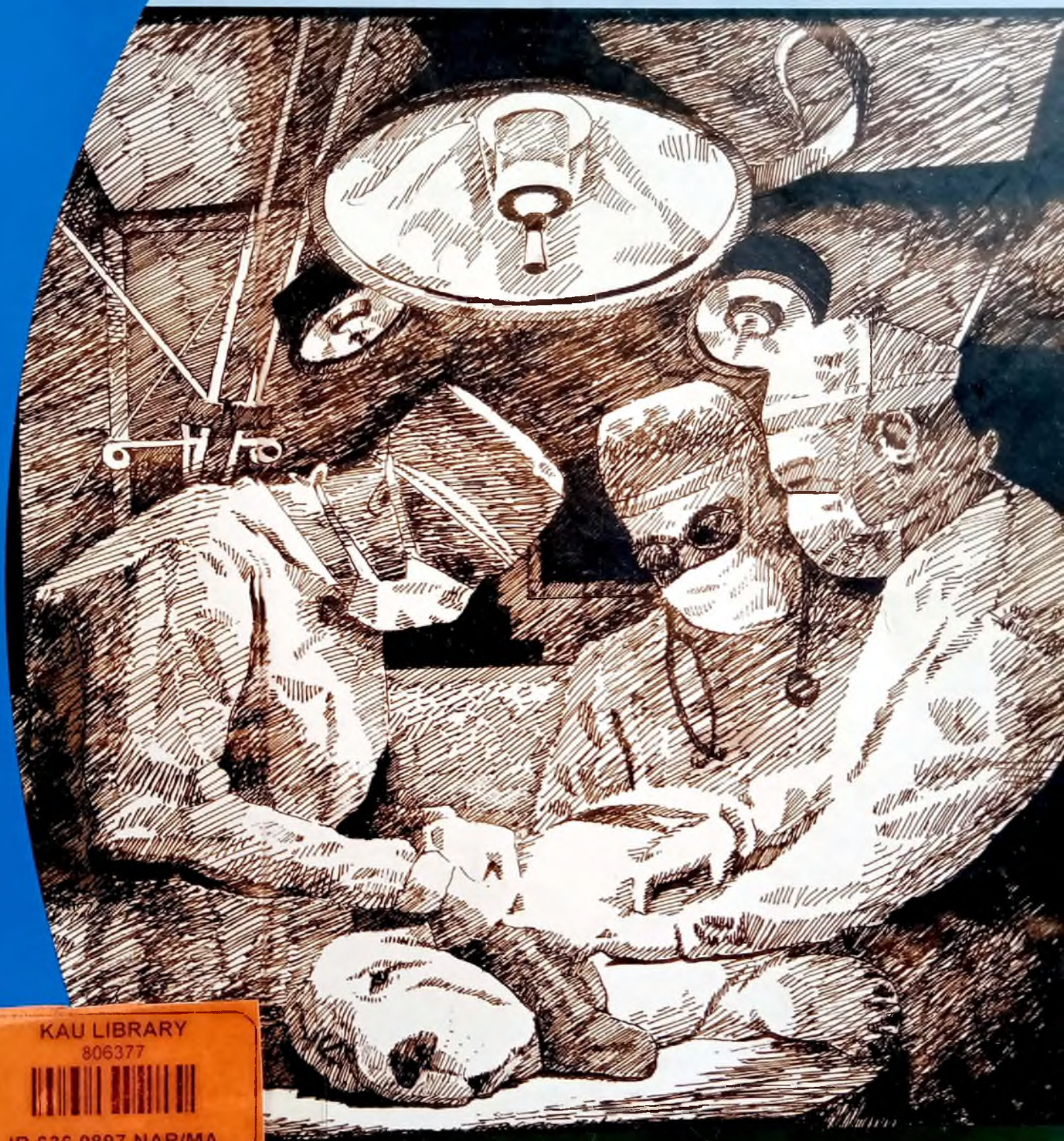
Manual On

ANAESTHETIC PROTOCOLS FOR CANINES, PATIENT MONITORING AND OPERATION THEATRE MANAGEMENT



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Kerala Agricultural University

Funded by Department of Animal Husbandry Government of Kerala

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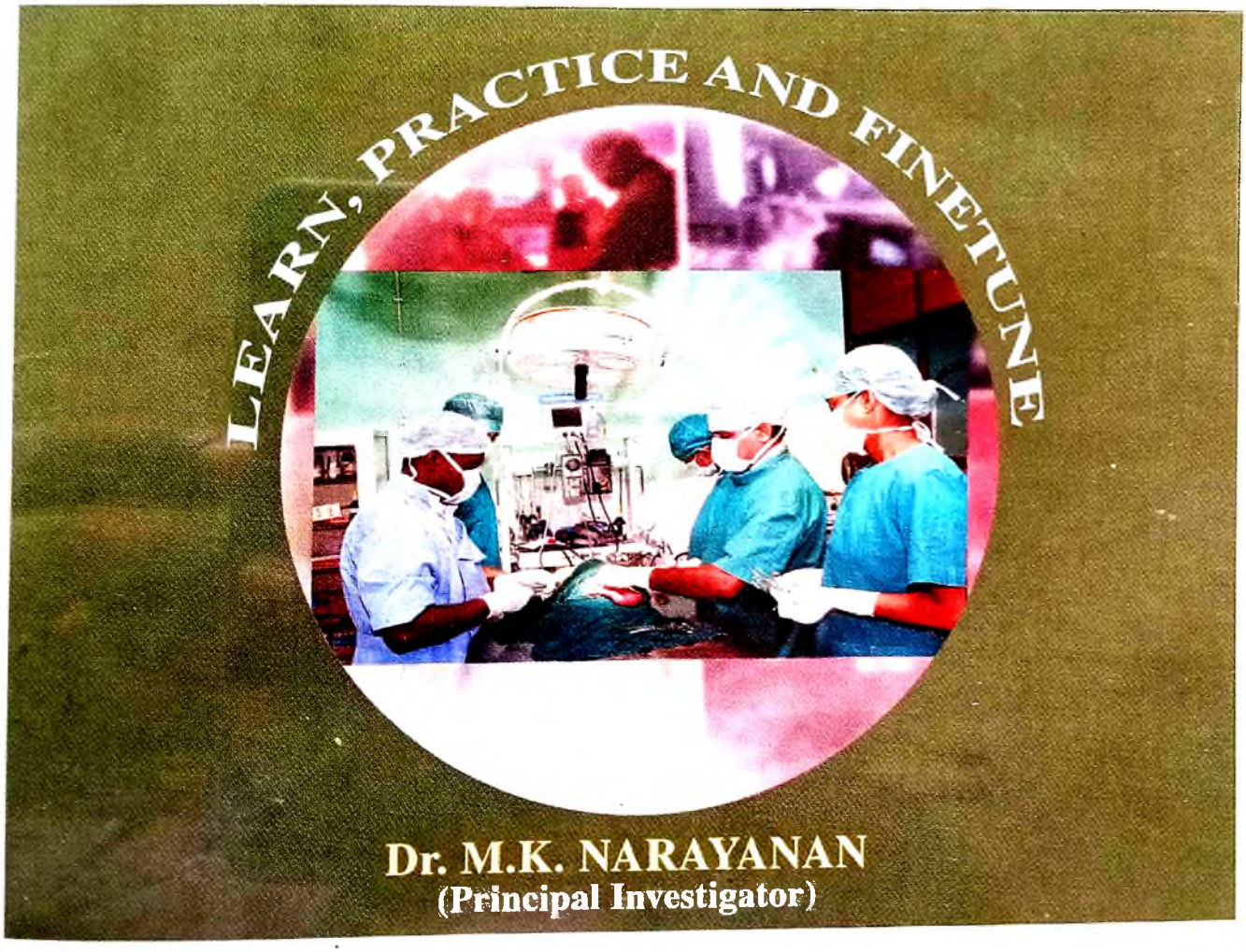

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Title of the Project : **Anaesthesia and Operation Theatre Management**

Location : University Veterinary Hospital, K A U, Kokkalai, Thrissur.

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Introduction

Anaesthesia is the mandatory prerequisite of all surgical procedures, which renders patient immobilization and pain management. Anaesthesia is also required for the physical restraint of agressive animals for certain diagnostic and therapeutic procedures.The concept of anaesthesia itself has undergone changes with the introduction of newer drugs, techniques and monitoring facilities.

In most of the cases, the veterinarian establishes one or two standard general anaesthetic protocols to be used for routine surgical procedures in healthy patients, with the facilities available. However, it must be evaluated for its suitability to the patients and surgical procedure to be adopted. Changes shall be made in each protocol whenever necessary for the safety of patients, depending upon the health status, complexity and duration of surgery.

Surgeon of ancient India

SUSRUTA

Founder of the principles of antisepsis and asepsis

JOSEPH LISTER

To improve the quality of general anaesthesia, the search for formulating simple, safe and effective anaesthetic protocols suited for short as well as long duration surgical procedures utilizing injectable and gaseous anaesthetic has to be continued and that will be of much help to the practicing veterinarians in the field hospitals.

Salient features of the project

Major objectives of the study:

1. To evolve safe and effective anaesthesia protocols for canine surgical patients for the use in field hospitals in Kerala.
2. To develop competency in the administration of injectable as well as inhalation anaesthetics.
3. To train the veterinarians in small animal anaesthesia and operation theatre management.
4. To train the veterinarians in surgical procedures and patient monitoring.
5. Creation of training modules and documentation.

Patient Evaluation

Patient evaluation is to be carried out to make a variety of decisions regarding anaesthetic management of cases such as the choice, dose and route of anaesthetic administration, specific type of intra operative and post operative pain management. Physical status of patient, presence of pre existing disease and the condition of the body systems to withstand stress of anaesthesia and surgery are to be evaluated. Patient evaluation is performed by gathering detailed history, physical examination and laboratory/special diagnostic procedures.

The animal presented for surgical procedures may vary in age, weight, temperament, physical status and condition (critically ill, injured or healthy). All the animals need not respond in the same way for a specific anaesthetic protocol and it is unrealistic to assume that the same anaesthetic technique shall be suitable for all patients. So database regarding dose and type of anaesthetics, routes of administration, physical examination, diagnostic test, nature of procedure and response of the animal are to be evolved before developing an anaesthetic protocol.

Patient Preparation

For the induction of general anaesthesia, it is best to have the patient off feed for 12 hours previously. It is always better to give intravenous fluids before surgery. Pre operative antibiotic therapy is preferred if contamination is expected. (eg. Oral antibiotics before surgery of GI tract). Decompensated heart disease is a contraindication for general anaesthesia. During anaesthesia, the patient shall, if possible, be restrained on its physiological position. Head should be kept extended to provide free air way and prevent kinking of endotracheal tube.

Selection of anaesthetic protocols

The anaesthetic protocols must be evaluated for their suitability to individual patients and changes shall be made in each protocol whenever necessary for smooth and safe anaesthesia. The factors to be considered for a given protocol include the physical status of the patient, facilities available, familiarity with the agents, nature of surgery, cost and duration of the procedure.

Patient stabilization

Fluid therapy is indicated in a multitude of circumstances in which an animal is unable to compensate for the changes in its fluid and electrolyte balance. The nature of therapy is specific to each circumstance and shall be based on the individual patient need. Fluid and blood replacement therapy are vital adjuncts to any anaesthetic plan. Almost all drugs used for chemical restraint or anaesthesia decreases the force of contraction of heart and relaxes blood vessels, thereby increasing the vascular volume. The effect of this can lead to decrease in cardiac output and arterial blood pressure. Blood loss must be replaced by at least two or three times with isotonic fluid, because most of the fluids do not contain protein and will distribute throughout the extracellular fluid, which is approximately three times of the vascular volume. The disease process on the other hand may also affect the fluid, electrolyte and acid-al obstruction, for example, results in significant secretion

of fluids into the lumen with resultant decrease in absorption of intra luminal fluids and electrolytes which may lead to decreased intravascular fluid volume and dehydration. If left untreated, the patient may develop hypovolemic shock. Mechanical obstruction of intestine can result in hypokalemia, hyponatremia and hypochloraemia. These losses can lead to metabolic acidosis. Anterior intestinal obstruction causes excessive loss of gastric hydrochloride due to persistent vomiting and may result in metabolic alkalosis.

Hypovolemia can be treated by intravenous fluid infusion with balanced electrolyte solutions and correction of acid-base abnormalities. Both crystalloids and colloids can be used. Crystalloid solutions are most commonly used to correct fluid - electrolyte imbalances. Type and quantity depends on the individual cases. Fluid therapy during surgery includes replacement of fluid loss that has already occurred and those that can occur during the surgical procedures (bleeding, tissue damage and evaporation). The requirement of fluid must be assessed frequently and evaluated individually.

Anaesthesia

Anaesthetic management includes pre anaesthesia, induction, maintenance and recovery from anaethesia.

Pre anaesthesia

This is the time period immediately preceding anaesthesia.

Induction

The stage in which the animal leaves the normal conscious state and enters the anaesthetized state. Induction is followed by intubation with an endotracheal tube for keeping the air way patent and to allow the administration of volatile anaesthetics from an anaesthetic machine.

Maintenance

Maintenance is the stage during which the animal is in a stable level of anaesthetic depth. Surgery is performed during this period as the analgesia, skeletal muscle relaxation, and cessation of movement occurs. Reflexes like pedal, palpebral reflex are also abolished. Respiratory and cardiac functions are depressed and further increase in anaesthesia leads to over dose.

Recovery

Stage starts when the concentration of anaesthetic in the brain begins to decrease and when the maintenance period ends.

Injectable drugs undergo biotransformation in liver by enzymes and are excreted through kidney. Inhalation agents are eliminated mainly through respiratory tract.

Classical stages and planes of anaesthesia

Patient enters to Stage I with the induction of anaesthesia. As the anaesthetic depth increases, patient enters Stage II and III. In overdosage, patient enters Stage IV. The stages described may not be evident in cases where pre medication is given but the general changes can be observed.

Surgical procedure can be carried out when the patient shows ventro-medial rotation of eyeball, loss of palpebral and pedal reflex and relaxation of jaw muscles.

Stage I	**(Stage of Voluntary Movement)** Stage I starts immediately after the administration of injectable / inhalation agent to loss of consciousness. Animal is conscious but disoriented. All reflexes are present. Respiration and heart rate become normal or increased.
Stage II	**(Stage of Delirium or Involuntary Movement)** The stage II is characterized by the following changes: Loss of consciousness, reflexes present, swallowing movement/yawning, dilated pupil but response to light (constriction), excitement in the form of rapid limb movement, vocalization and struggling, irregular respiration or breath holding. Take care to avoid injury due to excitement.
Stage III (Stage of surgical anaesthesia)	**Plane I : (Light Anaesthesia)** Respiration become regular, involuntary limb movement reduces, eyeball starts rotating ventrally and medially, partial constriction of pupil, palpebral reflexes present and endotracheal intubation is possible.
	Plane 2 : (Medium Anaesthesia) Suitable for surgical anaesthesia. Surgery evokes a response such as increased heart rate but animal is unconscious and immobile, pupillary light reflex sluggish, eyeball central or rotated downward, pupil slightly dilated, respiration becomes between 12-16 per minute, heart rate decreases, relaxation of skeletal muscles, protective reflexes like pedal and palpebral reflexes diminished or abolished.
	Plane 3 : (Deep Anaesthesia) Depression of respiration and circulation, respiration rate less than 12 per minute and becomes shallow, reduced pulse due to fall of blood pressure, pupillary light reflex poor or absent, eyeball becomes central, pupil moderately dilated, reflex activity totally absent, marked relaxation of muscles and loss of jaw tone.
Stage IV	**Plane 4 : (Overdosage)** Immediate resuscitation is needed to save the life of the patient in this stage.The adverse signs leading to death of the patient include rocking boat ventilatory pattern (spasmodic jerky inspiration caused by a lack of coordination of intercostal and abdominal muscles and the diaphragm). Fully dilated pupil and absence of reflexes,eyes become dry, dramatic drop in heart rate and blood pressure, pale mucous membrane and prolonged capillary refill time. respiration stops, circulatory collapse and death.

PREMEDICANTS (Preanaesthetics)

Atropine and Glycopyrrolate

Atropine and glycopyrrolate are the commonly used anticholinergics. When the parasympathetic system is stimulated , muscarinic receptors are stimulated by acetylcholine and can lead to bradycardia, pupillary constriction, gastro intestinal stimulation, salivation etc. during surgery, which are all undesirable. Administration of atropine or glycopyrrolate will block all muscarinic receptors and prevent these undesirable side effects during anaesthesia.

Atropine is a natural alkaloid and glycopyrrolate is a synthetic quaternary ammonium derivative. Administration by i/m, i/v or s/c route and acts on the body within 20 min after s/c, 15 min after i/m and immediately after i/v injection and action lasts for 60 minutes.

Side effects : Toxicity observed are tachycardia in animals (above 140 bpm) results in congestive heart failure (CHF), constipation, drowsiness, dry mucous membrane, thirst, excitability, dilated pupil, supra ventricular tachycardia, cardiac arrhythmias and restlessness.

Diazepam and Midazolam

Benzodiazepines are anxiolytic drugs, although high dose may cause sedation and hypnosis. It is effective in very young, very old animals and critically ill patients as it produces less cardiovascular and respiratory effects than phenothiazines and alpha 2 agonists.. It potentiates the CNS depressant effects of barbiturates and propofol allowing reduction in the dose of these drugs. The receptors are linked to chloride channel opening of which causes hyper polarisation and reduction in membrane excitability.These include diazepam, midazolam, zolazepam etc. Diazepam is insoluble in water, therefore solutions for injection are prepared using propylene glycol, sodium benzoate in benzoic acid and ethanol. Propylene glycol is a cardiac depressant and may produce hypotension,bradycardia and apnoea.

Benzodiazepines exert their effect through the enhancing action on the release of endogenous Gamma Amino butyric Acid (GABA), an inhibitory transmitter in the brain. It produces calming effect, skeletal muscle relaxation and anticonvulsant action. It depresses the limbic system, thalamus and hypothalamus and produces calmness. Benzodiazepines lack analgesic properties and should not be used for pain control. It is useful in counteracting the muscle rigidity seizures seen with dissociative agents such as ketamine administration to produce anaesthesia. Benzodiazepines are also useful in control of seizures in ketamine administration, in cerebrospinal tap or in myelography and are administered by intravenous route.

Diazepam is not water soluble, so it should not be mixed with other drugs. The only anaesthetic that is physically compatible is ketamine and can be mixed together in equal volume.

Midazolam, a benzodiazepan derivative, which is water soluble, can mix with other agents and less irritating to the tissues.

Side effects: High doses cause reduction in cardiac output and blood pressure. Dysarrhythmia occurs following i/v injections. Fast intravenous injection can lead to respiratory arrest. So slow i/v injection is recommended. It produces paradoxical increase in anxiety and fear response in excitable animals and CNS depression in neonates.

Propylene glycol is a cardiac depressant and may produce hypotension, bradycardia and apnea. Contraindicated in early pregnancy and avoid the use in neonates/liver diseases

Xylazine

Xylazine is a thiazine derivative and is available as 2% solution (20 mg/ml) for use in small animals and 10% (100 mg/ml) for use in equines and elephants etc. Xylazine is an alpha 2 adreno receptor agonists may be classed as non narcotic sedative or hypnotics and have additional muscle relaxant and analgesic properties. Xylazine produces profound effects on other body systems and the use should generally be limited to the young and healthy animals. The sedation is dose dependent and at a higher dose produces deep sleep or hypnosis and analgesia, but the duration of analgesia is short.

Xylazine is used as a premedicant in a variety of anaesthetic protocols. It reduces the requirement of injectable and inhalant anaesthetics but care should be taken to avoid overdosage. The most popular combination of xylazine is with ketamine, where the muscle relaxant properties of xylazine counteracts the muscle rigidity feature of ketamine anaesthesia and promotes smooth recovery.

Prominent symptoms of sedation depending on the dose include winking of eye, yawning, vomiting, incoordination in gait, sitting on haunches, sternal recumbency, sternal recumbency with head down posture and lateral recumbency. Action is observed within 3-5 min after i/v injection and 10-15 min following i/m injections and analgesia last for 20 minutes and sedation lasts for 30-40 minutes. Absorption from s/c tissue is very less so this route is not recommended. Make sure that the injection is given intramuscular and should not disturb the animal during the period of sedation (10-15 min. after administration of xylazine). Vomiting is centrally mediated through direct activation of receptors in the chemoreceptor trigger zone. It also produces centrally acting hypothermia.

Side effects: Xylazine has considerable potential to produce higher rate of anaesthetic complications than any other preanaesthetics. These include, cardiovascular changes like bradycardia (the heart rate reduces up to 50%) along with rhythm changes and second degree heart block and hypotension, respiratory depression, excessive vomiting, abdominal distension especially in ruminants and depresses the GI motility and prolongs the transit time. It also reduces the tone of gastro oesophageal sphincter, which increases the risk of gastric reflux. Xylazine reduces the release of insulin thereby producing hyperglycemia, personality changes i.e., unexpected aggression and biting reflexes may persist in dogs sedated with xylazine.

ANAESTHETICS

The state of general anaesthesia must be achieved without significantly affecting the patient's vital functions , particularly respiratory and circulatory systems, utilizing injectable and / inhalation anaesthetic agents.

General anaesthetic agents can be broadly divided into injectable anaesthetics and inhalation anaesthetics.

drug is not suitable for caesarean section. Foetus is more affected than the mother. Other side effects include cardiac depression, acidic pH, tissue irritation and excitement during recovery. Elimination of the drug is through liver metabolism.

Barbiturates store in fat tissues and redistribution takes places leading to delay in elimination and prolongs the recovery period. Laryngospasm and short period of apnea are common. Thiopentone is strongly alkaline and is incompatible with acidic and oxidising agents such as analgesics, phenothiazines, adrenalin and some antibiotics. It has an adverse effect on respiratory and cardiovascular system. Respiratory depression is more pronounced. A period of apnea (cessation of breathing) is commonly seen. So observe the mm colour, heart rate and pulse during induction.

Contra indications:

Septic patients, cardio vascular and respiratory diseases, uraemia, liver diseases and pregnancy are the contra indications.

II) Ketamine

Ketamine is one of the members of cyclohexamine (other members are phencyclidine and tiletamine) and causes muscle rigidity and is rarely administered as a sole agent but is usually given in conjunction with either an alpha 2 agonist such as xylazine or benzodiazepines such as midazolam or diazepam. Ketamine does not produce true anaesthetic state but induces dissociation from the environment and is characterized by profound amnesia, superficial analgesia and catalepsy. In anaesthesia muscle tone is increased and eyes may remain opened for all or part of the anaesthesia. Rapid induction and smooth recovery is seen in sedated dogs and excitation with muscle tremor is commonly seen in unsedated animals.

The mechanism of action of the cyclohexamine appears to be a disruption of nervous system pathways within the cerebrum and a stimulation of the reticular activating centers of the brain. Unlike the other general anaesthetics, which cause CNS depression, ketamine or cyclohexamine in general causes selective CNS stimulation. Nervous system stimulation may result from a suppression of inhibitory neurons by these drugs. This results in a distinctive type of anaesthesia termed dissociative anaesthesia or catalepsy, in which the animal appears awake but unaware of its surroundings.

The characteristics of dissociative anaesthesia are as follows: Reflex responses are exaggerated rather than depressed, laryngeal and pharyngeal reflexes may persist throughout anaesthesia, although they are weak and endotracheal intubation is difficult, increased muscle tone, almost to the point of rigidity. The animal assumes a stiff posture, with stretched out front limb and extended neck. This exaggerated movement can be controlled by the concurrent use of diazepam, midazolam or xylazine can provide satisfactory skin analgesia but visceral analgesia is poor.A patient in dissociative anaesthesia can perceive pain but is unable to respond to it. So control of pain is an obligation.

Ketamine can be used in dogs in combination with diazepam and given by i/m or i/v route in dogs and cats. Ketamine has a rapid onset of action after im/iv administration. This is due to the high lipid solubility, which allows quicker entry to brain tissues. Ocular and swallowing reflexes

remain intact and muscle tone generally increases. Large dose produces convulsion. No effect on GABA receptors. It acts as the NMDA antagonist and sigma agonist. Ketamine appears to provide greater analgesia for somatic or peripheral pain than for visceral pain.

In dogs, i/v injection of ketamine is preferred over i/m which can lead to convulsions. Repeated injection of ketamine can increase the risk of convulsion during recovery. Recovery from ketamine anaesthesia occurs within 2-6 hours in healthy patients. No redistribution and recovery occurs when the drug leaves the brain and it is metabolised in the liver and excreted. No effective reversal agents are available. Use anticholinergics to control excessive salivation and tranquilizers or sedatives to prevent convulsions after administration of ketamine. Ketamine-diazepam does not work well when given by i/m route as the diazepam is poorly absorbed from the muscles but midazolam is well tolerated.

Side effects: Increased intracranial pressure, hallucinating behavior, delirium excitement, and purposeless muscle rigidity. This can be avoided by concurrent administration of sedatives. Ketamine produces hyper salivation and increased bronchial secretions, which can be avoided by administration of anticholinergics such as atropine or glycopyrrolate. Ketamine increased intra ocular pressure and should be avoided in glaucoma. Contra indicated in tachycardia, glaucoma, epilepsy and malignant hyperthermia.

III) Propofol

Propofol is a substituted isopropyl phenol that is insoluble in water but forms a 1% aqueous emulsion with 10% soya bean oil, 2.25% glycerol and 1.25% egg phosphatide. It is a non-barbiturate intravenous anaesthetic which may be used as a sole agent for short duration surgical procedures or for anaesthetic induction before inhalation anaesthesia. It is slightly viscous milky white isotonic solution with pH of 7-8.5 and is compatible with RL or 5% dextrose. Although this agent has a milky appearance, it can be safely administered intravenously. Injection should be given by intravenous route only at a dose rate of 4-6 mg/kg. Anaesthesia sets within 60 seconds and lasts for 20 minutes and can be maintained by repeated injections and maintenance with 0.2-0.5 mg/kg/min intravenously as infusion. This emulsion can support bacterial growth and aseptic storage is necessary. It is provided as oil in water emulsion with a concentration of 10 mg/ml. Propofol exerts its CNS effects via modulation of GABA activated chloride channel. Its specific site of action appears to be distinct from those of barbiturates, steroids and benzodiazepines. For maintenance of anaesthesia by infusion, add 20 ml propofol to 180 ml of saline and administer as continuous infusion at the rate of 6 drops per kg per minute.

Advantages of propofol:

- Propofol has a wide margin of safety.
- Smooth induction and recovery
- Minimal effect on respiratory and cardio vascular system.
- Good muscle relaxation

Disadvantages:

- Analgesia is poor.
- Relatively costlier and poor storage quality.

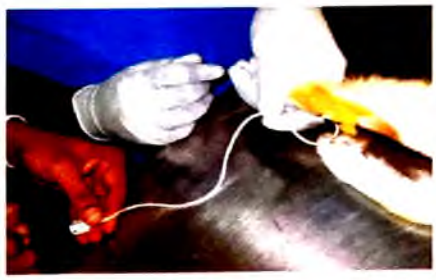
Side effects: Propofol produces apnea after rapid injection and decreases intracranial pressure. This can be advantageously used in trauma patients especially in head injuries. It reduces intraocular pressure (useful in glaucoma) and contra indicated in hypertension.

General guidelines for administration of injectable anaesthetics

The general dose of injectable agents required to produce anaesthesia is reduced in sedated, compromised old and pediatric patients. The requirements in healthy animal also vary from individual to individual. For this reason, the calculated dose of intravenous agent is not given on a single bolus but is administered to effect. The calculated dose is drawn up, one quarter to half of the dose is given and the patient is reassessed. If required a further dose is given i.e., give the anaesthetic by titration.

II. Inhalation anaesthetics

Induction technique



Induction of anaesthesia is done by administration of drugs by parentral routes, mask or using anaesthetic chamber. Most common method s are intravenous injections using thiopentone sodium, ketamine, propofol etc. and maintenance with inhalation agents such as halothane, isoflurane or sevoflurane. Since the duration of injectable anaesthetics is shorter (20-30 min), the prolongation of anaesthesia can be done by repeated administration of injectable anaesthetic agents which may lead to accumulation of large amounts of drugs within the body resulting in prolonged recovery and toxicity. Hence maintenance of anaesthesia with inhalation agents may reduce such side effects.

Endotracheal intubation

Endotracheal intubation is done to keep the patency of patient's airway. It conducts air from out side or anaesthetic machine to lungs and from the lungs and trachea to out side bypassing the pharynx and nasal passages.

Advantages

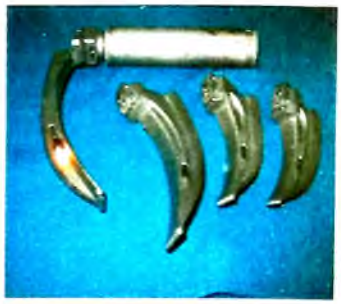
1. *More effective delivery of air/gas from anaesthetic machine.*
2. *Improves the efficacy of respiration and reduce dead space.*
3. *Helps in direct oxygen administration in emergency cases(IPPV)*
4. *Reduces the chance of aspiration of vomitus, saliva or broncheal secretions.*

Disadvantages

- *Vagal stimulation leading to increase of the parasympathetic tone particularly in dogs causing bradycardia, hypotension and cardiac arrhythmias.*
- *Brachiocephalic dogs – intubation is difficult because of the elongated soft palate,everted laryngeal sacules,stenotic nares and hypoplastic trachea.*
- *If the endotracheal tube is introduced too deep it may lodge in one side of the bronchii.*
- *Pressure necrosis of tracheal mucous membrane.*
- *Kinking of the endotracheal tube leading to airway obstruction.*

Procedure

1. Endotracheal tubes of varying size must be kept ready and test for the cuff inflation.
2. Length of the tube by measuring from incisors to the thoracic inlet.
3. Lubricate the tube with sterile lubricant containing local anaesthetic like lignocaine.
4. Check for the plane of anaesthesia by opening the mouth and assessing the tone of jaw muscles.
5. Keep the animal on sternal recumbency or lateral recumbency.
6. The neck is extended and the head is raised such that the head and neck are in a straight line pointing upward.
7. The upper jaw is held stationary, with the lip pulled dorsally and the lower jaw is pushed down by pulling the animals tongue forward and down and the mouth is opened wide enough to see the epiglottis. Normally it lies over the entrance of the trachea.
8. If available a laryngoscope is used for illuminating the pharyngeal area and by moving the epiglotis aside, expose the glottis and vocal cord. Then gently place the tip of endotracheal tube near the epiglotis and direct the tube into the trachea.
9. Check and confirm the position of endotracheal tube in the trachea by gently pressing the chest or keep a piece of dry cotton near the outlet of E.T. tube and observe for its to and fro movements along with the respiratory movements.
10. Secure the tube in position by tying it with a tape / gauze and tie it around the upper jaw.
11. Inflate the cuff of the endotracheal tube and check for any leakage.
12. Connect the breathing circuit to the endotracheal tube for administration of anaesthetics or oxygen.
13. During recovery when the animal regains its swallowing reflex,remove the endotracheal tube. For that deflate the cuff of endotracheal tube by withdrawing the air using a syringe connected to it. Untie the tape/gauze tied and remove the tube by gentle traction. Clean the mouth cavity to avoid aspiration of the srcretions. Extubation of the tube after partial deflation helps to use it as a wedge for removing the debris in the upper respiratory tract. Once the animal is extubated, make sure that the animal is breathing normally.Timely removal is necessary to avoid chewing of the tube by the animal.



Maintenance of Anaesthesia

During maintenance period the animal has to be maintained at an adequate depth of anaesthesia and keep the vital signs within the acceptable limit by proper monitoring.

Monitor the following parameters during maintenance:

- Mucous membrane colour and capillary refill time (CRT)

- Heart rate and ECG
- Respiratory rate, depth and quality.
- Pulse rate and strength
- Tone of the jaw muscle, eye ball position, palpebral reflex activity
- Oxygen flow rate and SPO2
- I/V catheter placement and fluid administration
- Temperature of the patient.

Recovery from general anaesthesia

The time period from the discontinuation of anaesthetic administration to the patient to the time of standing unassisted is considered as the recovery period. This depends on the length of anaesthesia, condition of the patient, type of anaesthetic, route of administration and temperature of the patient. Stage of recovery is the reverse of the anaesthetic stages, progress slowly during recovery. As the animal moves from deep to moderate anaesthesia or light anaesthesia, the vital signs and reflexes change in predictable ways. Heart rate, respiratory rate and respiratory volume increase. The eye balls move to the centre position. Palpebral reflex and pedal reflex become stronger. Animal may shiver, swallow, chew or lick. This is followed by appearance of signs of consciousness, voluntary movement of head and limbs opening of eyelids and vocalization and finally standing unassisted.

During recovery, frequent monitoring preferably in every 5 minutes, administration of oxygen if needed, extubation, nursing, prevention of self injury are important.

Inhalation anaesthetic agents

Inhalation anaesthesia has become so commonplace in veterinary and human anaesthesia that it is difficult to imagine the impact that the introduction of the first inhalation anaesthetic had on surgical practice. Isoflurane is used as the inhalant agent for maintaining anaesthesia.

Isoflurane

Commonly used halogenated hydrocarbon, inert, non toxic, similar to halothane in properties with great margin of safety; started being used in clinical cases since 1979. It is an agent of choice in critically ill patients. It is not well suited for mask induction. The pungent smell frequently causes breath holding. It is relatively less soluble and is therefore associated with more rapid induction, and recovery. It is a drug of choice for patients with cerebral injury. It produces generalized respiratory and myocardial depression, increases the heart rate, produces good muscle relaxation and crosses placenta rapidly. Induction dose is 2-2.5% and maintenance concentration at 1.5 to 1.8% in pure oxygen. MAC is 1.5%.

Comparison of injectable and inhalation agents

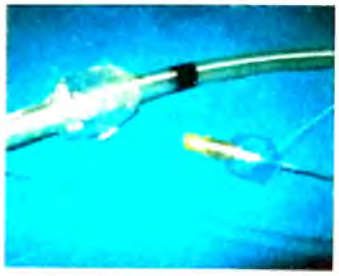
Margin of safety is high for inhalation agents and depth can be altered easily. Elimination of injectable anaesthetics is through redistribution within the body, liver metabolism and renal excretions where as inhalation anaesthetics are eliminated mainly through the lungs (respiratory system). Inhalation anaesthesia allows administration of pure oxygen whereas in injectableanaesthesia animal breaths from the room air. Mechanical ventilation is possible in inhalation anaesthesia but requires special equipment such as anaesthetic machine.

In fact, both injectable and inhalation anaesthetics are effective in veterinary practice and can be used with wide margin of safety, but both are depressants of cardiovascular, respiratory and thermoregulatory systems.

Equipment needed for anaesthetic administration

Before the introduction of anaesthetic machine, administration of anaesthesia was a relatively hazardous undertaking. The activity includes pouring the anaesthetic in a cloth and placing before the nose and mouth till the desired effect is produced or administration of vapors from a jar of liquid anaesthetic etc. Useful equipment needed is as follows.

- Syringe and needles for administration of preanaesthetics
- Cotton and alcohol / Tr. Iodine
- Gauze for taping endotracheal tube
- Syringe for inflating endotracheal tube cuff
- Laryngoscope
- Endotracheal tube
- I/V catheters and fluids
- Lubricating gel for endotracheal tubes
- Ophthalmic ointments
- Face mask
- Inhalation anaesthesia machine with oxygen supply
- Machine accessories
- Ventilator
- Emergency drugs
- Towels/Blankets
- Stethoscope
- Thermometer
- Lights
- Monitoring devices
- Pulse oxymetry probes
- Anaesthesia record
- Anaesthesia machines



ANAESTHETIC STUDY

The study on anesthetic protocols was conducted in five hundred dogs subjected to general anaesthesia during the period of three years (2007-2010) at University Veterinary Hospital, Kerala Agricultural University, Kokkalai, Thrissur, Kerala. The dogs of different age groups of either sex and various breeds subjected to elective and emergency surgical procedures were included in the study. The parameters of clinical importance were collected. The subjective and objective symptoms, approach to each case, problem identification and the treatment resorted were recorded. For each selected case, preanesthetics and anaesthetics required in that particular situations were administered, to achieve a balanced anaesthesia and for alleviation of postoperative pain.

Bain's circuit, a semi closed circuit (Phoebus MA 201, Ferro Curves, Kolkkota) was used for the administration of inhalation anaesthetic and anaesthesia ventilator (Excel, Global Medical System, Bangaluru) for the maintenance of mechanical ventilation. The animals were continuously monitored during anaesthesia with multipara monitor (Planet 50, L&T, Mumbai).

DRUG COMBINATIONS SELECTED FOR THE STUDY

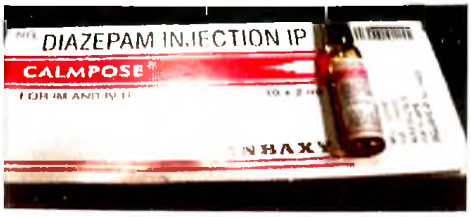
Sl.No.	Premedicants	Anaesthetic(s)
I	Glycopyrrolate – Xylazine – Midazolam	Ketamine
II	Glycopyrrolate – Xylazine	Ketamine- Midazolam.
III	Glycopyrrolate – Xylazine – Midazolam	Ketamine - Isoflurane
IV	Glycopyrrolate – Xylazine	Propofol
V	Glycopyrrolate – Xylazine	Ketamine - Propofol
VI	Atropine – Xylazine	Ketamine – Diazepam – (Xylazine + Ketamine)
VII	Atropine – Xylazine	2% Lignocaine(Local infiltration) - Ketamine
VIII	Glycopyrrolate – Xylazine	Propofol – Isoflurane
IX	Atropine – Xylazine	Thiopentone
X	Atropine – Xylazine	Ketamine – Thiopentone

Atropine

Glycopyrrolate

Xylazine

Midazolam

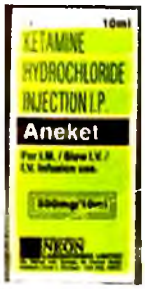


Diazepam

Lignocaine

Thiopentone

Propofol



Ketamine

Isoflurane

	Drugs		Trade Name
1.	Atropine	-	Atropa
2.	Glycopyrrolate	-	Pyrolate
3.	Xylazine	-	Xylaxin
4.	Midazolam	-	Mezolam
5.	Diazepam	-	Calmpose
6.	Lignocaine	-	Xylocaine 2%
7.	Ketamine	-	Aniket, Ketmin
8.	Propofol	-	Propofol
9.	Thiopentone	-	Pentothal
10.	Isoflurane	-	Forane

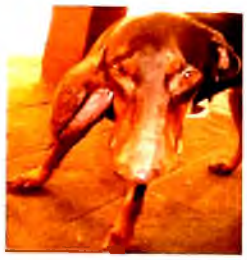
RESEARCH FINDINGS AND RECOMMENDATIONS

Anaesthetic Protocols for Canine Surgical Procedures

The observations on clinical signs, the onset, duration and depth of anaesthesia, and the recovery were recorded, analysed and interpreted.

Considering the merits and demerits, the following protocols are recommended for the field use.

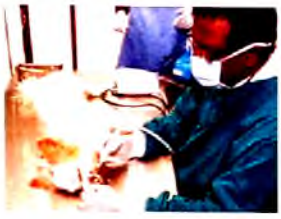
I. GLYCOPYRROLATE – XYLAZINE – MIDAZOLAM – KETAMINE.



Glycopyrrolate (0.011 mg/kg), followed by xylazine (1 mg/kg), both intramuscularly and midazolam (0.3 mg/kg) intravenously, at 15 minutes intervals for premedication and 10 minutes later, ketamine (10 mg/kg) intramuscularly for induction of anaesthesia.

This protocol was found ideal for short duration surgical procedures in healthy surgical patients.

II. GLYCOPYRROLATE – XYLAZINE –KETAMINE-MIDAZOLAM



Glycopyrrolate (0.011 mg/kg), followed by xylazine (1 mg/kg) both intramuscularly at 15 minutes interval for premedication. Later, at 10 minutes intervals, ketamine (10 mg/kg) intramuscularly and midazolam (0.3 mg/kg) intravenously.

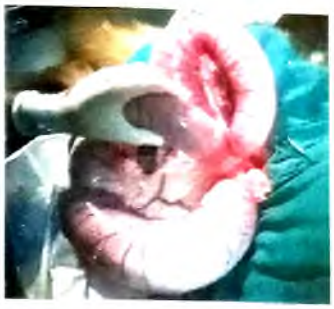
This protocol was found suitable for short duration surgical procedures in healthy surgical patients.Since the midazolam is a short acting drug, administration of midazolam after ketamine was found helpful in prolonging anaesthesia than when given prior to ketamine as in protocol - I

III. GLYCOPYRROLATE–XYLAZINE–MIDAZOLAM -KETAMINE - ISOFLURANE

Glycopyrrolate (0.011 mg/kg), followed by at 15 minutes intervals, xylazine (1 mg/kg) intramuscularly and midazolam (0.3 mg/kg) intravenously for premedication. Ten minutes later, ketamine (10 mg/kg) intramuscularly for induction of anaesthesia, followed by endotracheal intubation and maintenance of anaesthesia with isoflurane in pure oxygen at the rate of 2-3% 'to effect'.

This protocol is safe for both healthy and compromised surgical patients.

IV GLYCOPYRROLATE – XYLAZINE – PROPOFOL



Glycopyrrolate (0.011 mg/kg), followed by, xylazine (1 mg/kg) intramuscularly 15 minutes later for premedication. For induction of anaesthesia, 15 minutes later propofol 1% emulsion (4 mg/kg) as intravenous bolus injection. Anaesthesia maintained by propofol intravenous infusion (20 ml of 1% Propofol in 180 ml normal saline, ie.1 mg/ml) at the rate of 6 drops (0.4 mg) /kg /min till the end of surgical procedure.

This protocol was observed to be safe for healthy and compromised surgical patients, especially for delivering live pups by Caesarean section.

V. GLYCOPYRROLATE – XYLAZINE – KETAMINE – PROPOFOL

Glycopyrrolate (0.011 mg/kg), followed by at 15 minutes intervals, xylazine (1 mg/kg) intramuscularly for premedication. Later at 10 minutes interval, ketamine (2.5 mg/kg) intramuscularly and Propofol 1% emulsion (4 mg/kg) as intravenous bolus injection for induction of anaesthesia. Anaesthesia maintained with propofol intravenous infusion (20 ml of 1% propofol in 180 ml normal saline, ie.1 mg/ml) administered at the rate of 6 drops (0.4 mg) /kg /min till the surgical manipulations are completed.

In aggressive animals, intramuscular administration of ketamine helps for the easy restraint of animal for intravenous administration of propofol. More over, as the ketamine is being used at the lowest dose, this protocol is safe for compromised surgical patients also.

VI ATROPINE–XYLAZINE–KETAMINE–DIAZEPAM–(XYLAZINE+KETAMINE)

Atropine (0.045 mg/kg) and xylazine (1 mg/kg) intramuscularly at 15 minutes intervals for premedication. Later, at 10 minutes interval, ketamine (10 mg/kg) intramuscularly and diazepam (0.2mg/kg) intravenously. A combination of equal proportion of xylazine (20mg/ml) and ketamine (50mg/ml) in incremental intravenous doses to maintain satisfactory anaesthesia for required duration.

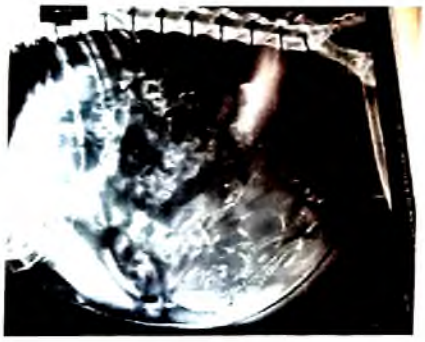
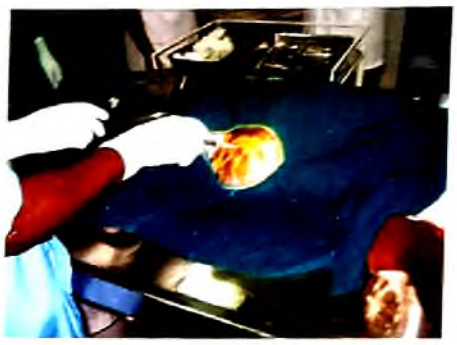
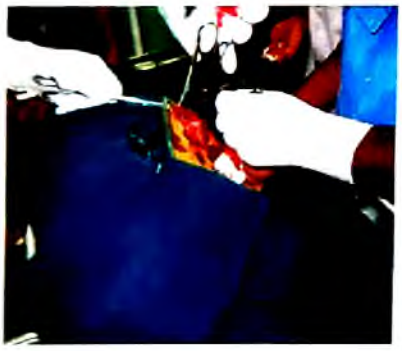
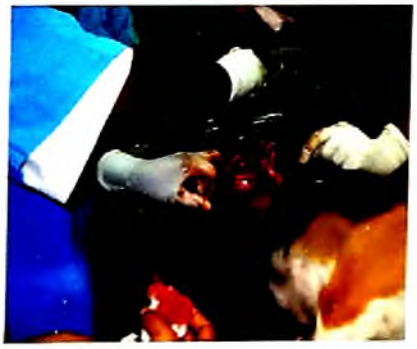
This protocol is recommended for long duration surgical procedures in healthy canine patients.

VII. ATROPINE – XYLAZINE–LIGNOCAINE – KETAMINE

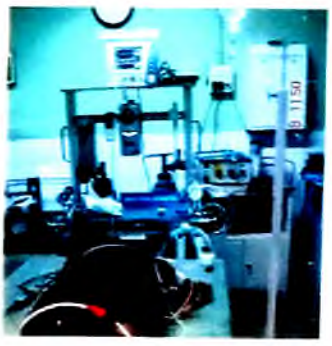
This protocol is specially intented for performing Caesarean section in dogs with live pups.

Atropine (0.045 mg/kg), followed by at 15 minutes intervals, xylazine (1 mg/kg) intramuscularly for premedication. After induction of sedation, ie., 15 to 20 min. later, local linear infiltration anaesthesia with 2% lignocaine hydrochloride at the site of surgery. After extracting all the pups, ketamine(5-10 mg/kg) is administered intramuscularly to complete the surgical procedures.

This protocol avoids the influence of the depressant effect of ketamine on the live puppies and is most suitable for adoption even in field hospitals with minimum facilities.


VIII.GLYCOPYRROLATE – XYLAZINE – PROPOFOL – ISOFLURANE



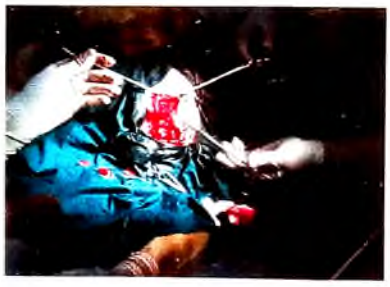
Glycopyrrolate (0.011 mg/kg) followed by xylazine (1 mg/kg) intramuscularly, 15 minutes later for premedication. For induction of anaesthesia, 15 minutes later, propofol 1% emulsion (4 mg/kg) intravenous bolus injection is administered. After induction endotracheal intubation and maintenance of anaesthesia with isoflurane in pure oxygen at the rate of 2-3% 'to effect'.

This protocol is safe for both healthy and compromised surgical patients.

IX. ATROPINE – XYLAZINE – THIOPENTONE

Premedication with Atropine (0.045 mg/kg) and after 15 minutes xylazine (1 mg/kg) intramuscularly. Fifteen minutes later, thiopentone sodium 2.5% solution intravenously for induction and maintenance of anesthesia. The dose of thiopentone will be calculated at the rate of 25mg/kg body weight. Initially, one third of the calculated dose is given as intravenous bolus followed by incremental doses 'to effect'. The requirement of thiopentone to produce anaesthesia will be one-third to half of the total calculated dose in sedated, compromised, old and pediatric patients. The requirements in healthy animal also vary from individual to individual. Occasionally, respiratory arrest may occur in a few animals but can be resuscitated by assisted ventilation.

X. ATROPINE – XYLAZINE – KETAMINE – THIOPENTONE



Atropine (0.045 mg/kg), followed by at 15 minutes intervals, xylazine (1 mg/kg) intramuscularly for premedication and ketamine (10 mg/kg) intramuscularly for induction of anaesthesia. Fifteen minutes later, thiopentone sodium 2.5% solution intravenously for deepening and maintenance of anaesthesia. (The general dose of thiopentone will be calculated at the rate of 25mg/kg body weight. Initially, 1/3 of the calculated dose followed by incremental doses).

In aggressive animals, intramuscular administration of ketamine helps for the easy restraint of animal for intravenous administration of thiopentone.

Agents used during post anaesthetic period

Reversing agents and analeptics are used to hasten recovery after anaesthesia. Reversing agent is a drug that negates the effects of a specific anaesthetic or preanaesthetic. Analeptic agent is a drug that causes general CNS stimulation.

Doxapram: is a respiratory stimulant and analeptic agent. It increases the respiratory rate and depth and accelerates arousal. It causes tachycardia and dysrrhythmia ; so use with caution in animals with cardiac diseases.

Doxapram is particularly useful for stimulating respiration in new born puppies and kittens; two or three drops placed under the tongue may greatly increase respiratory rate and depth.

Yohimbine: is given at a dose rate of 0.1 mg/kg IV is an effective reversing agent for alpha-2 adrenoreceptor agonist, particularly xylazine. It can be used alone or along with 4-aminopyridine or tolazoline to speed recovery.

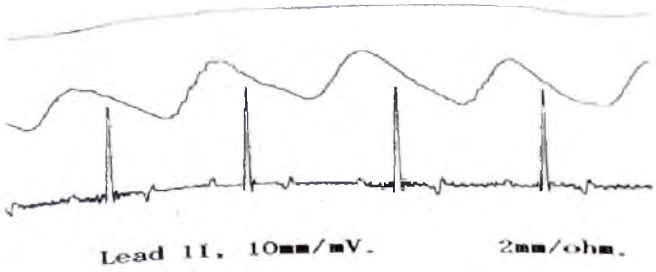
Atipamezole: is a specific antagonist for another alpha-2 adrenoreceptor agonist, meditomidine. Yohimbine is also effective as an antidot for amitras poisoning.

Flumazenil: is a reversing agent for diazepam / midazolam.

Naloxone: is an antagonist to reverse neuroleptanalgesia or opioid administration.

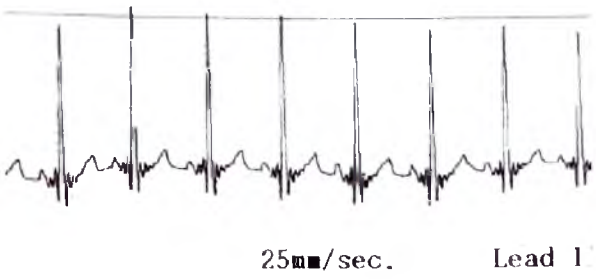
Selected ECG Changes during general anaesthesia

Normal ECG



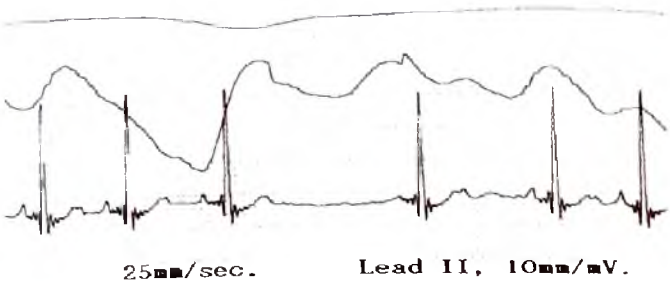
Normal

Tachycardia



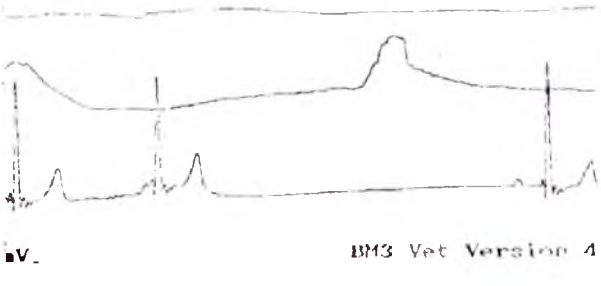
Tachycardia

S A Block



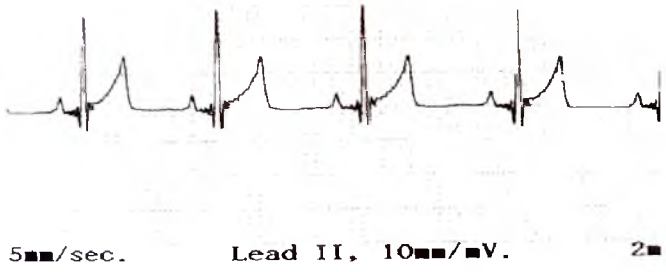
S A Block

S A Arrest



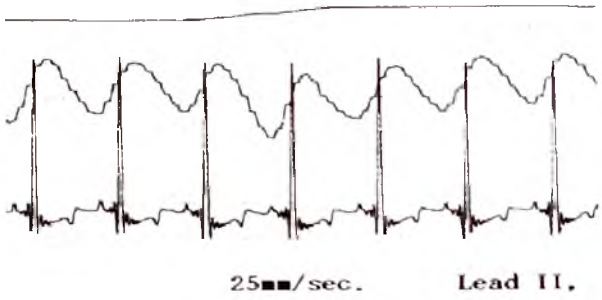
S A Arrost

S T elevation



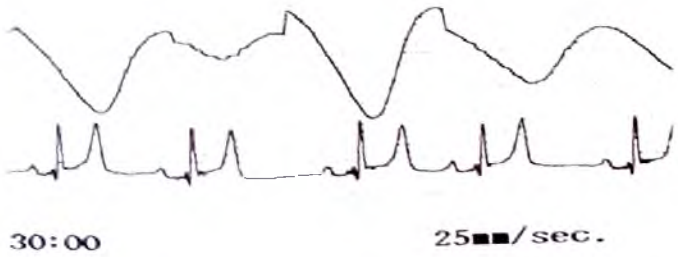
S T elevation

S T depression



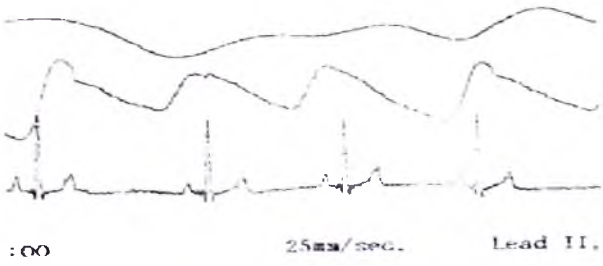
S T depression

Peaked T wave



Peaked T wave

Sinus arrythmia



Sinus arrythmia

Outcome of the study

1. *Modernized the existing operation theatre with facilities for inhalation anaesthesia*

2. *Established inhalation anaesthesia unit for the administration of anaesthetics available like halothane, isoflurane and sevoflurane with facilities for centralized oxygen supply, anaesthetic ventilator and patient monitoring using multi para monitor.*

3. *Minor research topics were selected and conducted research work in different aspects of anesthesia management and surgery.*

4. *Anaesthetic protocols for various surgical interventions in elective and emergency surgical patients were standardized and documented.*

5. *Based on the study, training modules were prepared and will be utilized for the future training programmes.*

6. *Protocols for maintenance and management of operation theatre with available minimum facilities for maximum sterile condition were established.*

7. *Documented methods for patient monitoring during anaesthesia and surgery using objective and subjective methods.*

SUMMARY OF ACTIVITIES AND OUTPUTS

Title of the Project	:	Anaesthesia and Operation Theatre Management
Funded by	:	Department of Animal Husbandry, Kerala

Infrastructure developments carried out at the project station

- Modernization of the existing small animal operation theatre
- Establishment of inhalation anaesthesia unit with accessories viz. anaesthetic ventilator, multipara monitor, centralized oxygen delivery system etc

PATIENT MONITORING DURING ANAESTHESIA

Why do we need monitoring during anaesthesia?

- The physiological homeostatic mechanism is altered during anaesthesia and the effect of chemical restraint and anaesthesia need to be monitored.
- Anaesthesia monitoring is needed to avoid side effects.
- There is significant depression of body systems at the doses of anaesthetic required to produce unconsciousness. Severe depression of the respiratory or cardiac system is life threatening.
- Monitoring equipment can be used to increase the efficiency and monitor will free up the anaesthetist's hands to tend to the patient, and it is impossible to monitor many parameters simultaneously.

Methods of Monitoring

By physical contact with the animal and monitoring of reflexes or involve the use of machine, most commonly used during inhalation anaesthesia. Write down the physiological variables on the anaesthetic record in every 15 minutes.

1. Physical methods

1. *Pedal reflex*
   - Disappear in plane III of stage III and is an indicator of deep anaesthesia.

2. *Palpebral reflex*
   - Reflexes disappear in medium plane of anaesthesia.
3. *Corneal reflex*
   - Disappear in deeper plane of anaesthesia.
   - One of the last reflexes to abolish.

4. *Lacrimation*
   - Ceases in plane III of stage III.
5. *Pupillary reflex*
   - Heavily influenced by the premedication and species variations occurs
   - Dilated in excitement stage
   - Constricted in light plane of surgical anaesthesia
   - Dilated in deep plane
   - Maximum dilation in respiratory and cardiac arrest.

6. *Eye ball position*
   - Ventromedial rotation of eye ball indicates surgical anaesthesia.
   - Eye ball position varies widely depending on the anaesthetic agent.

7. *Muscle relaxation*
   - Relaxation of jaw muscle tone and abdominal muscles.
8. Colour of *mucous membrane and capillary refill time*
   - Capillary refill time (CRT) must be less than 2 seconds.
   - Cyanotic m.m. indicates hypoxia.
   - Brick red colour indicates hypercapnea.
8. *Pulse-Rate and quality*
   - Assessed from the femoral artery/lingual artery.
9. *Respiration- Rate and quality*
   - Assessed by watching the chest movement or movement of rebreathing bag in inhalation anaesthesia.
10. *Temperature*
   - Usually decreases during anaesthesia. Record it in every 30 min.

2. Monitoring devices

Used commonly in inhalation anaesthesia. It can be invasive or non-invasive methods.

I. **Invasive methods:**

Haematocrit or haemoglobin concentration

Central Venous Pressure : An indicator of adequacy of blood volume.

Blood Gas Analysis :Arterial / venous blood analysis for PaO_2, $PaCO_2$, HCO3 and pH

II. Non-Invasive methods:

- ECG : Electrical activity of the heart
- Pulse oxymetry: Functional oxygen saturation in the peripheral circulation
- Capnography : Estimation of CO_2 tension in the inspired /expired air
- Blood pressure :Status of cardiac out put

3. Systemwise monitoring: Monitoring can be done systemwise.

- CNS monitoring
- Pulmonary monitoring
- Cardiovascular monitoring
- Musculo-skeletal monitoring using the subjective and objective methods.

General Considerations in Monitoring

1. Monitor the body system functions that are known to change based on pre operative assessment or during surgery.
2. Drug administration may affect more than one body system.
3. Monitoring devices will help to monitor more than one system, more than one parameter at a time in an integrated manner than fragments of information.
4. Use specific and accurate monitoring technique (Visual inspection, palpation, percussion and auscultation) or instrumentation.
5. Use invasive / non-invasive techniques

   Invasive - Information gathered by the instruments placed inside the body

   Non invasive - Information gathered by the instruments placed on the body surface.

"Human brain is the ultimate signal processor"

UNTOWARD EFFECTS ENCOUNTERED

1. Hypothermia- - Heat loss in excess of production common in small animal due to the larger surface area to body mass ratio. Caused by CNS depression, vasodilatation, reduced heat production, cold i/v fluids and open body cavities.
2. Hyperthermia - Excessive heat production during anaesthesia. (Malignant hyperthermia (MH) in pigs).
3. Tachycardia-Pain, Hypotension, hypoxemia, anaphylaxis, anaemia, drug effects.
4. Bradycardia - Hypertension, elevated intra cranial pressure, vagus stimulation,drugs
5. Apnea- Hypothermia, Drug effects (Thiopentone, Ketamine, Propofol)
6. Hypotension – Shock & Drugs (Inhalation agents & Thiopentone)
7. Hypertension – Pain, fever, drugs (Ketamine, catecholamines)
8. Regain of reflexes – Nerve stimulation and pain

Postoperative complications/infections are unpleasant to the patient/owner and the veterinarian. So follow these instructions to achieve the maximum possible asepsis.

General guidelines to keep the operation theatre with maximum possible asepsis are discussed here.

Patient Preparation

- Withhold food for at least 12 hrs and water for 6 hrs before surgery.
- If possible, in elective surgical patients give a bath on the previous day with medicated preparations to control fleas.
- Give an opportunity to the animal before anaesthesia to defecate / urinate.
- Remove the hairs from the surgical site and site for i/v injections.
- Clean thoroughly the surgical site thoroughly with suitable antiseptic solutions.
- Scrub the site with Povidone-Iodine /70% alcohol /Tr. Iodine.

Preparation of Surgeons

Follow proper attire in the operation theatre.

- Wear cap and mask.

  Cap should cover the hair and mask to cover the nose and mouth. Mask should fit the bridge of nose snugly.
- Wear scrub suit and shoes.
- Scrub the surgeons hand with antiseptics using brush.
- Scrub the fingers and hands first then proceed to the wrists and then forearms.
- Keep the hands higher than elbows to avoid running of water from contaminated area (elbows) towards hands.
- Dry the hands and forearm thoroughly.
- Wear the sterile gown and comfortable size well-fitting gloves.
- The surgeon is ready for doing surgery.

Operation theatre

- Smooth and non-porous surface for easy cleaning.
- Provisions to remove the air from the operating rooms.
- Air conditioning facilities.

Daily routine

- Remove the waste baskets
- Entire floor and tables are to be cleaned
- Switch off the lights

Weekly routine

- Clean all the walls with disinfectants.
- Clean the windows/doors/cupboards

Monthly routine

- Ceilings and wall air vents.
- Always clean the operating room first followed by scrub and preparation room.

Conduct in the operation theatre

- Keep everything ready before surgery and prepare a check list for each protocol.
- Minimize the movement inside the operating room.
- Avoid non sterile persons in handling instruments.
- Always handle the sterile instruments with a clean hand.
- Sterile packs are opened without touching the instruments.
- Follow aseptic techniques to prevent gross contamination of the field.
- Avoid unnecessary talking.

Sterilization of Instruments

- Autoclaving at 121°C under 15 lb pressures for 15 minutes holding time.
- Use of ordinary pressure cooker.
- Chemical methods of sterilization using alcohol/iodine/chlorine/oxidizing agents.

Aseptic surgery is a matter of team effort and the framework can be altered depending upon the practicing environment without compromising the general surgical principles.

Instrumentation

The knowledge in instrumentations helps in minimizing the damage to the tissues.

I. Cutting instruments

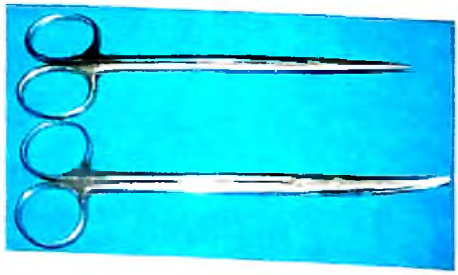
Scalpel

Blade No. 22 with handle number 4
Blade No. 11 with handle number 3.

Scissors - Sharp pointed or sharp blunt.

Mayo scissors used for cutting muscles, fascia, fibrous tissues, skin, ligaments, etc.

Metzenbaum scissors for the dis section of delicate tissues.



II. Forceps

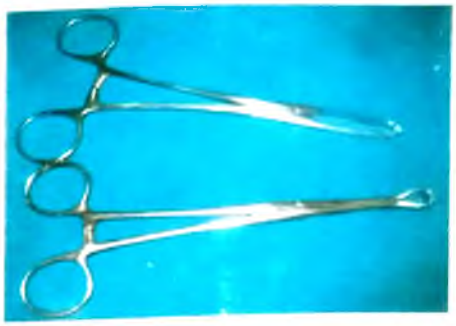
Thumb forceps – used to hold while dissection and suturing.

III. Holding instruments –for holding the tissues

Allis tissue forceps

Babcock's forceps

Doyen intestinal forceps



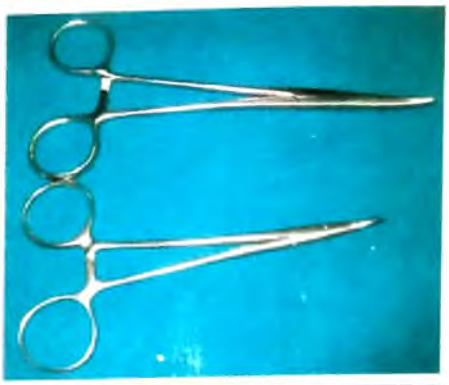
IV. Haemostats -for crushing the bleeding vessels

Halstead mosquito forceps.

'Bull dog' clamps

Artery forceps.

Rochester – Carmalts forceps



V. Towel clips –used to secure the drapes

Backhaus towel clips

Schiedls towel clips

VI. Retractors – To improve the visualization

Hand held retractors

Self-retaining retractors

VII. Suction tips -for removal of blood and fluids from the operating field.

VIII. Needle holders

An instrument to hold metallic instruments in surgery.

IX. Needles

Straight needles

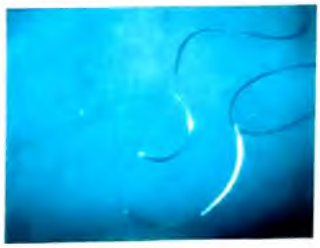
Curved needles

¼ curve, ½ circle, 3/8 circle, 5/8 circle

➢ Needles with tip taper point, either round or cutting edges/ trocar pointed.

Round tipped needles used in visceral organs like uterus, stomach.

Cutting edge needles used in muscles and skin.



➢ Needles available with eye or without eyes (A traumatic / swaged on)

Eyeless needles are ideal for surgery as they provide a leak proof suture line.

X. Suture materials

"***Surgery and sutures*** and also the ***Surgeon and sutures*** are inseparable".

Writings of Susrutha describe in detail triangular, round bodied, curved and straight needles. From 1900 onwards catgut is used and now synthetic absorbable sutures like 'Vicryl' are extensively used in surgery.

Classification of suture materials:

A) **Natural absorbable** (eg.Catgut)

B) **Natural non-absorbable (eg.nylon)**

C) **Synthetic absorbable** (eg. Poly glycolic acid)
(Polyglactin 910 (Vicryl)

D) **Synthetic non absorbable**
Polypropylene (Prolene)

Suture Selection

Skin	-	*Nylon / Polypropylene/Stainless steel/Linen*
Subcutaneous tissue	-	*Polyglactin 910 (Vicryl), Polyglycolic acid, Chromic catgut and Silk*
Visceral organs	-	*Chromic catgut, Polyglycolic acid*
Muscles	-	Catgut, *Polypropylene (Prolene), Stainless steel, Silk, Polyglactin 910 (Vicryl)*

Sutures and Needles

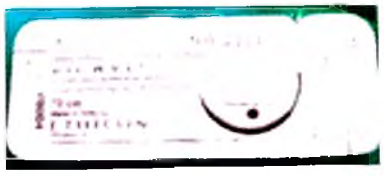
Surgeons learn the art and craft of surgery from one's chief and the tendency is to use the suture material used by him/her and the selection of material has been empirical than scientific.

In wound closure, surgical technique is far more important than the sutures used.

Suture materials

Plain Catgut

Chromic Catgut



Vicryl

Prolein

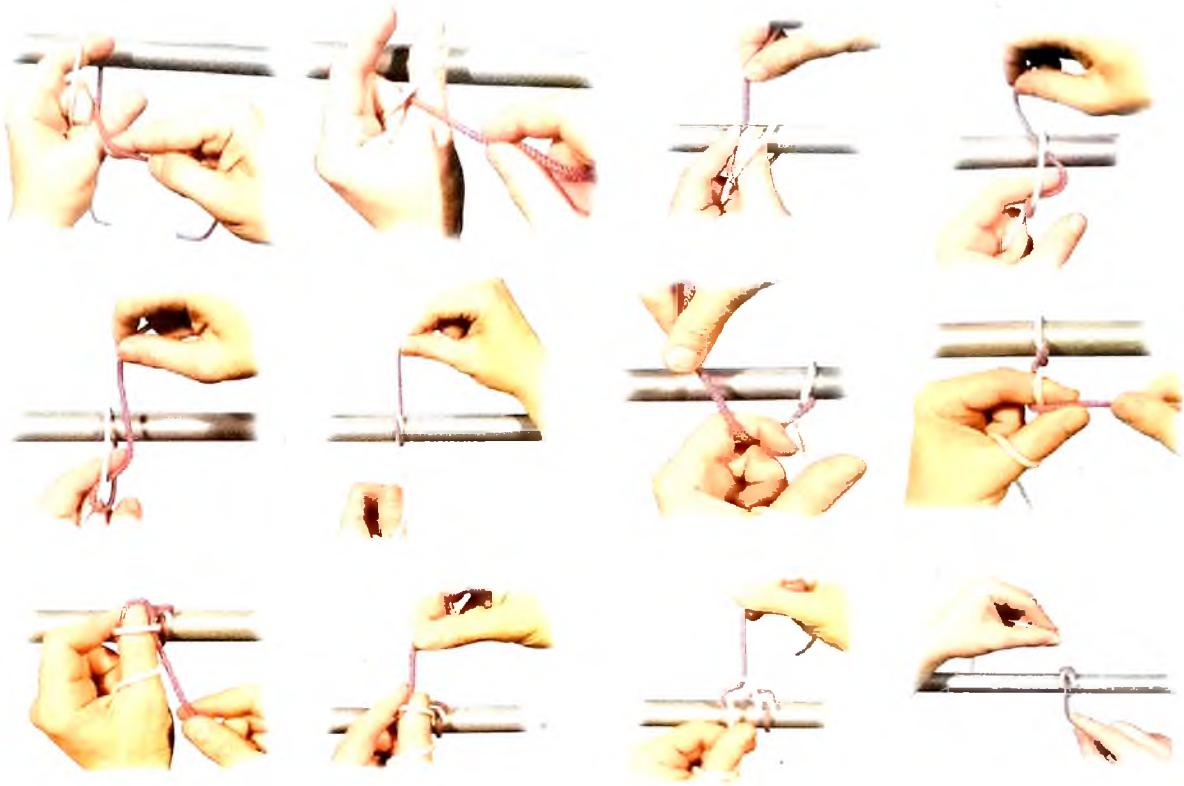
Silk

Nylon

Stainless Steel

Knot- tying

The pictures of most common knots are shown from the "surgeon's angle". Square knot is the best knot. Try to use instrument knot than hand knot.



Overview of square knots(Instrument method)

ANAESTHETIC EQUIPMENT AND ITS ACCESSORIES

The Boyle's Machine

The common inhalant anaesthetic machine is usually called as Boyle's apparatus, although named after the anaesthetist who invented it. The term Boyle's is actually a trade mark belonging to the British Oxygen Company in honor of the British anaesthetist H E G Boyle (1875-1941), and strictly speaking should be used in connection with only their apparatus. Despite numerous modifications, the modern apparatus retains many of the features of original Boyle's machine.

In a typical anaesthetic machine, there are two cylinders of oxygen and two of nitrous oxide (one of each 'running' and the other 'reserve'). Each cylinder is connected via its yoke to a regulator. Cylinder is made up of molybdenum steel. Cylinder 'E' type is generally attached to the machine and can contain nearly 680 liters of oxygen. Oxygen cylinders and nitrous oxide cylinders are also connected to a pressure gauge, which indicates the contents of the cylinder. Connections between the cylinder yoke, the inlet of the regulator and the contents gauge are of high-pressure metal tubing. The outputs of the two oxygen regulators are connected together, and to the fine adjustment valve on the oxygen flow meter, with either metal or rubber low-pressure tubing. Similar low-pressure tube connects the outputs of the two nitrous oxide regulators with their fine adjustment valve and flow meter.

The gases pass through their individual flow meters, the flow rate being adjusted by the fine adjustment valves. They are mixed in the top of the flow meter block and then passed via the vapourizers to the outlet. The components of the machine are usually mounted on a table with wheels.

Cylinder Yokes: In modern machines the cylinder yokes are bolted on to the side of the frame. In order to ensure that the correct cylinder is attached to the yoke of the machine, the 'pin-index' system is used.

Pressure (Contents) Gauges: Most of the anaesthetic machines have built in pressure regulators. They are usually fitted with thread and sealed with a non-inflammable washer or PTFE tape, or with a conical union and no washer. The entry to the pressure gauge contains a constriction to prevent sudden surges of pressure from damaging the mechanism. Each pressure gauge is marked for the gas for which it is intended and may be colour coded.

High Pressure Tubing and Low Pressure Tubing: High-pressure tubing is invariably of metal and the joints are cap and lining unions. They are constructed of heavy duty materials to withstand pressure, and also sudden surges of pressure when a cylinder is turned on, whereas the low-pressure tubing is made of rubber and is detachable. All connections are made with non-interchangeable connections. The rubber is of the antistatic variety and each end is colour coded for the gas it carries.

Regulators and valves: It is common practice to set the regulators at a slightly higher pressure for oxygen than for nitrous oxide to assure supply of the former, but except in special instances both the regulators for each gas should be set at the same pressure so that when a change is

made from one cylinder to another the flow rate is not altered. Sometimes one regulator and contents gauge is used for both the running and reserve cylinders. When one cylinder runs out its valve should be closed before the other is turned on, or gas will flow from one cylinder to the other, resulting in the two being partially filled. Fitting non-return valves can prevent this. Not only will this prevent the empty cylinder being refilled from the full one, it will also enable its removal and replacement when the reserve has been turned on, without interrupting the supply of gas.

Flow meters ('Rotameters'): Rotameters control the amount of a particular gas entering the anaesthetic machine. The gases from both cylinders and pipeline flow through narrow steel tubing to the rotameter, where the flow rate of gas is controlled. Uniform taper gives more accurate reading. 'Rotameter' is the trade name of one particular brand of flow meter. Since it was the pioneer of this type of flow meter in its time the term rotameters has become synonymous with flow meter.

'Back Bar': That part of the frame of an anaesthetic machine which supports the flow meters, vaporizers and various other parts is known as the back bar. Usually the flow meter block is mounted on the left-hand side of the back bar.

Vaporizers: Vaporizers are of two types, variable bypass and measured flow (precision and non precision) or it can be flow over or bubble through or injection method of vaporizer is used to classify vaporizers. In flow over vaporizer, the fresh gas is bubbled in to the liquid anaesthetic much like an aerator for an aquarium. Thermo compensated, deliver precise anaesthetic concentration for long period of time independent of temperature changes and semi independent of flow rate. Anaesthetic concentration can be changed relatively rapidly.

Key filler model

Caution while filling

- Follow the instruction of manufacturers.
- Avoid spillage of anaesthetic drugs while filling/ draining.
- Vaporizer control must be in the 0 (zero) position during filling/ draining.
- Keep the adaptor of the bottle/vaporizer tight.
- Pour fill (screw cap) filler – Always refit and retighten the filler cap. Key filler (Agent specific) – Always tighten the filter control and refit the key filler plug and tighten the clamp screw before using the vaporizer. Quick fill models – Remove the bottle and refit the filler block cap before using the vaporizer.

The halothane models need special care because halothane contains a stabilizing agent, thymol.

Quick filler model

Maintenance of anaesthetic machines

Thymol, a normal constituent of 'Halothane', tends to collect in vaporizers and most manufacturers advise that temperature compensated vaporizers be returned to their factory once in a year for overhaul. Always better to flush out the anaesthetic gas vapor from the vaporizer before use by opening the oxygen and releasing to outside. Otherwise there is a chance for leakage while filling due to the pressure developed inside.This is more important when costly drugs like sevoflurane is filled to the vaporizer.

Cockpit drill'

It is advisable to check an anaesthetic machine each time before use as follows:

1. Cylinders

   Check that the cylinders are in position. Turn on the reserve oxygen cylinder and see that it registers full on the gauge. Repeat this with the nitrous oxide cylinders. Check that the cylinders are correctly labeled 'full', 'in use', etc. Following this leave the cylinder key on the top of the anaesthetic machine. It is a good plan to attach it by a chain. You are lost without it!

2. Vaporizers

   Check all temperature compensated calibrated vaporizers, refill as required.

3. Check for Leaks from the vaporizer

   Obstruct the outlet of the machine with the palm of the hand and observe the oxygen rotameters, which should fall to below 200 cm3/min (a small leak of below 200 cm3 is permissible). Note that this test cannot be done on Boyle's machines which have safety relief valves on the back bar.

4. Breathing Circuits

   Semi- closed (Magill attachment). Check the reservoir bag, the hose and expiratory valve. Make sure that there is an elbow and a catheter mount. Check the circuit for leaks by closing the expiratory valve and squeezing the bag while fresh gases are flowing.

   Closed circuits: Check the rebreathing bag, expiratory valve and swivel outlet, remove the corrugated hoses and hang them vertically to make sure that there is no condensed water in them. Replace them. Check for leaks and make sure that the soda lime is fresh.

5. Check for Leaks from the breathing circuit

   With all the rotameters and oxygen bypass turned off, listen carefully for leaks, especially from cylinder yokes.

6. Accessories

   Check that the following are either on the anaesthetic machine or immediately available in some other nearby place: cylinder key, face mask, airways, elbow connector, catheter mounts, endotracheal tubes and connectors, laryngoscope, syringe and forceps for cuffed tubes, adhesive tape, bandage, mouth gag, tongue forceps, swabs, throat spray filled with suitable analgesic solution (such as 4 per cent lignocaine or 15% lignocaine sprey), lubricant and scissors.

Oxygen Failure alarm/Oxygen low pressure alarm

The risk of supplying a hypoxic gas mixture to the patient must never be forgotten. Oxygen failure alarms are attached to the machines. Some rotameters are installed with hypoxyguard where the nitrous oxide flow will take place only with oxygen i.e. flow meter for nitrous oxide will not work alone in the absence of oxygen. The safety device generates an audible alarm when oxygen pressure in the pipe line falls. The duration of the alarm is at least 7 seconds. Check the functioning of alarm by closing supply line and slowly depleting internal pressure by opening flow control valve. Replace battery in case of any problem.

Breathing circuits and their components

The breathing circuit is defined as that part of the anaesthetic apparatus downstream from the back bar and in which the gases are at, or not far from, atmospheric pressure, and from which and into which the patient breathes. It includes reservoir and rebreathing is intentional but where there is provision for the addition of extra oxygen and other gases and also for the removal of carbon dioxide.

There is a good deal of variation in the interpretation by anaesthetists regarding the classification of breathing circuits.

Simple approach is Rebreathing and Non-rebreathing or in modern anaesthetic machines - Open, semi Open, Semi closed or Closed.

Open: an open drop mask, which does not fit for face. There is free access of air.

Semi-open: Open drop, but with a mask which fits the face. An enclosure above the mask may be used to promote partial rebreathing.

Semi-closed: Circuits such as Mapleson A (the Magill attachment) where rebreathing at least of alveolar gases is not intended.

Closed: Total or partial rebreathing is intended. There is provision for carbon dioxide absorption. Some fresh gas flow is necessary to allow for oxygen utilization and unavoidable losses. Usually a considerable degree of 'spill' or leak is intended, the fresh gas flow rate being correspondingly higher.

Carbon dioxide absorption

In any system where there is functional rebreathing, whether total or partial, provision must be made for the removal of carbon dioxide, which would otherwise accumulate. The usual absorbent used is soda lime. This consists of calcium hydroxide with 5 per cent sodium hydroxide and sometimes a small percentage of potassium hydroxide. Silicates are usually included to make the granule less likely to reduce to powder.

Some moisture is also required for efficient absorption. However, even if the soda lime is dry to begin with, moisture is obtained not only from the patient's expired gases but also from the reaction between the soda lime and carbondioxide: viz. $2NaOH + CO_2 = Na_2CO_3 + H_2O$

Soda lime should be stored in sealed containers and handled with care to avoid the granules being reduced to dust.

Rebreathing and Reservoir Bags : The commonly used size in the Magill attachments is 2 liters (i.e., that which when fully but not forcibly distended has a capacity of 2 liters; in clinical practice it is seldom filled to this capacity). Larger bags are used as reservoir bags in ventilators, and smaller ones in paediatric anaesthesia.

In the Magill attachment and closed circuit apparatus the capacity to which the bag may easily be distended must exceed the patient's tidal volume. A larger capacity, though harmless, is unnecessary.

Expiratory (Pop-Off) Valves : The purpose of the expiratory valve is to allow the escape of exhaled (expired) and surplus gases from a breathing circuit, but without permitting entry of the outside air even if there is a negative phase. Usually it is desirable that the pressure required to open the valve should be as low as possible in order to minimize resistance to expiration. It must, however, present sufficient resistance to prevent the reservoir bag from emptying spontaneously.

Breathing Tubes : The tubing connecting the components of a breathing circuit must be of such a diameter as to present a low resistance to gas flows. The cross section must be uniform, in order to promote laminar flow where possible, and although it should be flexible, kinking should not occur.

The corrugated hose of rubber or neoprene allows acute angulations of the tube without kinking. The disadvantages of the corrugated rubber hose are that the irregular wall may cause turbulence and may harbor dirt and infection.

There are several standard sizes of corrugated hose both ends of which have parallel walls for about 1 in (2 to 3 cm). It is usual for these ends to be fitted with a metal or hard rubber tapered connector, which fits a component such as an expiratory valve or a bag mount.

Facepieces : These are also referred to as facemasks. They are designed to fit the patient's face perfectly without any leaks, and yet to exert very little pressure which might either depress the jaw and cause respiratory obstruction or cause pressure sores. A snug fit is achieved by anatomical shaping, by the use of an air-filled cuff which has a soft cushioning effect, or by a flap which takes up the contour of the face.

Endotracheal Tubes

There are various situations in which it is not feasible to administer anaesthetic gases via a face piece or nasal inhaler. In these cases an endotracheal tube is used. Where positive pressure ventilation is contemplated it is also necessary to make an airtight connection with the trachea.

Red rubber, plain tubes may be used when the patient is to breathe spontaneously. Various types of plastic endotracheal tubes, some of them disposable, have been introduced particularly for long term cases where they cause less tissue reaction. Cuffed red rubber endotracheal tubes are usually used for endotracheal intubation only.

The cuff is inflated via a small bore tube on which there is a 'pilot' balloon. The inflation of this pilot balloon indicates that the cuff is also inflated provided that the pilot tube is not kinked when the endotracheal tube is being fixed in position with strapping.

The cuff is inflated with air by using a 10 ml syringe. A pair of artery forceps is applied to the pilot tube between the syringe and the balloon when the cuff has been inflated just sufficiently to make an airtight fit in the larynx and trachea. Some pilot tubes have a one way valve, which prevents air from escaping when the syringe is removed: in which case the syringe is reinserted to deflate the cuff.

Red rubber tubes may be sterilized by cold sterilization (Chemical sterilization) or, better, autoclaved. In either case connectors should be removed before treatment. Tubes may be wrapped separately, in which case a transparent packet should be used so that they may be inspected before opening. Alternatively a day's supply may be kept in a single sterile box or tray. The cuff should be tested before use – the technician can do this with all those in the tray or box before the start of an operating list. When they are packed singly the cuff should be tested before packing. The size of the tube (internal diameter) can be selected by using the formula: Body weight +15/4 = Endotracheal tube size.

The common faults with endotracheal tubes are as follows:

(1) It may pass too far down the trachea and may even enter the main bronchus. This is because it is too long and requires shortening.

(2) There may be a leak between the cuff and the trachea. This may be because either the cuff has not been sufficiently inflated, or it has leaked. The latter may be due to a fault in manufacture, or due to over inflation.

(3) The tube may be obstructed in one or more of several ways. The opening may be occluded if the larynx or trachea is deviated to one side. A tube may kink when bent to too small radius, particularly if soft from frequent use. It may be compressed by a throat pack, which has been inserted too firmly, and it may also be obstructed if the patient is lightly anaesthetized and bites it. In cats, use lignocaine spray before intubation to avoid laryngospasm.

Endotracheal tubes may be kinked in the mouth or nasopharynx when the patient's neck is flexed, and this is particularly likely when procedures such as oesophagoscopy are being performed or during operations when extreme flexion of the head or the neck is required as in some neurosurgical procedures.

Ventilators–Resuscitators, Respirators, Breathing machines

Ventilators

There are three different groups of devices, which can be used to produce artificial ventilation of the lungs.

(1) Manual resuscitators such as the Ambu, Air Viva, Samson and Oxford Bellows.
(2) Mechanical respirators into which the patient is placed in order to simulate the negative intrathoracic pressure, which occurs in spontaneous respiration.
(3) Mechanical devices, which rhythmically inflate the lungs by means of applying intermittent positive pressure to the air passages (IPPR-intermittent positive pressure respiration).

Manual respirators

There are several manual respirators and the common AMBU bag is described here.

Ambu respirators : These consist of a bag, a valve and a face piece. The bag is so constructed that in the resting state it remains inflated. When the bag is squeezed the valve closes the expiratory port and the air passes to the face piece and inflates the patient's lungs. When pressure is released, the bag automatically re-inflates with fresh air and since, at the same time, the valve moves back to the resting position, the patient's expired air passes passively out to the atmosphere. There is provision for a supply of oxygen to the bag via a tube of small diameter. The diameter of the nozzle for attaching an oxygen tube is so small that if it is left open, very little air is lost through it from the bag during the inspiratory phase. In manual resuscitators such as the 'Ambu', air is drawn into one end of a self inflating bag and blown out of the other. The face pieces provided with this type of respirator are constructed of a transparent plastic so that if the patient has vomited it may be more quickly observed.

Mechanical respirators, which act externally on the chest

These ventilators act by applying external pressure to the chest in order to simulate the normal respiratory movements.

Automatic intermittent positive pressure ventilators

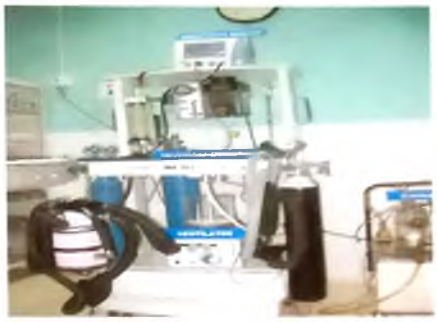
Nearly all the ventilators used for anaesthetic techniqus and intensive care procedures fall into this group. They intermittently inflate the lungs by positive pressure applied through a cuffed endotracheal or tracheostomy tube. Deflation of the lungs may be either passive or actually assisted. The power by which these ventilators are operated may come from an electric motor or a supply of compressed gases or air. The frequency and pattern of respiration produced may be varied.

Gas Supply Connection

Mount 5 Liter water capacity Cylinders for O_2 & N_2O in the respective Yokes.

- Close Rotameters flow control valves.
- Open O_2 cylinder valve slowly using cylinder keys. The oxygen cylinder pressure gauges will rise slowly and indicate cylinder pressure.
- Similarly, open N_2O cylinder valve and see the pressure gauge for cylinder pressure.
- Low pressure gauges for O_2 & N_2O will indicate pressure of about 4 Kg/cm^2.
- First, open N_2O Rotameter valve, the bobbin should not show any gas flow.
- Then open the O_2 Rotameter knob slowly;The O_2 Rotameter bobbin start indicating flow. N_2O flow to increase proportionately with increase of O_2 flow to maintain minimum 23-25% level of oxygen in the mix gas. This indicates proper functioning of Oxygen Ratio Controller.
- Check the functioning of Flush.
- With both gases supply lines open, leak test the circuit with soap/teepol solution.

- Slowly control oxygen flow. to check proportional increase/decrease of N_2O flow. This indicates proper functioning of Ratio controller.
- Mount the Vaporiser and fill it with proper agent.
- Connect either Magill Circuit Components to the mixed gas outlet or connect it with the circle absorber for closed circuit operation.
- Close Rotameter knobs.
- Slowly open O_2 & N_2O cylinder spindle with keys.
- Check cylinder pressure gauges for proper cylinder pressure.
- Slowly open O_2 Rotameter knob first. Then open N_2O knob to the desired level depending on the O_2 & N_2O/drug ratio required for the patient.
- See the gas is filling the Bag Re-breathing in the patient circuit.
- Check the functioning of Flush.



CONCLUSION

This study is an attempt to impart comprehensive understanding on clinical anaesthesia and helping the clinicians to choose the best anaesthesia suited to the needs.

I dedicate this manual to the practicing veterinarians as well as veterinary students.I have designed this to act as a desktop guide for clinical anaesthesia.

I have tried to summarize and simplify what has been a very large and confusing topic but this manual is not intented to replace the standard textbooks of anaesthesia and surgery.

I accept that there are many techniques often equally satisfactory (or unsatisfactory) but the recommendations in this book are based on the experiences of the faculty members. and the techniques are found to be simple, safe and effective. The recommendations will be of much value to the veterinarians to ***'learn, practice and finetune the existing practices'.***

Now I recollect the words of ROBERT SMITH

"There are no safe anaesthetic agents, There are no safe anaesthetic procedures, There are only safe anaesthetists"

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