General Anaesthesia In Cattle

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General anaesthesia is the controlled and reversible loss of consciousness, which is helpful in ruminants for many surgical procedures that warrant effective control of pain and movement. General anaesthesia is indicated when the demands of technical and anatomical aspects of surgical procedure exceed the capabilities of sedative drugs and local analgesia. Moreover, the patient cooperation and systemic analgesia are generally greater with general anaesthesia compared to local analgesia. The advances in large animal anaesthesia procedures are required to be available to ruminants essentially because of the considerable cost of the high producing dairy cattle and owner’s sentimental attachment with the animals in countries like India.

Physiological Concerns With Ruminant Anaesthesia

- Regurgitation of reticulo-ruminal contents
- Aspiration of refluxed material or saliva, leading to aspiration pneumonia
- Hypersalivation
- Ruminal tympany
- Hypoventilation
- Hypotension
- Neuropathy
- Fluid and electrolyte imbalances

Reducing The Risks Associated With Ruminant Anaesthesia

Pre-Anaesthetic Starvation
- Withholding food for 24 hours and denying access to water for 12-18 hours in adult cattle reduces the reticulo-ruminal bulk and fermentation rate and the subsequent development of ruminal tympany.
- Starvation for longer than 24 hours may result in: ketocidosis in high producing animals; alkalosis in less metabolically stressed animals; hypothermia and change in metabolic rate; increased fluidity of ruminal contents and likelihood of regurgitation; adverse effect on rumen motility and acid base status.

Regurgitation Management
- Sellick’s Maneuvre – Pushing hard against the larynx in order to squash close the oesophagus to prevent further regurgitation.
- Placing a cuffed endotracheal tube (ET) into the oesophagus, to duct the refluxed material away from the pharynx. The reflux tends to stream around the outside of the tube if cuff inflation is inadequate and has to be managed appropriately.
- Endotracheal intubation with a cuffed ET.
- Active regurgitation may occur when attempts are made to intubate the trachea at light planes of anaesthesia. Proper induction technique, eliminating gag reflex and maintaining the animal in sternal recumbency with the head elevated during tracheal intubation may avoid regurgitation.

Avoiding Aspiration
- Endotracheal intubation with a cuffed ET.
- Positioning the head so that saliva runs out of the mouth by placing a pad under the head-neck junction so that the opening of the mouth is below the level of the larynx. This also reduces the risk of facial nerve paralysis.

Managing Hypersalivation: Saliva production is copious in cows producing about 50-150 litres of saliva per day depending on the diet. The secretion tends to continue under anaesthesia and could potentially form a source of material for aspiration and obstruction of the respiratory tract. The continual outflow of saliva represents a substantial fluid, electrolyte and buffer loss and need to be replaced. Use of anticholinergics is not indicated as they (reduce only the aqueous part of salivary secretion) tend to render saliva more viscous which could result in airway blockade, if aspiration occurs. Also, anticholinergics reduce mucociliary function and thus reduce the clearance of material from respiratory tract.
**Relieving Tympany:** The bloated rumen decreases venous return and interferes with the movement of diaphragm and decreases its excursions and causes hypoventilation. Relieving the tympany with the trocar and cannula or gastric tube may improve the cardio pulmonary function.

**Counteracting Hypoventilation:** Ruminants have a rapid, shallow pattern of breathing awake and under anaesthesia. They tend to hypoventilate to a greater degree than other domestic animals during anaesthesia. Small increase in breathing rate during anaesthesia to compensate hypoventilation is not adequate and mechanical ventilation is indicated when there is significant hypoventilation. Mechanical ventilation with a tidal volume setting of 1 to 1.5 litre per10kg body weight, 10 breaths per minute and end tidal CO₂ monitoring could be employed to maintain normal ventilation. Due to the rapid shallow pattern of breathing deep sighs are not warranted in anaesthetized ruminants during mechanical ventilation. Ruminant lungs contain less fibrous connective tissue than horse lungs. Hence, they are more prone to alveolar rupture and pneumothorax if inadvertently high peak airway pressures are delivered during IPPV. The recommended PIP in ruminants is less than or equal to 30cm H₂O. The high gas flow velocity of ruminant ventilation generates significant resistance causing increased respiratory effort when smaller sized breathing tubes are used during inhalation anaesthesia. Moreover, the upper airway of ruminants is relatively large and larger endotracheal tubes are preferred to reduce the airway resistance and work of breathing.

**Avoiding Hypotension:** Hypotension during anaesthesia is reported when large doses of xylazine or acepromazine is included in the anaesthetic protocol and as well during very deep planes of anaesthesia. Selecting appropriate premedications and avoiding very deep planes of anaesthesia could prevent the potential effects of hypotension. Intropes such as dobutamine at the rate of 1 to 3 micro grams per kg per minute can be infused in hypotensive patients to augment cardiac output and improve tissue oxygen delivery. Calcium gluconate may also be administered to augment cardiac output.

**Neuropathy Prevention:** Large body weight places adult cattle at greatest risk for developing post anaesthetic myopathy and neuropathy. Proper patient positioning with sufficient padding and avoiding undue prolonged recumbency could avoid these complications. Radial nerve paralysis like syndrome may occur if due consideration is not given for patient positioning during prolonged anaesthesia. Placing an inflated rubber tube beneath the dependent shoulder could possibly avoid the injury to the radial nerve and post anaesthetic complication.

**Fluid Replacement:** The continuous outflow of saliva and regurgitation of reticuloruminal contents alter the fluid, electrolyte and pH status of the patient during anaesthesia. Intravenous crystalloids at the rate of 5-10ml per kg per hour should be administered during anaesthesia with electrolyte and pH monitoring.

**Premedication:** Premedication in ruminants is employed to enhance patient co-operation and modify the response to the induction bolus. Premedication can intensify or extend the effects of the induction bolus while minimizing its side effects. Apprehension and activity alter the distribution of cardiac output, directing a greater portion of blood flow to skeletal muscle. Centralization of cardiac output, directs a greater portion of the intravenously administered anesthetic induction agent to the target sites in the central nervous system, is desirable and is achieved by suitable premedication protocol.

**Commonly Used Drugs For Premedication And Induction Of Anaesthesia In Cattle**

- **Xylazine:** Xylazine is an alpha 2 adrenoceptor agonist and is a sedative analgesic with muscle relaxant properties. It is the most commonly used drug for sedation in large animals. Ruminants are 10 times more sensitive to xylazine than horses due to the differences in the post receptor signaling mechanism. The dose ranges from 0.05 to 0.2 mg per kg body weight. Titrated administration of xylazine minimizes the risk of over dosing in compromised patients. Xylazine increases airway resistance and may cause pulmonary hypertension and edema which could result in hypoxaemia under general anesthesia; increases uterine tone in both pregnant and non-pregnant cattle; causes vasoconstriction of uteroplacental blood vessels compromising placental perfusion and fetal viability. The oxytocin like effect of xylazine increases the risk of abortion in the last trimester of pregnancy. Xylazine reduces reticular activity favoring the development of tympany. It reduces laryngeal activity increasing the risk of aspiration. Xylazine produces dose dependent cardiovascular depression and intravenous xylazine produces a biphasic changes in blood pressure (initial increase due to peripheral vasoconstriction followed by gradual decrease because of reduction in sympathetic tone). The sympatholytic effect of xylazine can exacerbate brady-arrhythmia and hence should be avoided in patients with hyperkalemia.

- **Guaifenesin (Glyceryl Guaiacolate):** Guaifenesin is a milder sedative with strong muscle relaxant properties. Central muscle relaxation occurs due to blockade of intermuncial neurotransmission in the spinal cord and brain stem. It produces minimal cardio-respiratory / GI depression making ‘better sedative of choice’ in compromised patients. Guaifenesin is administered as a five per cent solution. Concentrations above five per cent may cause haemolysis in ruminants. Guaifenesin is administered intravenously (I/V) to effect. The usual doses are 30 to 100 mg per kg body weight, it is
cumulative and high doses could cause problems and hence a maximum dose of 100 mg per kg body weight, should not be exceeded in any 24 hr period. If doses in excess of 150 mg per kg body weight were given, recoveries could be prolonged and cardiac arrhythmia, CNS excitement reactions (opisthotonos/paradoxical muscle rigidity) and apneustic breathing pattern can all occur.

**Acepromazine:** Acepromazine is the 2 acetyl derivative of promazine and has a marked sedative property. At low doses it produces behavior modification and as the dose is increased sedation occurs but the dose-response curve rapidly reaches a plateau after which higher doses do not increase, but only lengthen sedation and increase side effects. The dose of acepromazine is chosen based on the duration of sedation required and purpose for which it is needed. The dose ranges from 0.03 to 0.1 mg per kg body weight. Acepromazine produces dose dependent hypotension mediated through vasodilation due to peripheral alpha1 blockade. It causes paralysis of retractor penis muscle and protrusion of penis. Acepromazine has a little antihistaminic activity but has a powerful spasmyloic effect on smooth muscle including that of gut. It has antiarrhythmic effects and protects against adrenaline induced fibrillation. Acepromazine causes peripheral vasodilation and hypothermia and its concomitant administration during regional block is not recommended. Acepromazine decreases the oesophageal sphincter tone and increases the likelihood of regurgitation in cattle.

**Benzodiazepines:** Diazepam and midazolam are moderate sedatives and centrally acting skeletal muscle relaxant. They produce minimal cardio-respiratory/GI depression at clinically used doses. The dose rates of vary widely from 0.02-0.25 mg per kg body weight I/V. Lower doses are favored in adult cattle possibly because of the hypersalivation and ruminal atony associated with higher doses. Occasionally animals may become ‘excited’ due to disinhibition. Diazepam has a poor bioavailability if administered intramuscularly (I/M) but midazolam can be administered by this route. Benzodiazepines are a very usual adjunct to ketamine anesthesia countering the muscular hypertonus associated with ketamine.

**Opioids:** The principal use of opioid in the anaesthetic protocol is to provide effective analgesia. Systemic administration of opioids can be used to increase the level of analgesic support for ruminant patients experiencing moderate levels of pain. The important undesirable side effect associated with opioid administration is respiratory depression. Increasing the dose of pure opioid agonists increases analgesia but, unfortunately also increases respiratory depression. Butorphanol, an opioid agonist-antagonist is the commonly used opioid in large animals practice. Butorphanol is a kappa and sigma opioid receptor agonist and a mu opioid receptor antagonist. Butorphanol at the rate of 0.05 to 0.1mg per kg body weight I/V or I/M in small ruminants, 0.02 to 0.05 mg per kg body weight I/V or I/M in large ruminants can provide total relief of milder levels of pain and a marked reduction in moderate levels of pain. Concomitant administration of NSAID can be used to provide additional analgesic support in ruminant patients with moderate levels of pain.

**Ketamine:** Ketamine produces catalepsy which is defined as a characteristic akINETIC state with loss of orthostatic reflexes but without impairment of consciousness in which the extremities appear to be paralysed by motor and sensory failure. Spontaneous involuntary muscle movement and hypertonus are not uncommon during induction with ketamine. Mild respiratory depression has been associated with ketamine administration and in clinical practice this is usually manifested by an increased rate which does not compensate for a decreased tidal volume. Although ketamine preserves, and even enhances cranial nerve reflexes, it will not guarantee a protected airway and endotracheal intubation with a cuffed endotracheal tube is warranted. Ketamine can be used as a part of intravenous infusion for maintenance of anaesthesia. Ketamine does cause direct myocardial depression, but this is not usually noticeable because of the sympathetic stimulation by ketamine. The dose recommended is 2 to 5 mg per kg body weight in cattle.

**Thiopental Sodium:** Thiopental produces unconsciousness in one injection site - brain circulation time. Aqueous solutions are strongly alkaline and are incompatible with acids such as most analgesics, phenothiazines, adrenaline and some neuromuscular blocking drugs. The duration and depth of anaesthesia are governed by the amount of the drug administered, speed of induction, rate of distribution to non-fatty tissue of the body and rate of uptake of thiopental by the body fat. The induction dose varies between 5 to 10 mg per kg body weight and the dose needs to be adjusted based on the premedication. All barbiturates cause respiratory depression and a short period of apnoea usually follows the intravenous administration of thiopental. Rapid intravenous administration causes a fall in blood pressure. The drug has a direct depressant effect on the myocardium. Thiopental does not effectively block motor nerve impulses and muscle relaxation achieved could be due to excessive central nervous depression. The incidence of hepatic damage is related to the dose administered and hepatic dysfunction always follows the use of large dose. It is preferred to use low concentration solution for administration as higher concentration solution may cause necrosis and sloughing of tissue if accidental perivascular injection occurs.

**Propofol:** Propofol is an intravenous anaesthetic agent unrelated to barbiturates, eugenol or steroid anaesthetic agents. The active ingredient, 2,6 disopropylphenol exists as an oil at room temperature. Like thiopental, propofol is a rapidly acting agent producing anaesthesia of shorter
duration without side effects. Propofol is compatible with wide range of premedicants, inhalation agents and neuromuscular blocking drugs. Propofol is now accepted as a most useful agent in all domestic animals, although its current price precludes its widespread use in adult farm animals. The dose varies from 4 to 6 mg per kg body weight.

**Inhalation Anaesthesia:** The need for quality anaesthesia of longer duration warrants the use of inhalation agents to cater the demands of complex surgical procedures. Inhalation anaesthesia in ruminants is considered to be superior to injectable techniques because it,

- Provides a patent airway,
- Improves oxygenation,
- Facilitates control of ventilation,
- Controls depth of anaesthesia,
- Ensures smooth and rapid recovery &
- It does not depend on tissue metabolism for its elimination.

The Minimum Alveolar Concentration (MAC) is the concentration of inhaled anaesthetic (measured as a percentage at one atmospheric pressure ie. Partial pressure) that prevents the reaction to surgical stimuli in 50% of subjects. The MAC is a measure of inhalant anaesthetic’s potency. The anaesthetic effects are a result of the partial pressure of the anaesthetic at the site of drug effect. Although MAC in terms of per cent inspired gas is used to commonly, the per cent will change as a function of the ambient atmospheric pressure. The maintenance level of anaesthetic (ie. Vapourizer setting) required for surgical plane of anaesthesia can be estimated from the MAC value of the inhalant anaesthetic. The vapourizer setting during maintenance is in the range of 1.5 to 2 times the MAC value and may be reduced by the administration of preanaesthetic and induction agents. Halothane and isoflurane are routinely used as maintenance agent in ruminant anaesthesia. The higher cost of sevoflurane and desflurane limits its use in ruminants.

**Feeding Systems**

In the Livestock Industry about 60-65 % of the inputs are through feeding alone. Therefore, management of feeding systems is an important single factor affecting the input: output ratio of this industry. Under the traditional system, cattle and buffaloes are either tethered or let loose in the field at day-time and brought to the enclosures/stalls at night time or they are confined in the stalls (mostly lactating animals) or a combination of the two systems is followed in different agro-ecological zones. Small ruminants are mostly grazed/browsed with little or no supplementation. Feeding systems are primarily based on grazing the animals on native pastures of low productivity.

As feed supplies to the animals depend on local cropping pattern as variations in feeding systems are observed from region to region. In the Northern region, wheat straw is utilized more intensively, while feeding paddy straw is common in Eastern and Southern regions and part of the Western region, particularly in coastal areas. Sorghum stovers are fed in the Central and Western regions and in parts of the Southern region. Feeding millet and pulse straw is also observed in certain localities.

Ruminants receive part or most of the feed requirements through grazing or natural grassland, the production potential of which may range from an exercise ground during the major part of the year to a fairly good pasture during rainy seasons. During wet season, some live weight gain (milk/draught) is achieved but this is followed by variable losses during dry season depending upon the pressure on the grazing land and the quality and quantity of vegetation. Large ruminants receive about 50-66 % of DM requirement through crop residues (straws, stovers), which is supplemented with small quantity of grass through scanty grazing or cut and carry grasses. Generally, concentrate (oil-cakes, brans, chunnies etc.) is given only to the lactating animals as the farmers get the immediate return on their investment. Usually, this quantity is inadequate, thereby; animals do not exhibit their full potential for milk production. Supplementation of ration of growing and dry animals with concentrate mixture is not practiced, which causes poor growth, late sexual maturity and long inter-calving intervals both in cattle and buffaloes.