

Ketamine:

SCHEDULING STATUS: S5

CURRENTLY COMPOUNDED FORMULATIONS:

Active ingredient(s)	Injectable	Oral equine paste	Oral carnivore paste	Orals for exotics	Oral solution/suspension	Topical treatment	Shampoo	Capsules/Tablets	Oral powder
Ketamine hydrochloride	✓				✓				

REGISTERED PRODUCT/ TRADE NAME: Anaket-V™

PHARMACOLOGICAL CLASSIFICATION: Dissociative general anaesthetic; NMDA-receptor antagonist

PHARMACOLOGICAL ACTION: Ketamine is a rapid acting general anaesthetic that has significant analgesic activity and a lack of cardiopulmonary depressant effects. It is thought to induce both anaesthesia and amnesia by functionally disrupting the CNS through over stimulating the CNS or inducing a cataleptic state. Ketamine inhibits GABA, and may block serotonin, norepinephrine and dopamine in the CNS. The thalamoneocortical system is depressed while the limbic system is activated. It induces anaesthetic stage 1 and 2, but not stage 3. In cats, it causes a slight hypothermic effect as body temperatures decrease on average by 1.6 °C after therapeutic doses. Effects on muscle tone are described as being variable, but ketamine generally either causes no changes in muscle tone or increased tone.^[1]

Ketamine's effects on the cardiovascular system include increased cardiac output, heart rate, mean aortic pressure, pulmonary artery pressure and central venous pressure.^[1]

INDICATIONS: As an immobilizing agent for examinations, radiographic procedures, minor surgery and prior to induction of general anaesthesia.^[1]

Ketamine has been found to be a useful agent for analgesia in burn-wound patients.^[2]

DOSAGE AND DIRECTIONS FOR USE:

Note: Ketamine is used in many different combinations with other agents. The following are representative, but not necessarily inclusive; it is suggested to refer to a recent veterinary anesthesia reference for more information.^[1]

DOGS:

Note: Ketamine/xylazine has induced cardiac arrhythmias, pulmonary oedema, and respiratory depression in dogs. This combination should be used with caution.^[1]

As an adjunct to anesthesia:^[1]

- Diazepam 0.5 mg/kg IV, then ketamine 10 mg/kg IV to induce general anesthesia (Booth 1988a)^[1]
- Midazolam 0.066 – 0.22 mg/kg IM or IV, then ketamine 6.6 – 11 mg/kg IM (Mandsager 1988)^[1]
- Xylazine 2.2 mg/kg IM, in 10 minutes give ketamine 11 mg/ kg IM. Dogs weighing more than 22.7 kg reduce dose (per kg) of both drugs by approx. 25% (Booth 1988a)^[1]
- Atropine (0.044 mg/kg) IM, in 15 minutes give xylazine (1.1 mg/kg) IM, 5 minutes later give ketamine (22 mg/kg) IM (Booth 1988a)^[1]

As an NMDA antagonist for adjunctive pain control:^[1]

- Ketamine has been found to be a useful agent for analgesia in burn-wound patients: a dose of 10 mg/kg qid per os was found to be an effective adjunct to pain therapy.^[2]
- 0.1 – 1 mg/kg PO, IM or SC q4 – 6h for mild to moderate pain in conjunction with opioids. (Nieves 2002)^[1]

- For intraoperative use: If anesthesia was induced with a drug other than ketamine, give a loading dose of 0.5 mg/kg IV, then an infusion of 10 – 20 mcg/kg/minute. A CRI of 2 – 10 mcg/kg/minute can be used post-op. (Hellyer 2006)^[1]

CATS:

Most clinicians recommend giving atropine or glycopyrrolate before use to decrease hypersalivation.^[1]

- 11 mg/kg IM for restraint; 22 – 33 mg/kg for diagnostic or minor surgical procedures not requiring skeletal muscle relaxation^[1]
- 2 – 4 mg/kg IV or 11 – 33 mg/kg IM (Davis 1985b)^[1]
- Restraint: 0.1 ml (10 mg) IV Anesthesia: 22 – 33 mg/kg IM or 2.2 – 4.4 mg/kg IV (with atropine) (Morgan 1988)^[1]
- Sedation, restraint: 6.6 – 11 mg/kg IM^[1]
Anesthetic: 17.6 – 26.4 mg/kg IM^[1]
Induction (following sedation): 4.4 – 11 mg/kg IV (Mandsager 1988)^[1]

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RABBITS/RODENTS/SMALL MAMMALS:

For chemical restraint:^[1]

MICE: Alone: 50 – 100 mg/kg IM or IP, 50 mg/kg IV;^[1]

- In combination with diazepam: ketamine 200 mg/kg with diazepam 5 mg/kg IM or IP;^[1]
- In combination with xylazine: ketamine 100 mg/kg with xylazine 5 – 15 mg/kg IM or IP (Burke 1999)^[1]

RATS: Alone: 50 – 100 mg/kg IM or IP, 40 – 50 mg/kg IV;^[1]

- In combination with diazepam: ketamine 40 – 60 mg/kg/diazepam 5 – 10 mg/kg IP;^[1]
- In combination with xylazine: ketamine 40 – 75 mg/kg with xylazine 5 – 12 mg/kg IM or IP (Burke 1999)^[1]

HAMSTERS/GERBILS: 100 mg/kg IM;^[1]

- In combination with diazepam: ketamine 50 mg/kg with diazepam 5 mg/kg IM;^[1]
- In combination with xylazine: not recommended (Burke 1999)^[1]

GUINEA PIG: Alone: 10 – 30 mg/kg IM;^[1]

- In combination with diazepam: ketamine 60 – 100 mg/kg with diazepam 5 – 8 mg/kg IM;^[1]
- In combination with xylazine: ketamine 85 mg/kg with xylazine 12 – 13 mg/kg IM (Burke 1999)^[1]

RABBITS: Alone: 20 – 50 mg/kg IM or 15 – 20 mg/kg IV^[1]

- In combination with diazepam for induction: Diazepam 5 – 10 mg/kg IM give ketamine 30 minutes after diazepam at 20 – 40 mg/kg IM or Diazepam 0.2 – 0.5 mg/kg and Ketamine 10 – 15 mg/kg (to effect) IV;^[1]
- In combination with diazepam for anesthesia without inhalants: Diazepam 5 – 10 mg/kg IM plus ketamine 60 – 80 mg/kg IM 30 minutes later;^[1]
- In combination with xylazine: Not recommended for pet rabbits (Ivey and Morrissey 2000)^[1]

FERRETS:

For injectable anesthesia: butorphanol 0.1 mg/kg, ketamine 5 mg/kg, medetomidine 80 mcg/kg. Combine in one syringe and give IM. May need to supplement with isoflurane (0.5 – 1.5%) for abdominal surgery. (Finkler 1999)^[1]

CATTLE:

- Premedicate with atropine and xylazine, then ketamine 2 mg/kg IV bolus (Thurmon and Benson 1986)^[1]
- After sedation, 2.2 mg/kg IV (Mandsager 1988)^[1]

HORSES:

- For field anesthesia: Sedate with xylazine (1 mg/kg IV; 2 mg/kg IM) given 5 – 10 minutes (longer for IM route) before induction of anesthesia with ketamine (2 mg/kg IV). Horse must be adequately sedated (head to the knees) before giving the ketamine (ketamine can cause muscle rigidity and seizures).^[1]

If adequate sedation does not occur, either: **1)** Redose xylazine: up to half the original dose, or **2)** Add butorphanol (0.02 – 0.04 mg/kg IV). Butorphanol can be given with the original xylazine if you suspect that the horse will be difficult to tranquilize (e.g., high-strung Thoroughbreds) or added before the ketamine. This combination will improve induction, increase analgesia and increase recumbency time by about 5 – 10 minutes, or **3)** Diazepam (0.03 mg/kg IV). Mix the diazepam with the ketamine. This combination will improve induction when sedation is marginal, improve muscle relaxation during anesthesia and prolong anesthesia by about 5 – 10 minutes, or **4)** Guaifenesin (5% solution administered IV to effect) can also be used to increase sedation and muscle relaxation. (Mathews 1999)^[1]

- Initially give xylazine 1.1 mg/kg IV and wait for full sedative effect (4 – 8 minutes); then give ketamine 2.2 – 2.75 mg/kg IV only (the higher dose may be necessary for ponies, young “high-strung” Arabians, Hackneys, and Thoroughbreds) as a bolus. Do not administer to an “excited” horse. If surgery time requires additional anesthesia, ½ – ½ of the original xylazine/ketamine doses may be given IV. For procedures where better muscle relaxation is required, use guaifenesin-thiobarbiturate. Do not disturb horse until fully recovered. (Thurmon and Benson 1987)^[1]
- For foals and ponies: Add 500 mg ketamine and 250 mg xylazine to 500 ml of 5% guaifenesin solution. For induction, give 1.1 ml/kg IV rapidly. Anesthesia may be maintained by constant IV infusion of 2 – 3 ml/kg/hr. Lower doses for foals, higher doses for ponies. (Thurmon and Benson 1987)^[1]
- For induction of surgical colic patients: Use guaifenesin to effect, then 1.6 – 2.2 mg/kg ketamine (Mandsager 1988)^[1]
- 200 mg bolus (in a 454 kg horse) intra-operatively to reduce movement with light general anesthesia (Mandsager 1988)^[1]

SWINE:

- Give atropine, then ketamine at 11 mg/kg IM. To prolong anesthesia and increase analgesia give additional ketamine 2 – 4 mg/kg IV. Local anesthetics injected at the surgical site (e.g., 2% lidocaine) may enhance analgesia. (Thurmon and Benson 1986)^[1]
- Ketamine (22 mg/kg) combined with acepromazine (1.1 mg/kg) IM (Swindle 1985)^[1]
- 4.4 mg/kg IM or IV after sedation (Mandsager 1988)^[1]

SHEEP:

- Premedicate with atropine (0.22 mg/kg) and acepromazine (0.55 mg/kg); then ketamine 22 mg/kg IM. To extend anesthetic time, may give ketamine intermittently IV at 2 – 4 mg/kg. (Thurmon and Benson 1986)^[1]
- 2 mg/kg IV for induction, then 4 ml/minute constant infusion of ketamine in a concentration of 2 mg/ml in Dextrose 5% in water (D₅W). (Thurmon and Benson 1986)^[1]

GOATS:

Give atropine 0.4 mg/kg, followed by xylazine 0.22 mg/kg IM 20 – 25 minutes later. Approximately 10 minutes after xylazine give ketamine 11 mg/kg IM. To extend anesthesia give ketamine 2 – 4 mg/kg IV (shorter extension) or 6 mg/kg (longer extension). (Thurmon and Benson 1986)^[1]

REPTILES:

- Medium to small land tortoises: medetomidine 100 – 150 mcg/kg with ketamine 5 – 10 mg/kg IV or IM;^[1]
Freshwater turtles: medetomidine 150 – 300 mcg/kg with ketamine 10 – 20 mg/kg IV or IM;^[1]
Giant land tortoises: 200 kg Aldabra tortoise: medetomidine 40 mcg/kg with ketamine 4 mg/kg IV or IM^[1]
Smaller Aldabra tortoises: medetomidine 40 – 80 mcg/kg with ketamine 4 – 8 mg/kg IV or IM. Wait 30 – 40 minutes for peak effect;^[1]
Iguanas: medetomidine 100 – 150 mcg/kg with ketamine 5 – 10 mg/kg IV or IM;^[1]
Reversal of all dosages with atipamezole is 4 – 5 times the medetomidine dose (Heard 1999)^[1]
- 20 – 60 mg/kg IM (McConnell and Hughey 1987)^[1]

BIRDS:

- Birds weighing:
<100 grams (canaries, finches, budgies): 0.1 – 0.2 mg/gm IM;

250 – 500 grams (parrots, pigeons): 0.05 – 0.1 mg/gm IM;
500 grams – 3 kg (chickens, owls, hawks): 0.02 – 0.1 mg/gm IM;
>3 kg (ducks, geese, swans): 0.02 – 0.05 mg/gm IM (Booth 1988a)^[1]

- In combination with xylazine: ketamine 10 – 30 mg/kg IM; xylazine 2 – 6 mg/kg IM; birds less than 250 g require a higher dosage (per kg) than birds weighing greater than 250 g. Xylazine is not recommended to be used in debilitated birds because of its cardiodepressant effects.
In combination with diazepam: ketamine 10 – 50 mg/kg IM; diazepam 0.5 – 2 mg/kg IM or IV; doses can be halved for IV use.
In combination with acepromazine: ketamine 25 – 50 mg/kg IM; acepromazine 0.5 – 1 mg/kg IM (Wheler 1993)^[1]

WARNINGS/ PRECAUTIONS/ CONTRA-INDICATIONS:

- Contra-indicated as sole anaesthetic in horses, donkeys or dogs; patients with hepatic or renal impairment; latter stages of pregnancy.^[1]
- Because ketamine can increase blood pressure, careful control of post-surgical hemorrhage (e.g., declawing) should be managed. It is not essential to withhold food or water prior to surgery, but in elective procedures, it is recommended to withhold food for 6 hours prior to surgery.^[1]
- Cats' eyes remain open after receiving ketamine, and should be protected from injury plus an ophthalmic lubricant should be applied to prevent excessive drying of the cornea.^[1]
- Ketamine can cause increases in CSF pressure and it should not be used in cases with elevated pressures or when head trauma has occurred. Because of its supposed epileptogenic potential, it should generally not be used (unless very cautiously) in animals with preexisting seizure disorders. As myelography can induce seizures, ketamine should be used cautiously in animals undergoing this procedure.^[1]
- To minimize the incidences of emergence reactions, it is recommended to minimize exposure to handling or loud noises during the recovery period. The monitoring of vital signs should still be performed during the recovery phase, however.^[1]
- In approved species the following adverse reactions are listed: "respiratory depression . . . following high doses, emesis, vocalization, erratic and prolonged recovery, dyspnea, spastic jerking movements, convulsions, muscular tremors, hypertonicity, opisthotonos and cardiac arrest. In the cat, myoclonic jerking and/or tonic/clonic convulsions can be controlled by ultrashort-acting barbiturates or acepromazine. These latter drugs must be given intravenously, cautiously, and slowly, to effect (approximately ⅓ to ¼ the normal dose may be required)."^[1]
- Seizures have been reported to occur in up to 20% of cats that receive ketamine at therapeutic dosages. Diazepam is suggested if treatment is necessary. It has been reported to rarely cause a variety of other CNS effects (mild CNS effects to blindness and death). Ketamine has been documented to cause hyperthermia in cats; low doses of acepromazine (0.01 – 0.02 mg/kg IV) may alleviate. Anecdotal reports of ketamine causing acute, CHF in cats with mild to moderate heart disease have been reported.^[1]
- Pain after IM injection may occur.^[1]
- Ketamine is considered to have a wide therapeutic index (approximately 5 times greater when compared to pentobarbital). When given too rapidly or in excessive doses, significant respiratory depression may occur. Treatment using mechanically assisted respiratory support is recommended versus the use of analeptic agents. In cats, yohimbine with 4-aminopyridine has been suggested for use as a partial antagonist.^[1]

REFERENCES:

1. Plumb's Veterinary Drug Handbook, Sixth Edition by Donald C. Plumb
2. JOUBERT, K - Ketamine hydrochloride – an adjunct for analgesia in dogs with burn wounds. Journal of the South African Veterinary Association (1998) 69(3): 95–97 (En.). Section of Anaesthesiology, Department of Surgery, Faculty of Veterinary Science, University of Pretoria
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