Anaesthesia in Cattle (I) — General Anaesthesia

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Introduction

Whilst there have been considerable advances in general anaesthetic techniques in the bovine species in the past 30 years, the procedure can give rise to a variety of problems. The problems are mainly related to the relatively unique anatomy and physiology of the digestive and cardiopulmonary systems of the bovine species. Whilst there is a considerable reluctance in some centres to use general anaesthesia, except in extremely rare or exceptional circumstances, this should not be the general approach. It is only by the refinement of and familiarity with techniques of general anaesthesia that progress can be made. If careful attention is paid to the physiological and pathological problems that are likely to occur, it is possible to carry out general anaesthesia in cattle in a relatively safe manner.

One of the first considerations of general anaesthesia in cattle is the problem of their size and temperament. These factors can have a marked influence on the choice of any particular anaesthetic technique. They can range in weight from around 30 kg for a new-born calf up to 1,000 kg for a mature bull of the larger breeds. The size of the animal will determine the type of anaesthetic equipment which is needed and also the amount of physical assistance and facilities that will be required. The temperament of a particular animal can have a profound effect on the anaesthetic technique. Young calves are usually easily handled and fairly docile. However, adult cattle and in particular bulls can be of extremely difficult temperament. This, by necessity, increases the need for a greater degree of both physical and chemical restraint with all of its attendant consequences.

As has already been suggested, the major problems associated with general anaesthesia involve the digestive and cardiopulmonary systems. However, what is less commonly appreciated is that there is often interaction between these systems which can give rise to major difficulties. This is illustrated by the fact that saliva and/or rumen content may cause respiratory obstruction. A further example is illustrated by the effect of ruminal distension on respiratory function.

It is a well established fact that adult cattle produce around 50 litres of saliva in 24 hours and that this process continues during general anaesthesia. However, there is no real quantitative information available as to the significance of any loss of saliva during general anaesthesia. The rumen occupies about three quarters of the capacity of the abdominal cavity and has a volume of up to 150 litres. In spite of the precipitous changes which may affect the rumen such as starvation before general anaesthesia, it is accepted that they are of limited significance in the normal healthy animal. When cattle are placed in sternal recumbency, changes occur in respiratory activity. The animals adjust their respiratory pattern by reducing the inspiratory frequency and prolonging the duration of inspiration. Clinical and experimental evidence indicates that the magnitude of these changes is considerably greater when animals are placed in dorsal recumbency. Ruminal distension with food, water or gas or a combination of these factors is likely to potentiate the problems produced by abnormal body position.

Anaesthetic and sedative drugs will affect the rumination mechanism and eructation will be subdued or abolished. Bloat can be minimized by changing the diet to hay at least 3 days before anaesthesia and by starvation for 24 hours. The problem of regurgitation and inhalation of rumen content is a constant consideration during general anaesthesia in cattle. The problem is minimized by withholding both food and water for 24-36 hours before induction of anaesthesia. There is a popular view which, in the view of the author is misplaced, that water should only be withheld for 6-9 hours. It is, in fact, the presence of a mainly liquid rumen content due to a normal/increased water content of the rumen that leads to an increased incidence of regurgitation of ingesta which consists mainly of water. It would appear that a more liquid rumen content is regurgitated with greater ease than a mainly solid one. The active process would appear to occur during light anaesthesia and the passive regurgitation during deeper planes of

This review of Anaesthesia in Cattle was prepared at the invitation of the Editor. Professor Jones will provide references by request. Anaesthesia (II) - Regional and Local Analgesia will be published in the next issue.

anaesthesia. The latter is probably of a more serious nature in that the protective laryngeal mechanisms will be reduced or even abolished by general anaesthesia. There is no firm evidence as to the most important factors associated with aspiration of ruminal contents which are likely to be the most deleterious to pulmonary function. These factors include pH, the size of the solid particles and electrolyte content.

Once general anaesthesia is induced in ruminant animals, it is essential that the trachea should be intubated with a cuffed tube as soon as possible. However, the anatomy of the upper respiratory tract makes endotracheal intubation a somewhat difficult procedure as it is very difficult to visualize the entrance to the larynx in cattle.

The induction of general anaesthesia and the production of recumbency in cattle is invariably associated with depression of respiration and an impairment of arterial oxygenation. Marked hypercapnia (rise in $p_a CO_2$) with a reduction in pH occur in recumbent and/or anaesthetised, spontaneously breathing cattle. Clinical experience would suggest that these changes are relatively greater than in a number of other species maintained at a similar anaesthetic depth. Another major complication is the problem of impaired arterial oxygenation. There are probably four main causes for this problem in anaesthetised cattle. They include hypoventilation, reduced inspired oxygen, diffusion limitation and ventilation/perfusion abnormalities. It is the latter condition which is likely to be of greater importance. The abnormal position of the anaesthetised and recumbent animal will produce a substantial maldistribution of the ventilation/perfusion ratio. The weight of viscera overlying the dependent lung, such as the diaphragm and gastrointestinal tract will have a significant deleterious effect on pulmonary function.

Prolonged recumbency, particularly in the lateral position, and associated with inappropriate positioning of the limbs will often result in an ischaemic myopathy in the postanaesthetic period in cattle. Traumatic damage to limbs may also occur during the induction of and recovery from general anaesthesia particularly if this is associated with incoordination in the larger animal.

Premedication and Sedation

There are a number of drugs which have been and are used for premedication and sedation in cattle. These include the anticholinergic drugs, the phenothiazine derivative tranquilizers, the alpha 2 adrenoreceptor agonists, chloral hydrate and other miscellaneous drugs.

It is well recognized that the anticholinergic drugs when administered to animals will decrease salivation, bronchial secretions and gastro-intestinal motility. They will also produce a tachycardia whilst reducing the risk of a bradycardia and possibly reducing the incidence of heart block. The administration of these drugs will also produce mydriasis of variable duration depending on the species. Classically it was accepted that the administration of these drugs was of little value in the ruminant species due to the fact that, whilst they certainly reduced the copious salivation in this species, they did not totally prevent it. In fact, animals were likely to produce a more viscous saliva which was much more difficult to remove from the mouth and pharynx. However, this philosophy is being questioned and the subject is in need of reappraisal particularly in relation to its use with intravenous combination agents such as xylazine, barbiturate/glyceryl guaiacolate mixtures. In addition, however, there has been a considerable move away from the routine use of anticholinergic drugs in veterinary anaesthetic practice and a reappraisal of their role. This is due mainly to the fact that their administration will produce a tachycardia and possibly dysrhythmia which will increase myocardial oxygen consumption. It also has to be considered in relation to the normal resting heart of an animal and its relationship to the state of anaesthesia. It has been demonstrated that the resting heart rate of the sleeping dog can be as low as 16 per minute.

Chloral hydrate has been used as a sedative agent in cattle for many years by a well tried and established technique. It is usually administered by the oral route either as a drench or by stomach tube. A dose of 30-60 gm is recommended for sedation in adult cows. However, there is a distinct difference in response between the sexes and adult bulls require a total oral dose of 120 - 160 gm to produce a similar degree of sedation to that produced in the cow by the lower dose. It is extremely interesting to note that this difference is not observed when chloral hydrate is administered to cattle by the intravenous route. The dose required for sedation of cattle with chloral hydrate administered by the intravenous route is in the range of 3 - 5 gm per 50 kg body weight. Intravenous injection is normally made into the jugular vein, utilizing a catheter in the standing, well restrained animal. The usual technique however is to cast the animal by Reuff's method and restrain it in lateral recumbency during the intravenous administration of the drug.

The use of chloral hydrate has been advocated for the sedation of bulls which are running free in a yard or paddock and are considered to be uncatchable. In such cases it is essential to withhold water for a period of 36-48 hours. The animal is then offered about 100 gm of the drug in 1 - 2 buckets of water. The method is often described but, in view of the particularly foul tasting nature of the solution, it is possible that the technique may not be all that easy to execute. It has been suggested that the description may even be of a somewhat apocryphal nature.

Until the relatively recent introduction of the alpha 2 adreno-receptor agonists, one of the few groups of drugs available to the veterinary surgeon for the sedation of a number of species were the phenothiazines. These included chlorpromazine, propionyl-promazine, acepromazine and promazine. Whilst there is a considerable degree of variation in the dosage of these drugs in cattle, their basic properties are very similar. The drugs, of which acepromazine is probably the most widely used, can be administered by either intramuscular or slow intravenous injection. They should not be used in depressed or hypovalaemic patients. Excessive dosage is likely to lead to hypotension due to their alpha adrenergic blocking action but they do confer some protection against cardiac arrhythmias. They also tend to reduce the stesss response in cattle. Whilst the administration of the phenothiazines will produce apparent signs of good sedation, the effect can be variable. Their use is generally not advocated for premedication before general anaesthesia as they tend to produce relaxation of the cardia and oesophageal musculature at the induction of anaesthesia and hence increase the incidence of regurgitation. In addition, they will increase the recovery period from general anaesthesia which can be extremely undesirable.

Alpha 2 adreno-receptor agonist drugs are widely used for their sedative properties in veterinary medicine. It is some 20 years since xylazine was introduced into clinical practice. The drug is very widely used in cattle practice due to the fact that it is very convenient to administer either intramuscularly or in small volumes by the intravenous route. In addition, it produces effective and dose related sedation. Pharmacokinetic studies in cattle have demonstrated that the agent has a relatively short half-life of 1.2 minutes. This effect was probably due to metabolism of the drug rather than rapid renal excretion of the unchanged compound. It has been suggested that the relatively long duration of action of xylazine is due to a long acting metabolite. Cattle appear to be much more sensitive to the effects of xylazine than most other species. In addition there would appear to be a marked breed variation in response. It has been shown that the duration of action of the drug is more prolonged in the Hereford breed than in Holsteins.

Xylazine may be used to produce sedation in the standing or recumbent animal. The effect is dose-related and recumbency will occur with higher doses. The drug may also be used for premedication before either intravenous or inhalation anaesthesia. The dosage of xylazine should be reduced in animals which are depressed or hypovalaemic. In addition, low doses should be used in newborn animals.

Xylazine administration is contraindicated in cows in the last trimester of pregnancy as it is likely to produce abortion or precipitate premature parturition. This is due to an oxytocin-like effect on the uterus with an increase in intra-uterine pressure. Both plasma glucose concentration and hepatic glucose production increase considerably after xylazine administration in cattle. A considerable increase in urine production occurs after xylazine administration with the greatest increase in the first hour following its administration. The hyperglycemia makes a significant contribution to the diuresis but the greater part of the diuresis is due to the suppression of antidiuretic hormone release. In light of this, animals which have a urethral obstruction should be carefully assessed before xylazine administration, as rupture of the urinary bladder may occur. Whilst xylazine impairs thermoregulation and produces hypothermia in some species, it is unlikely to be a problem in cattle apart from possibly the very young. It is also inadvisable to leave animals to recover from xylazine sedation in direct sunlight as hyperthermia may occur. Whilst animals under xylazine sedation do retain their ability to cough, eructate and swallow, these activities may be impaired. Animals must be closely watched during the recovery period to ensure that eructation does occur and excessive tympany is not present. Xylazine will decrease respiratory rate in calves and there have been reports of a reduction in the partial pressure of arterial oxygen and a rise in carbon dioxide. The drug also produces bradycardia in cattle. Whilst this can be reversed with atropine, the desirability of so doing has been discussed previously.

Mean arterial pressure will increase after xylazine administration and then slowly decrease and level out to return to normal. After many hours, xylazine administration produces a fall in cardiac output and an increase in peripheral vascular resistance.

A variety of compounds have been used to reverse the actions of xylazine in cattle. These include the non-specific stimulants such as doxapram and the more specific agents such as yohimbine. More recently the specific alpha 2 adrenergic antagonist such as idazoxan and atimpamezole have been shown to produce effective reversal of xylazine.

Detomidine has been used as a sedative agent in cattle but it is relatively expensive. The effects would appear to be dose related and somewhat more prolonged than those of xylazine. One distinguishing feature from xylazine is that it appears to produce less effect on the uterus and hence could be used in pregnant cows.

Pentobarbitone has been used for the sedation of nervous and/or excitable cattle and it would appear to be particularly useful as an adjunct treatment in hypomagnesaemia. It is given by slow intravenous injection and the effect is related to the dose.

Diazepan has been used to produce sedation in cattle when administered by the intravenous route. The high cost of the drug is likely to severely limit its usage.

Neuraleptanalgesic combinations such as the ones which are commercially available in some countries, a combination of etorphine with acepromazine have been used in cattle. Mixtures of xylazine and butorphanol have also been used in cattle. The results with all of these mixtures would appear to be somewhat variable.

The use of the opioid analgesic agents in ruminants is a subject which has received very little attention. It is likely that these animals are sensitive to pain in the pre-, peri- and post-operative periods. This whole subject of pain in food producing animals is in urgent need of rational study. At the present time, there is an increase in the utilization of the non-steroidal anti-inflammatory drugs such as flunixin in these animals.

Intravenous Anaesthesia

Whilst the vast majority of bovine surgery is carried out under general practice conditions utilizing sedation and regional and/or local anaesthesia, there are instances where general anaesthesia is essential. Under field conditions, anaesthetic agents administered by the intravenous route are the most appropriate for a number of reasons. The technique utilizes the minimum of equipment which is easily transported to the patient and such equipment is not expensive. **When utilizing intravenous agents for general anaesthesia, it is important for the veterinarian to be continually aware that the quoted and recommended doses are only guide-lines. A particular technique must be chosen and drugs administered to the requirements of the individual animal.**

Until relatively recently the choice of injectable anaesthetic agents for use in cattle under field conditions was extremely limited. Apart from chloral hydrate the choice was limited to the barbiturates. In the adult, the choice was in all practicality between thiamylal or thiopentone. However, with the development of such drugs as ketamine and guaiaphenesin the choice has been widened. The barbiturate group of drugs are extremely poor analgesics. Pentobarbitone is of limited value in bovine general anaesthesia as a large volume is required in adults. It also produces a prolonged and sometimes stormy recovery which is particularly evident if top-up doses are used. Its use is contraindicated in calves under one month of age. It does produce respiratory depression and care must be taken to ensure that this is not exacerbated by unsuitable positioning of the patient. **Endotracheal intubation is mandatory for all general anaesthetic techniques in cattle. This will ensure a clear air-way and prevent inhalation of any regurgitated rumen contents.**

Thiopentone and thiamylal are the most commonly used barbiturates in cattle and will produce satisfactory general anaesthesia. However, thiamylal is more popular in the United States and thiopentone in the United Kingdom. The popularity of thiamylal may be due to its relatively longer duration of action and higher potency. The most common side-effects are respiratory depression and cardiac dysrhythmias which in general are of relatively little significance in healthy animals. However, in cattle with compromised cardiovascular function, the use of these drugs is contraindicated but if they are used they should be administered with extreme care. In adults of the bovine species, a single dose of either thiamylal or thiopentone is used to induce anaesthesia of relatively short duration, or to enable endotracheal intubation to be performed before maintenance of anaesthesia with an inhalation technique. Until relatively recently, it was generally accepted that these agents should be administered by a rapid bolus injection. Recent experience would suggest that with adequate restraint and the judicious use of premedication, a relatively slow administration technique is to be recommended. This will certainly produce a better quality of induction of anaesthesia. Whilst catheterisation of the jugular vein is an essential requirement of all intravenous anaesthetic techniques, it is mandatory when a slow injection technique is utilized. Anaesthesia can be maintained by the use of incremental injections of thiobarbiturates. It will certainly prolong the recovery period. Premedication and the state of health of the animal will also be important factors which influence recovery from thiobarbiturate anaesthesia.

The drugs are commonly administered to cattle as a 5 or 10 per cent solution. It is not uncommon if catheters are not used for intravenous administration for extravascular injection to occur. If this happens, the area of injection should be infiltrated with up to one litre of fluid such as saline. Anaesthesia should not be attempted for at least 24 hours unless the procedure is vital and life saving. One of the commonest features of the administration of thiobarbiturates to cattle is apnoea of some 15 - 20 seconds but in general this is not a serious problem.

When death does occur under this type of anaesthesia, it is often related to respiratory depression due to an overdose. Inhalation of regurgitated rumen content is a not uncommon cause of death and hence endotracheal intubation is considered to be mandatory.

Methohexitone is an oxybarbiturate and is more potent than the thiobarbiturates. The administration of methohexitone as a bolus would appear to be somewhat unpredictable in its result. It is probably best administered by relatively slow intravenous injection.

Induction of and recovery from methohexitone when it is used as a sole agent can be accompanied by tremors and muscle movements which can occasionally proceed to convulsions. Hence it is best used with adequate premedication or in combination with another agent such as guaiaphenesin.

Guaiaphenesin is a centrally acting muscle relaxant which is administered by the intravenous route. When it is administered at doses within the clinical range, it produces a decrease in tidal volume and an increase in respiratory rate. It also produces a moderate degree of arterial hypotension and an increase in heart rate. However, when it is administered in excessive amounts it produces a profound hypotension and hypoxaemia. It is metabolized in the liver and excreted by the kidneys. It is recommended that a 5 per cent solution should be used in cattle due to the sensitivity of bovine red blood cells to the haemolytic effect of higher concentrations of guaiaphenesin. A combination of 50 gm of the compound with 2 gm of thiobarbiturate is administered slowly to effect by way of a catheter in the jugular vein. Once conditions are suitable for endotracheal intubation, a cuffed tube should be placed in the trachea.

Supplementation of the inspired air with oxygen is desirable particularly in the heavier animal. The anaesthetic period can be extended by intermittent infusion of the drug combination administered to effect. As an alternative to a thiobarbiturate, ketamine may be added to the solution of guaiaphenesin at the rate of 1 gm of ketamine to 50 gm guaiaphenesin. Alternatively guaiaphenesin may be administered to effect and a bolus dose of 1 - 2 mg/kg of ketamine administered.

Premedication with xylazine will substantially reduce the dose of either mixture required to induce general anaesthesia.

The use of ketamine in cattle is increasing in popularity. One of the main reasons for this is the fact that it can be administered in relatively small volumes by either the intravenous or intramuscular route. Whilst the administration of ketamine as a sole agent produces a number of undesirable side-effects, such as poor muscle relaxation and apneustic respiration, they can be eliminated by the judicious use of drug combinations such as xylazine and/or guaiaphenesin. A number of different regimes have been used for the administration of these drug combinations. The normal procedure in the adult is to administer xylazine by intravenous or intramuscular injection and this is followed at a suitable time interval by the intravenous administration of ketamine. Once anaesthesia has been induced, the trachea should be intubated. Anaesthesia after a single bolus dose of ketamine is relatively short and physical restraint together with regional or local anaesthesia may be required.

Anaesthesia may also be prolonged by the administration of small intravenous incremental doses of ketamine or infusion of a solution of ketamine, 2 mg/kl in 5 per cent dextrose.

Xylazine/ketamine combinations have been used relatively extensively in calves. The drugs are usually administered by the intramuscular route in combination. However, if the xylazine is administered 10 minutes before the ketamine, the duration of anaesthesia is reduced by some 50 per cent. Anaesthesia may be prolonged by the administration of incremental doses of the combination at one-half to one-quarter of the original dose. The larger dose can be used intramuscularly and the smaller one intravenously. Diazepam has been used as a substitute for xylazine in calves but it should be remembered that it produces very little analgesia.

Extensive experience from the University of Illinois would suggest that xylazine, ketamine and guaiaphenesin will produce safe and effective anaesthesia in cattle.

A mixture of ketamine 500 mg, xylazine 50 mg is added to a 500 ml container of 5 per cent guaiaphenesin. The mixture is infused at a rate of 0.55 ml/kg to induce anaesthesia and this is followed by a dose of 2.2 ml/kg/hour in adults and 1.65 ml/kg/hour. Muscle relaxation is excellent with this anaesthetic regime and produces good conditions for endotracheal intubation. Endotracheal intubation should be carried out in all animals and supplementary oxygen may be administered. Recovery is usually smooth and uneventful.

Inhalational Anaesthesia

Whilst inhalational anaesthesia has been available for use in ruminants in Veterinary Hospitals and Veterinary Schools, its use in a controlled manner is relatively new under general practice and farm conditions. It is generally accepted that a wide variety of surgery can be carried out under farm conditions with either sedation/regional anaesthesia or intravenous anaesthesia, but well administered general anaesthesia can provide excellent operating conditions and save time. It must be accepted that this form of anaesthesia does require considerable capital outlay for the purchase of equipment and adequate training in and familiarity with the techniques. Induction of anaesthesia can be achieved by a variety of techniques most of which have already been discussed. Induction of anaesthesia with an inhalational anaesthetic agent is rarely practiced in cattle due to their size, propensity to regurgitate and the production of large volumes of saliva. The technique may occasionally be used in young calves but preference is for the use of insufflation of an inhalation agent by a narrow bore tube placed up the nostril.

Endotracheal intubation with a cuffed endotracheal tube is mandatory for the proper administration of inhalation anaesthetic agents to cattle. The choice of the size of the tube can be estimated by external palpation of the larynx but this technique is certainly not infallible and a wide variety of sizes of tubes should be readily available before induction of anaesthesia. It is also essential to check that the cuff is intact before embarking on the procedure. The largest size tube which will fill the larynx/trachea without excessive force at its introduction should be used as the tube's internal diameter is the main factor in the resistance to respiratory movements by the anaesthetised animal. It is usually by experience that one is able to select the appropriately sized tube.

A variety of techniques have been described for directing the endotracheal tube into the larynx-trachea of cattle. One of the earliest techniques described the use of a guide tube over which the endotracheal tube was threaded. Following induction of anaesthesia, the animal normally falls into lateral recumbency but if it is not, then it should be placed in that position with the minimum of disturbance. Once the jaws are relaxed a wedge shaped gag such as a Drinkwater is placed firmly between the molar teeth on one side of the mouth. This is to prevent damage to the anaesthetist's arm/hand or the endotracheal tube when they are being passed through the mouth. The teeth of adult cattle are particularly sharp and it is easy to damage the skin of the anaesthetist even with a gag in place. The anaesthetist then introduces a relatively flexible tube, such as horse stomach tube into the pharynx, the epiglottis and arytenoid are palpated and the tube is then placed through the arytenoids into the larynx and into the pharynx. The hand is then withdrawn and the endotracheal tube is threaded over the guide tube and into the trachea. The guide tube is removed and the cuff of the endotracheal tube is inflated. Whilst the technique has been largely superseded by the direct manual introduction of the endotracheal tube into the larynx-trachea it is still practiced in some large beef breeds. The reason for this would appear to be the relatively small pharynx of these animals with little space for a large endotracheal tube and the anaesthetist's arm. The direct manual technique is similar to that described for the introduction of the guide-tube in that the hand and arm are introduced into the mouth and pharynx and the endotracheal tube is guided between the azytenoids with the fingers and on into the trachea. Direct palpation of the exterior of the larynx with one hand and its fixation with the thumb and finger of the same hand followed by introduction of the endotracheal tube through the mouth is practiced in some centres in small ruminants. It is a technique which can often be successful in calves but is rarely successful in adult ruminants. It requires considerable practice to be successful in the majority of cases, even in calves, and the passage is often aided by the use of a solid stiletto to stiffen the tube. The use of laryngoscopes has also been described for endotracheal intubation in cattle in order to directly visualize the larynx. A long and extended blade is required for use in the adult and a Rowson laryngoscope is available commercially. The head and neck is extended to ensure that the laryngoscope can be inserted into the mouth and on into the pharynx. The wedge-shaped gag is placed between the molar teeth to facilitate the insertion of the laryngoscope. Whilst the entrance to the larynx can be visualized it is extremely difficult to insert an endotracheal tube under direct vision. Hence, the "guide-tube" technique, as previously described is used. In calves a more conventional or human type laryngoscope with a special manufactured long blade or an extended adult blade is used and the tube is introduced into the larynx under direct vision.

On no account must a local anaesthetic lubricant be used on endotracheal tubes in cattle. This will leave the laryngeal and laryngeal mucosa anaesthetised for a considerable period and may extend to the recovery period. Hence the protective laryngeal and cough reflexes will be abated and regurgitated material may be inhaled into the respiratory tract.

Of the inhalational agents utilized in veterinary anaesthesia, nitrous oxide is the only commonly available gas. Its use in anaesthesia of the bovine species is very limited mainly due to their size and the potential for the creation of hypoxia. Its only real use is in small calves where it may be used as a carrier gas with oxygen to induce anaesthesia with an inhalational agent administered via a mask.

Halothane is a well established and widely used agent in veterinary anaesthesia. It is a non-flammable colourless liquid and should be administered to cattle in a closed circuit. Halothane produces a dose-dependent depression of the cardiovascular system. Whilst arterial blood pressure and cardiac output are depressed it does appear to have very little effect on heart rate. Halothane produces depression of ventilation and hypercapnia is very common in large adult cattle which are allowed to breathe spontaneously.

Methoxyflurane has been used as a general anaesthetic agent in cattle but due mainly to its high solubility and low volatility it is very inflexible in its use. Hence there is often a slow induction of and recovery from anaesthesia.

Whilst the two newer agents enflurane and its isomer isoflurane have been used to produce general anaesthesia in cattle, there is very little information in the literature. Their physical characteristics of a low solubility and the consequent rapid changes in anaesthetic depth may well be advantageous. As these agents are relatively expensive, there may well be considerable economic constraints on their use in cattle.

Clinical signs of anaesthesia in cattle tend to vary with the particular agent. The position of the eye and the nature of the eyelash reflex will provide useful information. During surgical anaesthesia the eyeball will be rotated downwards and eyelash reflex is extremely sluggish. The respiratory rates during general anaesthesia vary between 20 and 40 breaths per minute. However they can be in excess of 40 and this is most likely to occur in animals which are placed in dorsal recumbency. The heart rate in anaesthetised cattle varies between 45 and 80 beats per minute. However, in the presence of hypercapnia the rate may be higher. If, however, xylazine and ketamine are used for anaesthesia the rates may be lower i.e. between 50 and 60 beats per minute. A wide range of arterial blood pressures has been reported in cattle with a diastolic of 60 to 200 mm Hg. and a systolic of 120 - 280 mm Hg. Hence it is very difficult to be specific with regard to "normal values" in anaesthetised cattle. However, it is well accepted that halothane will produce a dose dependent reduction in arterial blood pressure and hence trends must be carefully monitored. Catheterisation of the median auricular artery is a relatively easy and well tried technique for the measurement of arterial blood pressure in cattle.

Inhalational anaesthetic equipment is not manufactured specifically for use in cattle. However, young calves, up to 100 kg in weight, can be anaesthetised utilizing equipment which is used for large dogs and/or adult humans. The equipment which is used for horses is suitable for adult cattle. It is usual to utilize a machine with the vaporizer outside of the circuit. In view of the large size of these animals a rebreathing circuit, utilizing soda lime for carbon dioxide removal is essential. Flow rates of approximately one litre per 100 kg are used and the excess gas is allowed to spill from the circuit. Scavenger systems should be used to reduce pollution of the atmosphere to a minimum or even zero.

Functional effects of a muscarinic receptor blockade during acute respiratory distress syndrome in double-muscled calves.

B. Genicot, F. Mouligneau, R. Close, P. Lekeux.
Veterinary Record (1994) 134, 110-113.

Eighteen Belgian white and blue double-muscled calves suffering from the acute respiratory distress syndrome were studied. Fifteen of the calves inhaled ipratropium bromide (0.6 mg) four times a day for three to four days, whereas the other three control calves inhaled sterile 0.9 per cent saline. All the animals were injected with ceftiofur sodium (1 mg/kg/day) for five days, the first injection being given one hour after the first inhalation of ipratropium bromide or saline. Arterial oxygen tension, alveolar arterial oxygen difference, carbon dioxide tension and arterial pH, respiratory and heart rates, oscillatory resistance and phase angle, measured by the mono-frequency forced oscillation technique, were recorded both before and one hour and 168 hours after the first inhalation. The measurement of oscillatory resistance and phase angle made it possible to resolve the impedance of the respiratory system into its real and imaginary components. The oscillatory compliance (Cosc) was determined from the imaginary component (Im). By one hour after the first inhalation of ipratropium bromide the oscillatory resistance was already significantly reduced and Im and Cosc had significantly increased, but the other parameters showed no significant improvement. However, between one hour and 168 hours after the first inhalation all the parameters reached physiological values. The control calves did not show any change. It was concluded that the pulmonary dysfunction associated with the acute respiratory distress syndrome in these calves was at least partly due to a severe bronchoconstriction. The stimulation of the muscarinic receptor population was at least partly responsible for this bronchoconstriction and that the administration of a non-selective muscarinic receptor blocker helped the smooth muscle fibres in both the central and peripheral airways to relax quickly.