Practical Aspects of General Anaesthesia in Cattle

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Introduction

General anaesthesia (G.A.) of cattle often evokes passionate arguments among veterinarians. Some almost never employ the technique, but may indeed do little surgery. Others do many operations, but claim that it is hardly needed, since most surgery can be done under local or regional analgesia. Accepting that certain indications exist for G.A., some recent improvements in anaesthetic techniques may diminish the reluctance of relatively inexperienced veterinarians. Nothing can replace personal experience, and "an ounce of practice is worth a pound of precept." But there is a quandary, as "experience is good, if not bought too dear" (J. Kelly 1721, "A Complete Collection of Scottish proverbs").

Indications for General Anaesthesia in Cattle

There are few absolute indications apart from extensive surgery of the head and neck, thorax and abdominal wall, penis/urethra and some experimental intra-abdominal manipulations (e.g. in embryo transfer procedures) where excellent muscular relaxation is essential.

There are also a number of relative indications for G.A. where the technique will improve conditions for good surgery. The liability of cattle to have spontaneous movement during procedures under local (LA) or regional analgesia (RA) has been responsible for the breakdown of aseptic procedures with consequent wound infection. Who has never seen an infected flank laparotomy incision? It is for this reason that umbilical hernia repair is preferably performed under G.A.

Potential Complications of G.A.

The main potential problems include a) regurgitation of rumenal contents and its aspiration, with saliva, with potentially lethal consequences (aspiration pneumonia), b) rumenal tympany causing inadequate lung expansion and pulmonary ventilation, c) poor oxygenation from lateral recumbency (ventilation-perfusion mismatch), and d) the risk of skeletal injury.

Regurgitation

Rumen contents are liable to be regurgitated during G.A. Incidence figures have rarely been published and the mortality from this cause is unknown. In a personal series of 110 cases of bovine G.A. (thiopentone induction, halothane and O_2 maintenance), 16% regurgitated, two cases immediately following barbiturate induction (14). Regurgitation may occur in light (stage 2 to stage 3 plane 1) or in surgical or deep anaesthesia (planes 2 and 3). The mechanism may differ. It has been speculated (6) that anaesthetic agents first depress the medullary centres including the oesophageal centres and that lack of oesophageal tone causes relaxation of the cardiac sphincter so that rumenal content trickles into the partly relaxed oesophagus, possibly aided by gravity.

Significant factors, which are important when considering practical measures, are the body position, the development of slight tympany, coughing (as in passage of the endotracheal tube) and body movements such as struggling and repositioning of the animal.

In connection with repositioning of a bull after induction of G.A., a Scottish judge in a civil case for damages against a veterinary surgeon for allegedly causing the death of the bull by aspiration pneumonia, stated that "turning over a bull caused or contributed to the regurgitation of rumenal material and this could have been avoided by pulling the bull sideways (from beneath the operating table) and inserting the endotracheal tube before doing anything else" (8). Attempts at repositioning should not be done therefore until an endotracheal tube has been inserted.

Saliva production persists until deep surgical anaesthesia is attained. It is a considerable volume, and 5-10 ml/100 kg per minute has been recorded (14). The volume is reduced by premedication with atropine (50-100 mg), but its continued production (105 ml/100 kg/minute) means that the head should be tilted so that the mandibular symphysis is the lowest point, permitting natural drainage of saliva from the mouth rather than its entry into the larynx and trachea.

Practical measures to reduce the risk of regurgitation include, where possible, total starvation of food and water for 48 and 24 hours, respectively. Although these measures are more stringent than recommendations made elsewhere (4, 12) there is no evidence that fluid balance is seriously affected.

Futhermore a stomach tube should be passed via the nares into the oesophagus prior to anaesthetic induction, and immediately after any sedative medication (11). It has been suggested (4) that such a stomach tube should have an inflatable cuff: this requires a special design.

An alternative and preferable measure is to pass an endotracheal tube via the nares and into the oesophagus immediately after sedation and before the animals falls. This tube should then have the cuff inflated to prevent refluxed remenal contents passing between tube and oesophageal mucosa.

However, should aspiration occur into the larynx and upper trachea in light anaesthesia the persisting cough reflex tends to expel the material. In the smaller bronchi and bronchioles no cough reflex can be elicited. Aspirated material should be drained by gravity and, though it is recommended that inhaled material should be removed by active aspiration using a suction device and negative pressure, such equipment is rarely available for immediate use and could be useless due to the distribution of rumenal material into numerous small diameter airways.

In any case where aspiration is even remotely suspected, high level dosage with broad spectrum antibiotics (e.g. oxytetracycline) should be given for a minimum of 5 days. Severe systemic signs of bronchopneumonia and pulmonary oedema (pyrexia, anorexia, dyspnoea, bronchovesicular rales, etc.) may be seen after 24 hours and animals may die 48-96 hours following massive aspiration.

Rumenal tympany

Rumenal tympany is an ever-present hazard of G.A. of cattle. It is reduced by prior starvation. When cattle lie on the side the upper flank becomes distended at once. The effect is purely mechanical, but can severely impair normal diaphragmatic movement. Respiratory acidosis results with a severe reduction of blood pH and oxygenation. Problems arise later as fermentation of rumenal contents continues. The additional lack of rumenal motility associated with xylazine medication inhibits passage of material to the abomasum.

As a practical measure, rumenal tympany can only be effectively relieved by trocarisation in the left sublumbar fossa, as passage of a stomach tube frequently fails. Trocarisation has been recommended as a routine procedure at the start of any prolonged G.A. (4). The canula may have to be left in place and there is an obvious risk of localised peritoneal contamination by rumen contents. If time permits, a small rumenal fistula may be created by a 5 cm laparotomy incision and suture of the adjacent parietal peritoneum to an oblique area of rumenal wall after which the rumen is punctured by scalpel to create a 1 cm opening.

Poor oxygenation

Poor, inadequate oxygenation of the bovine lungs occurs as a result of mechanical interference with diaphragmatic movement mentioned above, but is also due to a ventilation-perfusion mismatch. As a result of gravity, more blood passes to the lower ventral lung in lateral recumbency. This lung is more severely compromised in terms of movement than the upper, dorsal lung. The result is that very poorly oxygenated blood from the ventral lung mixes with fairly well oxygenated blood from the upper dorsal lung giving a lowered systemic blood oxygenation and increased CO_2 retention (hypercapnoea).

Practical measures to deal with this problem are difficult to make. Again, reduction of the development of tympany is important. A good cardiac activity and a high blood pressure should be maintained by avoiding excessive doses of premedicants (tranquilizers, sedatives) and by the maintenance of a minimal level of anaesthesia compatible with effective operating conditions. It has been suggested (12) that, in circumstances where no anaesthetic machine is available, oxygenation may be improved by administering oxygen from a cylinder through a small stomach tube inserted via the ventral nasal meatus into the pharynx (15-25 liters 0_2/min) or into an endotracheal tube (10-15 liters O_2/min). I have no experience of the effectiveness of this step. The increased carbon dioxide retention and respiratory acidosis occurs despite little change in the minute volume (1). The respiratory rate is increased, the tidal volume reduced but, significantly, due to the considerable dead space, the animal re-inspires a considerable volume of expired air.

Use of a non-depolarizing muscle relaxant diallylnortoxiferin ("Alloferin"–Roche) together with controlled ventilation has been shown to maintain good oxygenation and to avoid respiratory acidosis (11). However, these are only practical measures in clinics and institutes, and not under field conditions.

Injuries

Injuries may occur during induction or recovery. Most injuries are to the skeletal system. Myositis or radial nerve injury occurs occasionally following prolonged lateral recumbency. As in horses, it is largely avoided by extending the lower limb forward, keeping the upper limb raised above the horizontal by straw bale support to encourage blood flow, and by judicious use of soft bedding material and foam pads, tyre inner tube, etc. under the forequarters. During recovery some animals are liable to experience excessive abduction of one or both hind legs and possibly to have hip dislocation. This is a particular problem in large animals after prolonged recumbency. It is avoided by tying the hind legs above the hocks by ropes with about 45 cm (18″) distance between the legs.

Drugs and Bovine General Anaesthesia

Calves

The use of pentobarbitone sodium in G.A. of calves is outdated. The prolonged recovery period, particularly in animals less than 2 months old, has made it a hazardous choice. The preferred mixture today is a combination of xylazine and ketamine hydrochloride.

Ketamine HCl is a dissociative anaesthetic which produces catalepsy, a state with light sedation and profound analgesia, although by itself it has the disadvantages of

causing hypertonicity and there are spontaneous muscle movements.

A suggested routine (again following 48 hours starvation and 24 hours restriction of water for such procedures as umbilical hernia repair in 6 month old calves) is 0.2 mg/kg xylazine intramuscularly followed 10 minutes later by 10 mg/kg ketamine HCl by rapid intravenous injection (13). Alternatively the two doses may be given mixed in the same syringe at a similar dose rate by the intramuscular route. Intubation may easily be performed with the aid of a long-bladed laryngoscope. Anaesthetic duration averages 20-30 minutes and can be prolonged by incremental injections of ketamine. This mixture has been shown to produce some hypotension, reduced ventilation and oxygenation (3, 9), and in the intubated calf on a closed circuit, it is useful to give supplemental oxygen at intervals (9). Alternatively the rebreathing bag should be squeezed (35-40 mm H_2O pressure) to produce a deep breath or sigh every 5 minutes to maintain adequate ventilation (2).

Adult Cattle

The hazards of G.A. appear to increase with the weight of cattle and are maximum in adult bulls where personal experience suggests that the mortality rate may approach 10%. The suggested procedure for general anaesthesia in premeditated surgery is:

1. 48 hours starvation of food.
2. 24 hours no water
3. 100 mg atropine sulphate subcutaneously
4. 0.1 mg/kg xylazine HCl intramuscularly
5. Oesophageal intubation by stomach tube or endotracheal tube.
6. Ten minutes following xylazine, 0.75 g/100 kg (cows) or 0.65 g/100 kg (adult bulls, e.g. 6.5 g for 1000 kg bull) thiopentine sodium by rapid intravenous injection.
7. Insertion of mouth gag (e.g. Drinkwater pattern) and endotracheal intubation by direct palpation of epiglottis and arytenoids, with or without initial endotracheal passage of a (guide) stomach tube.
8. If available, connection to closed or semi-closed anaesthetic circuit for maintenance with halothane/O_2 (0.5-2% halothane) with or without cyclopropane.
9. At the end of surgery the animal should be supported in sternal recumbency as soon as possible.
10. The endotracheal tube is only removed when there is a demonstrable cough reflex or spontaneous chewing movements. In removal of the tube, the cuff is kept inflated until it is in the pharynx. This avoids material in the proximal trachea, outside the tube, passing further down.

Xylazine sometimes results in an undesirably long period of recumbency with the potential hazards of severe tympany and respiratory embarrassment. Doxapram hydrochloride (Dopram V-A.H. Robbins) is an extremely effective analeptic given at a dosage of 1-2 mg/kg intravenously. In cattle given xylazine the injection of doxapram resulted in recovery in 1½-2 minutes, animals rising spontaneously and being able to walk (5). The safety margin is very wide, and convulsions have not been reported in clinical use. It may be necessary to repeat the dose 30 minutes later in some individuals.

Several major side-effects of xylazine including bradycardia, hopotension, reduced respiratory rate, lowered blood pO_2 and increased pCO_2 and reduced rumenal activity may be reversed by intravenous injection of tolazoline (Sigma St. Louis, USA, no. T.6886, 1.5 mg/kg bodyweight), as found in a single clinical study of 24 cattle (10). This product is not yet freely available.

Signs of General Anaesthesia

The lack of widespread experience of G.A. in cattle makes it necessary to list the clinical signs of state 3 plane 2 surgical anaesthesia. The signs differ somewhat from those seen in horses and small animals. Respirations are rapid, shallow and range from 40-60/min. Heart rate is increased to 100-130/min. Muscular relaxation is excellent and there is profound analgesia. Saliva production is reduced compared with light (plane 1) anaesthesia, as is lacrimal secretion. The corneal reflex is present, the palpebral is slow or almost absent, and the eyeball is partially rotated so that the pupil is level with the lower lid.

As anaesthesia deepens further, the eyeball rotates back to a normal position, salivary and ocular secretion ceases, respiration becomes irregular and gasping, the palpebral reflex is absent and the corneal reflex slow. Heart rate increases further and respiratory arrest is imminent.

Other Methods of General Anaesthesia

Inhalation anaesthetic agents such as ether (difficult to vaporise in adequate concentration), methoxyflurane (similar problems) and other fluorinated compounds such as isofluranl and enflurane, etc. (inadequate clinical experience to date) have not found widespread acceptance. Some practitioners retain old favourites. One Scottish practitioner (7) has claimed to have anaesthetised over 10,000 cattle over the last 30 years using chloroform in a semi-open (mask) system and has never seen the alleged complications of asphyxia, pulmonary oedema, excessive salivation and the regurgitation of rumenal contents. Oh happy man!

References

1. Becker, M. and R. Walti: 1980 Cardiac and respiratory effects of assisted ventilation during inhalation anaesthesia in cattle. (in German) Schweiz Arch. Tierhlk. 122, 287-299. 2. Blais-Difrucia, D., C.E. Short and R. Gleed: 1980 General anaesthesia in calves. Vet. Anaesth. 8, 2/3, 31-34. 3. Campbell, K.B., P.A. Klavand, P. Richardson and J.E. Alexander: 1979 Haemodynamic effects of xylazine in the calf. Am. J. Vet. Res. 40, (12), 1777-1780. 4. Hall, L.W. and K.W. Clarke: 1983 Veterinary Anaesthesia. Eighth edition. London. Bailliere Tindall. 5. Holenweger Dendi, J.A. and

H.L. Parada: 1981 Analeptic effect of Doxapram after Rumpun treatment in cattle. Vet. Med. Rev. (Bayer), no. 1, 70-74. 6. Lee, B.F.: 1979 The reflux of rumen contents into the oesophagus during anaesthesia. Proc. Assoc. Vet. Anaesth. G.B. & Ireland, no. 5, 55-57. 7. MacPherson, R.: 1979 General anaesthesia in cattle (letter) Vet. Rec. 104, 559-560. 8. Porter, A.R.W.: 1975 The Legal Aspects of death of a bull. Proc. Assoc. Vet. Anaesth. G.B. & Ireland no. 5, 58-62. 9. Rings, D.M. and W.W. Muir: 1982 Cardiopulmonary effects of intramuscular xylazine and ketamine in calves. Can. J. Comp. Med. 46, 386-389. 10. Roming, L.G.P.: 1984 Tolazoline as a xylazine—antagonist in cattle (in German) Dtsch. tierarztl. Wschr. 91, 154-157. 11. Schatzmann, U. and J.P. Held: 1977 Inhalation anaesthesia, controlled ventilation and muscular relaxation in cattle (in German) Scheiz. Arch. Tierhlk. 119, 447-452. 12. Trim, V.M.: 1981 Sedation and general anaesthesia in ruminants. Bovine Practitioner no. 16 (November), 137-144. 13. Waterman, A.E.: 1981 Preliminary observations on the use of a combination of xylazine and ketamine hydrochloride in calves. Vet. Rec. 109, 464-467. 14. Weaver, A.D.: 1971 Complications in halothane anaesthesia of cattle. Zbl. Vet. Med. A, 18, 409-416.

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Abstracts

Guidelines on the recognition of pain, distress and discomfort in experimental animals and an hypothesis for assessment

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Under the 1876 Cruelty to Animals Act it is necessary to recognize pain so that an assessment may be made to determine if it is 'an experiment calculated to give pain' and 'to prevent the animal feeling pain'. Under the conditions of the licence it is also necessary to recognize 'severe pain which is likely to endure' and 'suffering considerable pain'.

In the White Paper May 1983 (Command 8883) it is stated that: 'in the application of controls the concept of pain should be applied in a wide sense' and 'the Home Secretary's practice has been to interpret the concept of pain to include disease, other disturbances of normal health, adverse change in physiology, discomfort and distress'.

The draft European Convention for the Protection of Vertebrate Animals used for Experimental and other Purposes, aims to control, subject to specific exceptions, any experimental or other scientific procedure which 'may cause pain, suffering, distress or lasting harm'. (The White Paper states that UK control will be stricter than the Council of Europe proposals.) Thus, there is a considerable onus on the experimenter to recognize pain (not to define it) and to alleviate it.

It is intended that this article should be of help, not only to newcomers inexperienced in the recognition of pain, but also possibly to those relatively experienced workers who may be called upon to evaluate the pain involved in a new model or an individual animal. The clinical signs and observations detailed in this paper have been based on the experience of animal technicians, animal nurses, research scientists and veterinary surgeons who have looked after experimental animals for a number of years. Some of the signs referred to will appear conflicting and this may reflect the types of physiological abnormality that exist in a broad spectrum of progressive debilitation in an animal.

Anticipating when signs of pain may occur is an important part of minimising and preventing unintended suffering in animals. The prevention of pain by the use of analgesics at critical time periods is important but the effect these might have on the experiment should be considered. Analgesics may not affect the research but those that are anti-inflammatory or have central effects may be unacceptable and an alternative method of controlling the pain will have to be instituted.

If an animal is thought to be experiencing moderate or severe pain it is important that professional and experienced advice be sought as soon as possible. Good communication between all parties involved should lead to the prevention and effective treatment of suffering. An agreement as to the time (based on the signs) and methods of treatment should be reached before an experiment is started whenever possible and certainly after experience of a novel experiment has accrued. It should be noted that conditions such as pain and stress may introduce unwanted variables into an experiment and complicate the results obtained.

Use of an enzyme-linked immunosorbent assay in a bovine brucellosis eradication program

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SUMMARY: An enzyme-linked immunosorbent assay was developed and was compared with the complement fixation test (CFT) in a bovine brucellosis eradication program. The ELISA detected significantly more reactors than the CFT in both strain 19 vaccinated infected herds (1.79% versus 1.14%) and non-vaccinated infected herds (4.2% versus 3.59%) but not in either vaccinated or non-vaccinated brucella-free herds. The specificity for both tests in brucella-free herds was greater than 0.998. The specificity and sensitivity of the ELISA were compared with those of 3 other tests (the Rose Bengal test; the indirect haemolysis test [IHLT] and the CFT) on serum from 151 animals cultured at slaughter. The calculated specificity of the ELISA in this infected group was lower than for both the CFT and the IHLT (0.58 versus 0.67 versus 0.75). The sensitivity however was much greater (1.0 versus 0.73 versus 0.71). The value of the ELISA when used in an eradication program is discussed.