspiration to avoid intra-arterial injection. These three injections are sufficient to regionally block the scalp for the region of most head post and chamber placements.