General Anaesthesia

Injectable anaesthetic agents

Injectable anaesthetics can be administered through various routes. The equipment required for administration of injectable anaesthetics is minimal.

Routes of administration:

i. Intravenous e.g. thiopentone in horses
ii. Intramuscular e.g. ketamine in dogs
iii. Subcutaneous e.g. droperidol – fentanyl in cats
iv. Intraperitonial e.g. thiopentone in cats
v. Intrathoracic e.g. thiopentone in cats
vi. Intratesticular e.g. pentobarbitone in pigs for castration

Advantages

Injectable anaesthetic agents are simple to administer, have rapid onset of action, useful as induction agents and does not irritate the airways. They are non-explosive and are not inflammable.

Disadvantages

They may induce tissue damage if not injected through appropriate route (thiopentone if administered perivascularly induce severe tissue reaction and accidental administration of xylazine through carotid artery may cause fatal). Excess dose administered without calculating the dose or patient evaluation may cause toxicity. It may not be possible to recover the patient without the use of specific reversal/antagonistic agents, oxygen supplementation, intermittent positive pressure ventilation and other lifesaving supports.

Classification of injectable anaesthetics

Category	**Examples**
Barbiturates	Thiobarbiturates e.g., thiopentone sodium, thiamylal sodium
	Methylated oxybarbiturate e.g., methohexitone sodium
	Oxybarbiturates e.g., pentobarbital sodium
Dissociative anaesthetics	Ketamine, Tiletamine, phencyclidine
Steroid anaesthetics	Combination of alphaxalone and alphadolone e.g., saffan, althesin
Imidazole derivatives	Etomidate and metomidate
Alkylphenols	Propofol
Opioid synthetic analgesics	Fentanyl citrate, sufentanyl, alfentanil, lofentanyl
	Etorphine
Neuroleptanaesthetic mixtures	Droperidol + Fentanyl
	Fluanisone + Fentanyl
	Etorphine combinations
Chloral hydrate	

BARBITURATES

Derived from barbituric acid, barbiturates are classified into four groups namely, long acting, intermediate acting, short acting and ultrashort acting barbiturates. All of those used for clinical anaesthesia fall in the short or ultrashort classification, whereas those used for sedation or control of convulsions are of long or intermediate action.

ULTRA SHORT ACTING BARBITURATES

The commonly used ultrashort acting barbiturates are thiopentone sodium, thiamylal sodium and methohexitone sodium. Thiopentone and thiamylal are thiobarbiturates and Methohexitone is an oxybarbiturate. These agents are strong alkalis (pH: 11-12). Following administration, the blood buffers neutralize the sodium carbonate. Thiopental and thiamylal are converted into acid form, which bind with the plasma protein particularly, the albumin fraction. The narcotic and anaesthetic action is induced by the unbound fraction. These agents produce dose dependent action varying from hypnosis to general anaesthesia.

Binding with protein depends on the drug concentration and the protein level. Hence care must be taken in calculating the dose of thiopentone, thiamylal and methohexitone for hypo-proteinaemic animals. Unbound fractions will be more and may cause profound depression.

These agents produce unconsciousness in 30 to 90 seconds as they cross the blood-brain barrier in one arm-brain circulation. The duration of anaesthesia varies from 5 to 15 minutes.

The recovery from anaesthesia is not due to the detoxification, biotransformation and elimination, it is due to distribution. From the blood it moves to the highly vascularised tissues and from there slowly redistributed to less vascularised tissues. Initially the concentration in the fat will be more. If fluids are administered during recovery the redistributed fractions may be mobilized into the circulation resulting in further deepening of anaesthesia. The distribution depends on the speed and quantity injected. A small quantity injected rapidly as a bolus will produce high plasma and brain concentration resulting in narcosis and the recovery will be faster.

The amount of thiopentone and thiamylal required to produce anaesthesia vary from 10 to 18 mg/kg in small animals and 6 to 10 mg/kg in large animals. Anaesthesia is induced by administering half of the calculated as a bolus followed by slow incremental doses to abolish pedal reflex. Thiopentone and thiamylal are administered as 1 to 5% solutions in dogs and cats and 5 to 10% solutions in horses and cattle.

Methohexitone is administered as 1% solution in small animals and as 6% in large animals. The dose is 3 to 5 mg/kg intravenously.

Cardiovascular effects

Barbiturates are potent cardiovascular depressants. They increase the heart rate and peripheral resistance with reduction in cardiac output and increase in central venous pressure. These actions are due to the reflex action secondary to the stimulation of baroreceptors and chemoreceptors and myocardial hypoxia. Myocardial hypoxia may result in cardiac arrhythmia, bigeminy, premature ventricular contraction and depression/elevation/slurring of S-T segment. Administration of oxygen prevents further manifestations. Lidocaine can be administered to control ventricular arrhythmia and it can act as a useful adjunct if incorporated in the anaesthetic regimen. It prevents and corrects ventricular arrhythmia and reduce the requirement of barbiturates. Separate syringes must be used for administration to prevent the formation of precipitation.

Respiratory effects

Ultrashort acting barbiturates induce severe respiratory depression even at clinical doses. Rapid administration results in apnea during induction. The changes are- reduction in respiratory volume, tidal and minute volume. If respiratory arrest is noticed it must be managed with oxygen supplementation and mechanical ventilation. Artificial respiration by compressing the chest and

stimulation of respiratory reflex may help to overcome apnoea but may not be as effective as oxygen supplementation.

Thiopentone protects the ischemic brain hence used in patients with brain injury and in cardiopulmonary bypass anaesthesia. Thiopentone is used as an induction agent in patients suffering from epilepsy. These agents are metabolized in the liver and to a less extend in kidney, brain and in other tissues.

They are eliminated as alcohols, ketones, phenols and carboxylic acids through urine. Microsomal enzymes of the liver get elevated following administration of barbiturates. These agents do not cause prolonged decrease in gastrointestinal motility. They produce sufficient muscle relaxation required for minor surgery. Barbiturates readily cross the placental barrier and depress fetus. However, the amount of thiopentone transferred is not large enough to be detrimental to the neonate at birth.

Concurrent use of other drugs and benefits

Anticholinergics: Administered to reduce salivation and prevent bradycardia. In horses, anticholinergics can be administered if they are fasted for 6 to 8 hours.

Tranquilizers: Administered to reduce the anxiety and the dose of the anaesthetic drugs

Neuroleptanalgesics: Not safe to combine with barbiturates as the combined effects will be extreme bradycardia, hypotension and cardiac arrest.

Narcotics: Narcotics markedly reduce the dose of barbiturates. Morphine, Methadone and Innovar vet are not recommended in cats

Muscle relaxants: In large animals centrally acting muscle relaxant glyceryl guaiacolate (Guaifenesin) is combined with barbiturates. In dogs succinyl choline, pancuronium, gallamine and other products can be combined with barbiturates. Oxygen administration and intermittent positive pressure ventilation are essential to maintain respiratory and cardiovascular functions.

Procaine and lidocaine: Procaine hydrochloride and lidocaine hydrochloride can be combined with thiopentone and thiamylal. They should not be mixed in the same syringe because the local anaesthetics are acidic and barbiturates are alkaline. Every time the needle or the catheter must be flushed with normal saline before administration of each agent. Analgesia, Reduce the dose of barbiturates to 50%, Protects the myocardium and brain from ischemic changes, Act as antidysrhythmic agents and Provide good muscle relaxation.

LONG-ACTING BARBITURATES

Pentobarbital sodium is the long-acting barbiturate used in anaesthesia and is marketed in vials containing 50 mg/ml and 65 mg/ml. Use of pentobarbital is restricted to small animal and swine anaesthesia. The standard solution is diluted and given intravenously.

Dose - Dogs & cats 20 - 30 mg/kg without premedication and 10 - 20 mg/kg with premedication. For continuous infusion an initial loading dose of 2 - 5 mg/kg is given followed by 1 - 2 mg/kg/hr.

A special preparation containing 240 mg/ml of pentobarbital is available and is used for euthanasia of animals. For euthanasia it is administered at the rate of 48 mg/kg (1 ml/5kg). This solution is often used to castrate large boars. The solution is administered deep into both the testicles at a dose not exceeding 24 mg/kg. Castration is performed immediately after reaching light stage of anaesthesia by ligation of the cord and emasculation. The testicles must be disposed carefully otherwise dogs may get access and die due to poisoning.

DISSOCIATIVE ANAESTHETIC AGENTS

Ketamine hydrochloride and tiletamine are the commonly used dissociative anesthetics in veterinary field. Phencyclidine is another cyclohexamine product withdrawn from use because of drug abuse.

The dissociative anaesthesia is characterized by profound amnesia, superficial analgesia and catalepsy, Involuntary spontaneous movements, persistence of reflexes like swallowing, pharyngeal palpebral and corneal, large dose may induce convulsions, lack of muscle relaxation

KETAMINE

Ketamine is a popular anaesthetic used in veterinary and human anaesthesia due to its wide margin of safety and compatibility with other agents. It was first synthetised in 1963 and introduced in human anaesthesia in 1965 and in veterinary anaesthesia in 1970. Ketamine alters the central nervous system activity to sensory impulses without blocking it at spinal cord or brain stem levels. It allows the impulses to reach the cortical receiving areas but not perceived because of the depression and dissociation of limbic system and other cortical association areas.

It can cause seizures even in patients not known to be epileptic and may occur even after 24 hours administrations. The depression effects of ketamine are determined in the central nucleus of thalamus, neocorticothalamic axis and nociceptive cells in the medial medullary reticular formation.

Cardiovascular effects - Ketamine increases heart rate, cardiac output, peripheral vascular resistance, systemic and pulmonary blood pressure, cardiac contractility and myocardial oxygen consumption. The cardiovascular stimulation is attributed to stimulation of sympathetic discharge, vagolytic activity and Negative inotropic effects on heart.

Respiratory effects - The effect of ketamine on respiratory functions are- increase in respiratory rate with or without decrease in tidal volume. Also, the partial arterial carbon dioxide level (PaO_2) will increase with reduction in partial arterial oxygen level ($PaCO_2$).

Muscle relaxation will be poor hence must be used with other drugs which produce muscle relaxation. It induces copious salivation and lacrimation. Salivation can be controlled by the prior administration of anticholinergics. Ketamine is metabolized in the liver and certain amount is excreted as unchanged through urine. Decreases total RBC counts due o the sequestration of RBCs in the spleen. Classical stress leukogram; leukocytosis with lymphopenia and neutrophilia can be observed following ketamine administration. Induces hyperglycaemia. Contraindicated in patients with increased intracranial pressure or in patients who are undergoing brain or spinal cord surgery as it increases the cerebrospinal fluid flow and pressure. Not recommended for intraocular surgery as it increases the blood pressure and intraocular pressure. Ketamine maintains the uterine blood flow hence can be a useful alternative for thiopentone in cardio vascular. The aims of combining other agents with ketamine are to achieve muscle relaxation, eliminate side effects like salivation and recovery delirium, improve visceral analgesia and prolong the period of anaesthesia.

Dose rate of ketamine:

In *cats* the dose of ketamine is 10 - 30 mg/kg I.M. If it is combined with narcotics, tranquilizers or sedatives the dose can be reduced to 5 - 15 mg/kg I.M. and 2- 5 mg/kg I.V.

Dogs

Xylazine 1 - 2 mg/kg I.M (lower dose in larger dogs) and Ketamine 10 mg/kg IM/IV OR
Diazepam 0.2 - 5 mg/kg I.V and Ketamine 5 mg/kg I.V
Meditomidine 40 μg/kg I.M. and Ketamine 5- 7.5 mg/kg I.M.
Butorphenol 0.1 mg/kg I.M, Meditomidine 25 μg/kg I.M. and Ketamine 5 mg/kg I.M. 15 minutes later.

Horses

Xylazine 1.1 mg/kg I.V and 4 to 5 minutes after Ketamine 2.2 mg/kg I.V. To prolong the anaesthesia half of the initial dose of both the drugs must be repeated at every 10 to 20 minutes. Diazepam at the rate of 0.22 mg/kg I.V can be combined to reduce muscle fasciculation. Often glyceryl guaiacolate is combined with xylazine and ketamine at the rate of 50 mg/kg I.V and even administered as mixture to maintain anaesthesia and this mixture gives good muscle relaxation.

Cattle
Xylazine 0.1 mg/kg and Ketamine 2 - 5 mg/kg I.V
Sheep and Goats
Xylazine 0.04 - 0.06 mg/kg and Ketamine 2.2 - 4.4 mg/hg I.V

TILETAMINE

Tiletamine is closely related to ketamine and is two to three times potent than ketamine. It induces muscle rigidity and tonic-clonic convulsions if administered alone hence it is marketed in combination with a benzodiazepine Zolazepam (Telazol in USA and Zoletil in Australia). It contains 250 mg tiletamine and 250 mg zolazepam. This combination provides muscle relaxation and a dissociative state of anaesthesia in dogs, cats and wild animals. Its use in horses may result in potential severe reactions. Premedication with xylazine minimizes the adverse reactions in horses.

Animals anaesthetized with telazol will respond to palpebral, laryngeal, pharyngeal, pedal and pinnal reflexes. Salivation is more marked and can be controlled by the use of anticholinergic premedication. Anticholinergic premedication is very important while using this combination
Dosage: Cat @ 7 - 15 mg/kg i.m., 5 - 10 mg/kg i.v., Dog @ 10 - 15mg/kg i.m.; 5 - 7 mg/kg i.v.,

STEROID ANAESTHETICS

Combination of alphaxalone and alphadolone is marketed as Saffan (in veterinary) and Althesin (in human). Alphaxalone is insoluble in water and can be dissolved in Cremophor EL (vehicle-polyoxyethylated castor oil). Alphadolone is another steroid which has hypnotic property and increase the solubility of alphaxalone in cremophor. Each mL of Saffan contains 9 mgs of alphaxalone and 3 mgs of alphadolone. This preparation is viscid and the pH is around 7. Saffan froths in syringes due to the presence of cremophor EL and is miscible with water. Low solubility of these steroids in water made them less popular.

Saffan is used in cats. In dogs it induces histamine release and causes severe hypotension hence not recommended in dogs. It selectively decreases cerebral oxygen consumption to a greater extend by reducing the blood flow. Indicated in cats with head injuries. Retching, vomiting and twitching of facial muscles may occur during induction. In cats it does not induce significant change in cardiac index and systemic vascular resistance. It induces respiratory depression. It produces good muscle relaxation. It can be used in cats for caesarian section because the neonates are less depressed at the dose of 4.0 mg/kg. It may cause oedema of ear pinnae and paws in cats due to histamine release. It has got week antioestrogenic effect. It may induce laryngeal oedema.It is not recommended in horses.

Dose: Cats 4 - 6 mg/kg i.m./i.v., Pigs 4 - 6 mg/kg i.v., Pig neonates 2 - 3 mg/kg i.v., Sheep 1.65 - 3 mg/kg i.v.

IMIDAZOLE DERIVATIVES

METOMIDATE

Metomidate is a non-barbiturate crystalline power belonging to imidazole group. At room temperature, the dissolved solution is stable only 24 hours. Metomidate has hypnotic and central muscle relaxant property, but does not have analgesic property hence often combined with fentanyl or azaperone premedication. It is mainly used in pigs and birds. It is not recommended in horses.

Dose: Birds 3 - 20 mg/kg i.m.

ETOMIDATE

Etomidate is a white crystalline power available as 20 mg dissolved in 10 ml of a mixture containing 35% propylene glycol and 65% water (v/v). Intravenous injection is associated with high incidence of spontaneous movements, involuntary muscle tremors and hypertonus. Premedication with fentanyl or diazepam reduces the side effects. It induces less cardiovascular depression and does not release

histamine. Hence it is used in dogs for caesarian section at the dose of 1.5 - 3.0 mg/kg i.v. along with diazepam (0.2 mg/kg I.V total dose not exceeding 5 mg).

Etomidate is recommended in high risk allergic patients who had exhibited or are expected to exhibit severe anaphylactic responses. Etomidate like thiobarbiturates decrease the circulating cortisol concentration in hyperadrenocortism, hence can be used as safe induction agent in these patients.

ALKYLPHENOLS

PROPOFOL

It is a lipophilic alkylphenol (2-6 di isopropyl phenol) becoming popular in human and veterinary anaesthesia. It is an oil at room temperature and cannot be injected hence was formulated with Cremaphor EL (polyoxyethylated castor oil) as vehicle. Cremaphor EL as with other agents induced histamine release in human and animals. Now the vehicle is changed and reformulated with a parental nutritional agent called as Intralipid which contains soybean oil, glycerol and egg Lecithin.

The new formulation is milky in colour. The vehicle added favors bacterial growth hence the open ampule after 6 to 12 hours must be discarded. Propofol induce rapid loss of unconsciousness in 20 to 40 seconds after I.V. administration due to its lipophilic nature. It crosses the blood-brain barrier in one arm-brain circulation and further redistributed from plasma, brain and well-perfused tissues to less perfused tissues as thiopentone. Recovery periods are shorter without any undesirable side effects in propofol anaesthesia half of the calculated dose in infused as a bolus and the remaining half is administered in a slow phase.

Propofol can be administered in continuous infusion to maintain anaesthesia. It is conjugated in the liver and metabolized as glucuronide and sulphate and excreted in urine.

Cardiovascular effects- Propofol induce 20 to 40% reduction in arterial blood pressure due to reduction in cardiac output and systemic vascular resistance. Its use is cautioned in dogs with serious volume depletion.

Respiratory effects- Propofol induce apnea and greater respiratory depression.

Propofol does not affect hepatic and renal functions. It can be used for long term sedation and anaesthesia in intensive care patients, as it does not alter adrenocortical function. It reduces the intraocular pressure hence can be used in patients undergoing intraocular procedures Propofol is a good induction agent for caesarian section in dogs and cats. It reported that the puppies were bright and the mother was alert enough to care the puppies immediately following recovery. It is a safe anaesthetic in brachycephalic breeds of dogs.

Dose: Dogs- 3 - 4 mg/kg i.v. in premedicated, 5 - 6.5 mg/kg i.v. in un-premedicated (continuous infusion 0.4 – 0.6 mg/kg/minute)

Cats- 8 mg/kg i.v. in un-premedicated (continuous infusion 0.51 mg/kg/minute)

Horses- 2.0 mg/kg with xylazine 0.5 mg/kg i.v. (continuous infusion 0.2 mg/kg/minute)

Sheep and goats- 3 - 4 mg/kg i.v.

Rabbit- 7.5 - 15 mg/kg i.v.

Mouse- 26 mg/kg i.v.

Birds- 1-15 mg/kg i.v.

Reptiles- 10 mg/kg

PURE AGONISTS

MORPHINE

It is derived from the dried milky exudates of the unripe seed capsules of the opium poppy (*Papaver somniferum*). The exudates contains 3-25% of morphine, 5% noscapine and 0.8% papaverine. The laboratory synthesis of morphine is different hence still it is derived from opium poppy. The laboratory synthetic agents are codeine, heroin (dimorphine = diacetylmorphine) and oxymorphine. Morphine

acts and produces analgesia, drowsiness, nausea and vomiting by stimulating chemoreceptor trigger zone for vomiting. It induces dopaminergic excitement in cats, horses, pigs, dogs and cattle. It induces respiratory depression, depresses cough. The effects on myocardium are not significant; but produce increase in vagal tone and slowing of heart.

Morphine is used as a postoperative analgesic for pain relief in veterinary practice. Morphine decreases motility of stomach with increase of antral portion. Initial use may cause defecation and chronic use will result in constipation. It is absorbed from the gut and oral mucosa. It is used in the treatment of congestive heart failure to relieve pain and decrease after load. Preservative free morphine can be administered epidurally to relieve pain.

Dose: Horses- Morphine gives good results in horses if administered after xylazine sedation. Xylazine 1.0 mg/kg I.V and morphine 0.6 mg/kg i.v.

Dogs 0.2 – 0.5 mg/kg (total dose not exceeding 10 mg i.m. / i.v.

Cats 0.05 – 0.1 mg/kg s.c./i.m.. must be administered with caution because it may induce CNS stimulation. Hence must be used with suitable tranquilizer.

Morphine is administered after administration of Acepromazine. Acepromazine 0.1 mg/kg i.m. and Morphine 0.6 mg/kg i.m.

PETHIDINE

Pethidine is a vagolytic and negative inotropic drug at clinical doses. It reduces salivation and respiratory secretion without inducing vomiting and defecation. Pethidine induces histamine release if administered through intravenous route.

Dose: Dogs- 2 - 6.5 mg/kg s.c./i.m.; Cats- 2 - 4.4 mg/kg s.c./i.m.

MEPERIDINE

It is a synthetic product, less potent (one tenth of morphine) and used in dogs and cats. Intravenous administration causes release of histamine hence most often used along with acepromazine. (Phenothiazines are potent antihistaminics)

Dose: Dogs and Cats 2-5 mg/kg i.m.

OXYMORPHONE

Oxymorphone is a synthetic derivative having 10 times greater potency than morphine. It is widely used in dogs and cats for its analgesic property. Analgesia lasts for 4 hours. It does not cause histamine release as meperidine. It is used popularly in small animal anaesthesia due to its analgesic and lack of release of histamine. The only limitation with drug is stimulation of vagus leading to bradyarrhythmias and it can be reduced or prevented with the use of antichlinergic agents in the protocol. It is also administered epiduraly to control pain in the hindquarters (0.025 - 0.05 mg/kg).

Dose

Dogs 0.05 - 0.2 mg/kg i.v./ s.c./i.m. (total dose not exceeding 4.5 mg)
Cats 0.05 - 0.4 mg/kg i.v./ s.c./i.m.
Horses 0.02 - 0.03 mg/kg i.v./i.m.

FENTANYL CITRATE AND ETORPHINE

FENTANYL CITRATE

Fentanyl is a synthetic opioid product related to phenylpiperidines. Its analgesic property is 80 times greater than that of morphine. Cardiac output, heart rate, respiratory rate and arterial oxygen tension (PaO_2) are reduced following administration of fentanyl. Fentanyl citrate is available alone, or in combination with droperidol (Innovar vet- 0.4 mg fentanyl + 20 mg droperidol per mL) or fluanisone. (Hypnorm- 0.315 mg fentanyl + 10 mg fluanisone per mL). Fentanyl combinations provide good intra-operative analgesia. In dogs and primates, it produces sedation and myosis whereas in horses it produces excitement and mydriasis. It is not recommended in cats. *Dose* - Dogs 0.01 - 0.02 mg/kg i.v./i.m. The other synthetic pure agonists are *afentanil, sufentanil, lofentanil and carfentanil.*

ETORPHINE

Etorphine is a potent synthetic morphine derivative (1000 times more potent than morphine). Its general properties are similar to morphine. Etorphine is extremely potent in human and any accidental injection may cause death if not treated with naloxone or diprenorphine. Etorphine is an extremely long-acting agent whose effects are maintained by enterohepatic recycling. The action of this drug can only be terminated by the administration of the specific antagonist Diprenorphine. In clinical dose etorphine alone may produce initial excitement hence it is marketed in combination with phenothiazine derivatives. Separate combinations are available for large and small animals. Each pack of the marketed drug will be having two components. 1-Immobilon and 2-Revivon.

Preparations:

- Immobilon L A contains Etorphine 2.45 mg/ml and acepromazine 10 mg/ml
- Immobilon S A contains Etorphine 0.074 mg/ml and Methotrimeprazine 18 mg/ml
- Revivon L A contains Diprenorphine 3.0 mg/ml
- Revivon S A contains Diprenorphine 0.272 mg/ml
- This mixture is popularly used to capture elephants and giraffes
- Not recommended for domesticated and wild felines

PENTAZOCINE, BUTORPHANOL TARTRATE AND BUPRENORPHENE

PENTAZOCAINE

It is used as an analgesic. In human it causes dysphoria and hallucination and pentazocine is developed to prevent drug abuse. In clinical doses it produces pulmonary vascular resistance. In horses it is used in the treatment of colic and administered at the rate of 0.33 mg/kg I.V. Dose -3 mg/kg for 1 to 3 hours of analgesia. Penlog -Duration of analgesia 3-4 hour. Onset- 1 min – one hour

BUTORPHANOL TARTRATE\

It is used in horses, cats and dogs. It produces sedation, analgesia and increase in pulmonary vascular resistance. *Dose* Horse- 0.1 mg/kg i.v.; Dogs- 0.2 – 0.8 mg/kg i.m./s.c.; Cats- 0.2 – 0.4 mg/kg i.v./i.m./s.c. Onset 1 mint – 15 mint on rapid i.v.

BUPRENORPHINE

Respiratory depression is more and often treated with intermittent positive pressure ventilation.

Dose: Horses- 6 - 10 μg/kg; Dogs- 0.01 - 0.02 mg/kg i.v./i.m./s.c.; Cats- 0.005 - 0.02 mg/kg i.m./s.c.

PURE ANTAGONISTS

Naloxone hydrochloride, nalorphine hydrochloride and diprenorphine are the opioid pure antagonists used for the reversal of the effects of pure agonists and partial agonists. In horses naloxone is used in the control of crib biting.

Naloxone: Dogs and cats- 0.04 - 0.1 mg/kg i.v./i.m./s.c.; Horses 0.005 = 0.2 mg/kg i.v.

Diprenorphine: Dogs & Cats- 0.0272 mg/kg i.v.;Horse- 0.02 - 0.03 mg/kg i.v.

CENTRALLY ACTING MUSCLE RELAXANTS (guaifenesin)

Glyceryl guaiacolate ether (Guaifenesin) is the centrally acting muscle relaxant and it acts on the internuncial neurons of the spinal cord. It affects the polysynaptic reflexes more than monosynaptic reflexes hence it has got little action on the diaphragm. It does not influence the respiratory centers in brain. Diaphragmatic muscle is composed of mainly striated titanic fibers and not striated tonic fibers; hence GGE does not affect the diaphragm. It also induces sedation and hypnosis due to its action on the reticular formation of the brain stem. It has got bactericidal action. In practice, it is administered as 5% (50 mg/ml) solution in 5% dextrose. Concentration greater than 10% is irritant to body tissues and can induce haemolysis. GGE dissolves readily in 5% dextrose if warmed slightly. GGE is used in combination with other agents in 5% dextrose solution as induction and maintenance agent. These mixtures are administered after routine premedication. The maximum dose of GGE is 90 to 100 mg/kg and if this dose is exceeded it will cause spasm, hypertonicity of muscles and cardiac arrest. GGE does not cross the placental barrier due to its high molecular weight.

Horses

- GGE 50 mg/ml (5% solution) in 5% dextrose, mixed with xylazine 0.5 mg/ml and ketamine 1.0 mg/ml is the routinely used mixture in horses.
- Induction is achieved at the dose rate of 1.1 ml/kg and further maintenance is done with this mixture at the rate of 2.75 ml/kg/hour. Alternatively, induction can be done using xylazine (1.1 mg/kg I.V) and ketamine (2.2 mg/kg IV) and further maintenance can be done with this mixture.
- GGE can be combined with thiopentone or thiamylal (1-3 grams) and administered in horses (See barbiturates)

Cattle

- GGE 50 mg/ml (5% solution) in 5% dextrose mixed with xylazine 0.05 mg/ml and ketamine 1.0 mg/ml is the mixture used in cattle. 1.0 ml/kg I.V is administered for induction and further maintenance can be done with this mixture.