

# INTRAVENOUS ANAESTHESIA

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## General anaesthesia:

It is the controlled, reversible intoxication of CNS producing unconsciousness with complete loss of sensory as well as motor reflexes. The common methods to induce GA in animals are by using inhalation and intravenous anaesthesia. The other not so common methods are oral, Per rectal, intramuscular, intra peritoneum etc. However out of these methods the most preferred method is intravenous anaesthesia.

## Intravenous anaesthesia:

Intravenous anaesthesia in veterinary practice is primarily used for the induction of anaesthesia which is subsequently maintained by inhalation anaesthesia in small animals. However in large animals intravenous anaesthesia is mostly used for both induction as well as maintenance of anaesthesia.

## Advantages:

1. Easiness in administration.
2. Produces surgical anaesthesia with speed and pleasantness.
3. No sophisticated facilities are required as for inhalation anaesthesia.
4. Requires minimum equipment.
5. Economical

## Disadvantages:

1. Recovery depends upon the ability of the animal to redistribute, metabolize and excrete the anaesthetic drug. Very important in sick and debilitated animals.
2. Depth of anaesthesia cannot be decreased quickly unless you have an antagonist.
3. Recovery period may be longer depending upon the health status of the animal and the drug used.
4. Characteristic excitement and premature attempts to stand during recovery may be dangerous sometimes.
5. Long procedures can lead to severe physiological changes in the patient.
6. Oxygen and assisted controlled ventilation may not be available during emergency.

## **RUMONANTS ARE POOR SUBJECTS FOR INTRAVENOUS ANAESTHESIA.**

### **WHY?**

The ruminants are considered as poor subjects for general anaesthesia by any method because of many reasons as listed below:

1. **Regurgitation:** It is the most common complication seen following GA in large ruminants even after 24-36 hr fasting as it practically impossible to evacuate the rumen. Generally 2 types of regurgitation is seen following GA in ruminants.
  - **Active regurgitation:** It results due to the uncontrollable contractions of the oesophagus during induction of anaesthesia leading to reverse peristalsis.
  - **Passive regurgitation:** It results during anaesthesia when the animal comes in the lateral recumbency. The oesophagus as well as cardia is relaxed and so there is drainage of rumen contents into the oesophagus resulting regurgitation. This type of regurgitation can be prevented by raising the level of head above the level of the cardia. However if the regurgitation still develops, there are chances of aspiratory pneumonia. Therefore in this case raise the posterior part of the body to expel out all the regurgitated material.
2. **Tympani:** In normal standing position the oesophageal groove comes at a level higher than the level of the fluid in the rumen and so there is normal eructation with regular rumen motility. During anaesthesia the animal comes in the lateral recumbency – the level of the groove comes below the level of the rumen fluids – no eructation – tympani develops. This can be managed by canulation of the rumen in the lateral recumbency so as to expel the rumen gases.
3. **Respiratory depression:** This type of complication is because of tympani and the anaesthetic used.
4. **Hypoxia with uneven ventilation:** It results due to the lateral recumbency of the animal during anaesthesia – uneven ventilation – more CO<sub>2</sub> retention – less O<sub>2</sub> diffusion at alveolar level in the lungs – decreased pO<sub>2</sub> levels – hypoxia. The other possible causes for such complication are consolidation of the lungs due to aspiratory pneumonia.
5. **Radial paralysis:** This type of complication results due to prolonged lateral recumbency of the animal on the hard surface. Provide soft bedding to the animal to prevent such complication.

## INTRAVENOUS ANAESTHESIA – REQUIREMENTS

1. **Syringes:** Mostly disposable (sterile) of different capacities – 2ml, 5ml, 10ml or more.
2. **Needles:** Disposable needles – 22-25G, 2cm for cats; 18-22G, 2.5cm for dogs; 16-18G, 3-5cm for large animals. Use of butterfly needles (needles with plastic wings) is advantageous as can be properly secured with tape.
3. **Scalp vein sets:** Better than needles for long term administration of fluids and maintenance of anaesthesia.
4. **Infusion sets:** These are required when administering large volumes of anaesthesia (Chloral hydrate, guaifenesin etc.) and IV fluids.

## FACTORS AFFECTING THE ANAESTHETIC EFFECT FOLLOWING INTRAVENOUS ANAESTHESIA

1. Blood flow to the brain and other tissues of the body.
2. Amount of non-ionized drug: More the non- ionized form of the drug, readily it crosses the cellular boundaries. When the pH of the blood = pKa, 50% of the drug will be in the non-ionized form.
3. Protein binding: Higher the protein binding (70-80% in case of thiopentone sodium) lesser is the anaesthetic action.
4. Oil/water solubility: Lipid soluble drugs cross the cellular boundaries immediately and so less concentration in the blood/brain.
5. Rate of metabolism: Higher the rate, shorter/lesser is the effect.
6. Excretion.

## THE BARBITURATES

This group of drugs is still a popular choice for anaesthetic agents in veterinary practice. The drugs are based on the molecule of barbituric acid which is itself a convulsant. The name of the drug ends in 'one' in the UK e.g. Thiopentone. Substitution on three key parts of the molecule provides four distinct sub-groups of barbiturates with a wide variety of actions.

- 1) **Oxybarbiturates** e.g. pentobarbital. Various groups are added at C5 to form drugs with sedative and hypnotic properties.
- 2) **Methylated oxybarbiturates** e.g. methohexital. Methylation of the N-1 atom increases lipid solubility and shortens the duration of action. It also confers convulsive activity.

3) **Thiobarbiturates** e.g. thiopental, thiamylal. Substitution of oxygen at C2 by sulphur increases lipid solubility and decreases the duration of action.

4) **Methylated thiobarbiturates.** These are not used because of severe convulsions.

Barbiturates are also classified according to their length of action:

1) **Long-acting** - phenobarbital, barbital sodium

2) **Medium-acting** - amobarbital

3) **Short-acting** - pentobarbital, secobarbital

4) **Ultra-short-acting** - thiopental, thiamylal, methohexital

All anesthetic barbiturates are sodium salts and the ultra-short-acting drugs are highly irritant to tissues. Use the correct concentration and catheters. There is no true antidote to barbiturates. Overdoses are treated by ventilatory support, inotropic agents, warmth and production of diuresis with intravenous fluids to increase excretion.

Thiamylal is not available at the moment and thiopental is used instead. There is very little difference clinically although some practitioners may notice thiopental is not as potent as thiamylal.

### 1) Pentobarbital Sodium

Usually available in solutions containing 50 mg/mL or 65 mg/mL. Use is usually restricted to small animals and swine. The standard solution should be diluted half and half with sterile distilled water or physiological saline for administration to very small animals.

The drug is slow in crossing the blood brain barrier and onset of action is slow. If administered slowly then anesthetic induction excitement may occur. This can be dangerous due to injury or to administration of an overdose in an effort to control the excitement stage. The drug is not particularly irritant if injected perivascularly. The drug is metabolized in the liver and this is the main route of excretion. Enzyme induction occurs on repeat doses. Very low doses will act as a sedative without causing excitement. The anesthetic action is affected by the degree of ionization of the barbiturate molecule (see under thiobarbiturates).

## Dogs and cats

Without premedication the dose ranges from 20 mg/kg for light surgical anesthesia to 30 mg/kg for deep surgical anesthesia. With premedication the dose is generally lowered by about 1/4 to 1/2. (i.e. 10 to 20 mg/kg).

Two-thirds of the calculated dose should be administered rapidly intravenously to get over the initial excitement associated with second stage anesthesia. The drug should be given to effect and as it is very slow crossing the blood-brain barrier, the remainder of the dose should be given in small fractions over a period of 2 to 5 minutes, depending on the duration of effect desired and in order to fully assess the effects. The animal should not be stimulated in the preliminary stages or excitement may occur.

Four stages are seen:

1. Unable to raise head - deep narcosis.
2. Complete relaxation of jaws and inability to move tongue. Pedal reflex present - Light anesthesia.
3. Sluggish pedal reflex. Medium depth.
4. Loss of pedal reflex. Deep anaesthesia. Danger point. Respirations are shallow, quiet, and regular. It is very easy to overdose and cause respiratory failure.

Infusions can be used for treatment of epilepsy or to provide long-term sedation in critical patients.

Dose: 2 - 5 mg/kg loading dose and thereafter 1 - 2 mg/kg/hr infusion.

## Horses and cattle

Pentobarbital is not used alone in the horse and cattle as recovery is slow, and accompanied by excitement. **Foals** - Recovery may take up to three hours, because of poor microsomal enzyme function. May be used in calves over one month old but recovery takes about three hours.

## 2) THIOBARBITURATES

### a) Thiopentone sodium

## A. General

1. Prepared for use as sodium salts and are usually available as yellowish white crystalline powders to be dissolved in water or saline before use.
2. Aqueous solutions are strongly alkaline (pH 11-12) and are incompatible with acids.
3. The thiobarbiturates are partially ionized and act as weak organic acids. The undissociated fraction is the lipid soluble, active portion, while the dissociated portion is bound to plasma proteins and not active. A decrease in arterial pH will allow for more of the undissociated unbound portion and a more pronounced anesthetic action.
4. Perivascular injection will cause irritation, and with concentrations of greater than 2.5%, necrosis and sloughing may occur (**Barbiturate slough**). Xylocaine and/or physiological saline should be infiltrated around the area when a perivascular injection is made.

## B. Uptake, Redistribution, Metabolism

- Following IV administration, the thiobarbiturate crosses the blood brain barrier and, if given in a sufficient dose, produces hypnosis in one circulation time.
- Also rapidly diffuse into other highly vascularized tissues, such as the kidney, heart, and gastrointestinal tract.
- Rapidly diffuses out of the brain and other vascular tissues and is redistributed to muscle, fat, and eventually all body tissues. Termination of anaesthetic action is determined by redistribution in the body rather than by metabolism of the drug.
- Redistribution to poorly vascularized tissues (fat) is slow, taking minutes to hours but removal from the brain usually occurs rapidly with brain levels down to half of the peak levels after five minutes. It is because of this rapid removal from brain tissue that a single dose is so short lasting.
- The depth of anesthesia produced depends upon the concentration in blood and brain tissue. However, the relationship is rather complex. When the initial dose is large, the brain concentration will be high and anesthesia will be deep. However, the brain concentration (serum concentration) when waking occurs will be higher when a larger dose had been given than it will be with a smaller induction dose.

- Metabolism occurs much slower than redistribution and takes place primarily in the liver.
- A small amount may also be metabolized in the kidney and brain.
- With continuous administration of a thiobarbiturate, the body will eventually become "saturated" and recovery will become dependent on metabolism rather than redistribution and recovery will be prolonged.

### **C. Cardiovascular Actions**

1. Dose-dependent decreases in arterial blood pressure, stroke volume, and cardiac output. Reflex tachycardia.
2. Intravenous boluses in dogs can cause ventricular bigeminy (one normal beat constantly coupled with one premature ventricular contraction). This usually occurs if using high concentrations or "crash" induction techniques. This does not seem to occur in large animals. It is probably related to their resting heart rate and to the distribution of nerves in the ventricles. Thiopental is slightly less arrhythmogenic than thiamylal.
3. There is no change or a slight increase in total peripheral resistance.
4. Dose-dependent myocardial depression.

### **D. Clinical Use**

1. Thiamylal and thiopental are most commonly used as induction agents prior to inhalation anesthesia or as a sole agent for short procedures. Care must be taken with giving several repeated doses for longer procedures (>1 hr.) as the tissues may become "saturated" and the recovery prolonged.
2. Should not be used in animals in shock, animals with arrhythmias, or animals with severely impaired cardiovascular function.
3. Overdose and death is usually due to respiratory arrest. Ventilatory support, preferably with 100% oxygen, will usually pull animals out of the crisis.
4. Prolonged recovery occurs in sighthounds ("coursing breeds", "Gaze hounds", e.g. Greyhounds, Whippets, Borzoi). While the thiobarbiturates can still be used as induction agents in these breeds, one has to be very cautious with the dose. One explanation is that these breeds have little body fat and have a high bone/body mass ratio. The muscles therefore readily become saturated with thiobarbiturate and this is slowly released into the circulation maintaining high

circulating blood levels. There is also some suggestion that they do not metabolize barbiturates as rapidly as other breeds.

5. Although they readily cross the placenta, thiobarbiturates can be used for Cesarean sections provided they are used only as the induction agent and not the sole means of anesthesia unless constant infusion techniques are used supplemented with local anesthesia. Fetal respiration is very sensitive to the depressant effect of thiopentone sodium.
6. In small animals a 2.5% solution and in large animals a 5% solution of thiopental is used. The dose varies widely depending on the type and degree of sedation from any premedication. The drug is given to effect in small animals rather than to bolus a preset amount. This causes fewer problems with arrhythmias, apnea, etc.
7. An acidemic state will cause more thiopental to be in the unionized, active form and thus have greater effect. This is an important consideration with very sick animals.
8. Muscle relaxation and analgesia are poor in light anesthesia.
9. Thiobarbiturates cause respiratory depression. Depression of the central CO<sub>2</sub> response may lead to the phenomenon of "induction apnea", when the patient receives oxygen.
10. Rapid intravenous administration produces a fall in blood pressure. In cases where compensatory mechanisms are already at a maximum, rapid administration may cause decompensation and death. The patient should be intubated rapidly and ventilation supported. Circulation should be supported by i/v fluid administration.
11. Shivering is common in all the species due to persistent vasodilation and anti analgesic properties (light anaesthesia). Small doses of analgesic can control this.
12. Hepatic dysfunction is common but not dangerous.
13. Oliguria is common probably because of prolonged hypotension.
14. It causes addiction.
15. **Glucose effect:** It is a unique reanaesthetic effect observed in barbiturate anaesthesia in almost all the animals who receive glucose/dextrose as intravenous fluid during recovery. This is because of decreased microsomal metabolism of the anaesthetic in the liver. Therefore it is mandatory to use NSS in animals anaesthetized with thiopentone sodium so as to prevent the glucose effect.

### **E. Administration:**

1. Preferably by **intravenous route** because by this route dose can be controlled and the drug is given “to effect”.
2. Intraperitoneal route can be used but the dose cannot be accurately controlled. Mostly used in lab animals rabbits etc.
3. Intramuscular/subcutaneous routes are rarely used in unusual circumstances like in wild animals. But there is problem of “Barbiturate slough” which is to be prevented in such cases by using local anaesthetics/physiological saline solutions.
4. Intrathoracic route has been used in cats and in small animals.

**Concentration:** 1%, 2.5%, 5%, 6.4% or 10% solutions can be used depending upon the species, size of the animal. The most preferred concentrations are 2.5 and 5%. The solutions are always prepared fresh. Always mention the date of preparation and the concentration on the vial. The unused solution can be stored under refrigeration temperature for few days. If stored solution becomes turbid, discard it.

### **F. Doses in different animals: (All by intravenous route)**

1. Small animals (Dogs and cats): 6-8mg/kg for rapid induction of shorter duration and 20-30mg/kg, “to effect” for surgical anaesthesia without any preanaesthetic. When preanaesthetics are used the dose for surgical anaesthesia is 10-20mg/kg “to effect”.
2. Horses and ruminants: 6-15mg/kg with preanaesthetic “to effect”.
3. Small ruminants: 8-30mg/kg with preanaesthetic “to effect”.
4. Swine: 2.5-5mg/kg with preanaesthetic “to effect”.

**In all the animals  $1/3^{\text{rd}}$  of the calculated dose is administered rapidly as bolus and rest of the dose is given slowly “to effect” as per the requirement. Never administer whole of the calculated dose at one time.**

#### **b) Thiamylal sodium:**

1. Closely resembles thiopentone sodium but some consider it more potent.
2. Causes less excitement during induction and recovery.
3. The dose used in dogs is 18-25mg/kg, IV, “to effect”.

### 3) METHYLATED OXYBARBITURATES

#### Methohexitone sodium

- Not commonly used in practice, but good if quick recoveries are desired.
- Potency about twice that of thiopental.
- Shorter duration of effect than thiopental.
- More rapid recovery to full alertness even after prolonged anesthesia.
- May produce CNS excitatory effects.
- The short duration of action depends on both rapid redistribution and rapid hepatic metabolism.

#### Clinical Use

1. Can be used in both large and small animals for shorter procedures as very short duration of action.
2. Animals that are allowed to recover from just methohexital i.e. without any premedication can have very rough recoveries with lots of paddling, head shaking, etc.
3. Generally, use a 1% solution in small animals, and induction usually is smoother with a bolus of methohexital. After this there may be a period of apnea, and one should be prepared to support ventilation.
4. Contraindicated for patients with epilepsy.

#### Doses:

**Dog and Cat** (use 1% solutions): 5 mg/kg IV. Use with premedication. Draw up an extra third in the syringe in case it is required to finish induction. **Large animals:** As 2.5% solution (25mg/ml), IV, “to effect”.

### NON BARBITURATE INTRAVENOUS ANAESTHETICS

#### Chloral Hydrate:

- A white crystalline translucent substance.
- Has pungent smell.
- Volatile at room temperature.
- Readily soluble in water.
- Decomposes in the presence of alkali.
- Melts at 57°C and boils at 98°C temperature.



- Should be given slowly to allow its conversion to trichloroethanol and onset of action.
- Conjugates with glucuronic acid in the liver and excreted as urochloralic acid mainly through urine and partially in bile.
- Drug of choice in horses, cattle and buffaloes as hypnotic/narcotic agent.

### **Clinical effects:**

1. No analgesia but at higher doses can produce GA, however may cause respiratory arrest at this higher dose.
2. Hypnotic doses cause little respiratory depression.
3. During administration, locomotory incoordination in the early stages followed by deep sleep in later stages. The eyes appear sleepy. In buffaloes once lacrimation starts, stop the infusion, cast the animal and further requirement is upto 1/5<sup>th</sup> of the initial dose.
4. Causes hypotension and tachycardia in large animals but within safe limits (severe hypotension in camels so mainly used in combination with magnesium sulfate).
5. Crosses placental barrier.
6. Contraindicated in animals suffering from hepatic/renal diseases or when the patient is under one month of age.

**Doses:** The solutions are always prepared fresh before administration. The effect is produced within 20-30min and remains for 2-3hr.

1. **Horses:** 6-10g/50kg, per os in 1:20 ratio with water (total @ 20-70g) with stomach tube or after withholding water for 24-36hr; 5-6.5g/50kg as 6-8% solution, IV, "to effect"; 5g/50kg as 6% solution, Intraperitoneal.
2. **Cattle and buffaloes:** 40-60g in 1:20 ratio with water per os; 5g/50kg as 6% solution, IV in adult and 140mg/kg, 6% solution in calf.
3. **Camels:** 100mg/kg, 10% solution, IV.

### **Chloral-mag:**

- A mixture of chloral hydrate and magnesium sulfate in 1:1, 2:1 or 3:1 ratio used as 10% solution for horses, cattle & buffaloes and camels.
- Reduces the irritant effect of chloral hydrate when used alone.
- Has low toxicity.



- Produces excellent muscle relaxation due to the neuro-muscular blocking action of magnesium sulfate.
- The dose rate used is 5g/50kg, IV, “to effect”.

### **Chloral-mag-pentobarbitone (Equithesin):**

- General anaesthetic combination for horses.
- Has low toxicity.
- Excitement during induction is negligible.
- Produces very good muscular relaxation.
- Recovery is fast.
- Never use thiopentone in the combination instead of pentobarbitone as not compatible and precipitation seen.
- **Composition: Chloral hydrate: 28g; Magsulf: 14g; Pentobarbitone: 6.5g.**  
All dissolved in sterile distilled water to make the solution 1000cc. Always prepared fresh. Few drops of ethyl alcohol may be added to make it stable.
- **Dose: 670ml/450kg, IV**

### **Saffan:**

- A mixture of two steroid i.e. alphaxalone (9mg/ml) and alphadolone (5mg/ml) in cremophor.
- Produces short duration anaesthesia.
- Recovery is always rapid and complete.
- There is little respiratory depression.
- Produces adequate muscle relaxation.
- May cause anaphylaxis in dogs so not used.
- Dose in cats: 4-6ml/kg, IM or IV.

### **Propofol:**

- A new short acting intravenous anaesthetic for dogs and cats and becoming popular in other animals.
- Its gaining popularity because of rapid metabolism with reduced post anaesthetic nausea and complication free rapid return to full activity.
- Mostly used as 1% solution in soybean oil vehicle (Milky appearance) without any problem. Earlier was used in cremophor vehicle but was highly painful.

**Clinical Use and effects:**

- Rapid loss of consciousness in 20-40 sec.
- Concentration declines rapidly in plasma because of redistribution from brain and other highly perfused tissues.
- Rate of metabolism is 10 times more than thiopentone sodium, so rapid recovery.
- First half of the dose is given rapidly and the last half at slow rate “to effect”.
- **Anaesthesia is mostly seen for 8-13min.**
- Excretion is seen through urine after liver metabolism.
- IM injection doesn't produce a state of anaesthesia.
- Reduces blood pressure by 20-40% which remains as such for several min. So must infuse intravenous fluids.
- Produces dose dependant reduction of myocardial contractibility.
- Cardiac out put is decreased.
- Apnea during induction is common with subsequent respiratory depression of longer duration, more than thiopentone sodium.
- Hepatic or renal toxicity is not seen.
- No tissue reaction/damage if there is perivascular infiltration.
- Produces significant decrease in the intra ocular pressure.
- Mostly used in combination with preanaesthetics so as to have excitement free induction with better analgesia.
- **Doses: Horses: 2mg/kg, IV; Dogs: 4-6mg/kg, IV with premedication.**