XYLAZINE HYDROCHLORIDE AND KETAMINE HYDROCHLORIDE COMBINATIONS FOR GENERAL ANAESTHESIA IN SHEEP

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DECLARATION

(a) This thesis is my original work and has not been presented for a degree in any other University

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(b) This thesis has been submitted for examination with our approval as University supervisors.

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ABSTRACT

Xylazine and Ketamine combinations for general anaesthesia have been used in horses, cattle and goats. The literature available contained little research into the anaesthetic, analgesic, muscle relaxant and hematologic effect of the combinations in sheep. It was found desirable to investigate these parameters in sheep.

A total of 80 experiments were carried out on 60 sheep. The drugs were injected alone or in combination via the intramuscular and intravenous routes. Rompun^{R} (Xylazine Hydrochloride) was used at 0.22 mg/kg while Ketalar^{R} (Ketamine Hydrochloride) was injected at 11 mg/kg.

Pain sensation was tested for by pricking with a regular 19 G 1½ inch needle at the horn base, paralumbar fossa and coronet. Muscle relaxation, salivation and nystagmus were evaluated at regular intervals. Temperature, heart rate and respiratory rate were also taken at regular intervals. Jugular blood samples were regularly taken for hematologic examination.

Group and individual variations were observed in most of the experiments. Ketamine used alone intravenously and Xylazine used alone by either route failed to cause loss of pain sensation at the coronet of the feet. Both drugs when used either alone or in combination produced analgesia at the horn base and flank, the combination producing faster onset and longer

duration. There was a gradual but transient decrease in PCV, RBC and WBC both when the drugs were used alone and when used in combination. MCHC, MCV and differential WBC count were unaffected.

It is concluded that Xylazine and Ketamine are safe for general anaesthesia in sheep. However, the duration of anaesthesia is short and the degree of analgesia is variable for the different parts of the body. The use of the drugs in combination for general anaesthesia in sheep is recommended provided that the Veterinarian is aware of the limitations.

DEDICATION

I hereby dedicate this thesis to my parents Mr. Justus M. Byagagaire and Mrs. Dorcas N. Byagagaire, to my sister Miss Celia G. Byagagaire and to my brother Mr. Jimmy G.M. Byagagaire.

INTRODUCTION

The availability of a safe and effective general anaesthetic is of great importance to the practicing Veterinarian to enable him to carry out various operations many of which are life-saving.

The available, commonly used general anaesthetics have a relatively low safety margin in the ruminant because of the tendency of the ruminant to bloat which can be rapidly fatal. Bloating is due to the elimination, by these anaesthetics, of the pharyngeal and esophageal reflexes essential for eructation. To minimise bloating animals have been starved for periods of 24 to 48 hours prior to induction of anaesthesia.. However this method is not entirely useful in the ruminant especially in emergencies when the Veterinarian cannot delay an operation for this length of time.

Xylazine and Ketamine alone and in combination have been tried for anaesthesia in various domestic and non-domestic species including the equine, feline, canine, bovine, caprine, ovine and laboratory animals. The results of these experiments have shown both individual and species variation in anaesthetic, analgesic and other aspects. However, one consistent finding is that in the ruminant, bloating does not often occur. This is decidely due to the fact that these two agents do not eliminate the pharyngeal or the esophageal

reflexes and hence eructation can take place. These reflexes also remain intact in the monogastric species. Furthermore both these agents can be administered both by the intramuscular and intravenous routes a property not found in most other general anaesthetics.

This project was therefore designed to evaluate the use of Xylazine and Ketamine alone and in various combinations for general anaesthesia in sheep bearing the following major objectives in mind:-

1. To evaluate the sedative and analgesic effects of Xylazine used alone both intramuscularly and intravenously.

2. To evaluate the anaesthetic and analgesic effects of Ketamine used alone both intramuscularly and intravenously.

3. To evaluate the combined effects of Xylazine and Ketamine in various combinations both intramuscularly and intravenously.

4. To evaluate the effects of Xylazine and Ketamine used alone and in various combinations, intramuscularly and intravenously, on the blood picture.

LITERATURE REVIEW

XYLAZINE HYDROCHLORIDE

"Xylazine" is the British Veterinary Codex-approved non-proprietary name for 2-(2- 6-demethylphenylamine) 5-6-dihydro-4H-1, 3 thiazine (Clarke and Hall, 1969). Xylazine is also known as Bayer Val470 (Sagner et al. 1970) and by its trade name of Rompun^{R} (Bayer, Germany). It is available for both intramuscular and intravenous use.

The use of Xylazine has been reported in horses (Clarke and Hall, 1969; Keller, 1970), cattle (Clarke and Hall, 1969; Wittke et al., 1973; Rickard et al., 1974; Eichner et al., 1979; Lindley, 1980; Mbiuki, 1981), sheep (Seifelnasr, 1974; Souza de et al., 1975; Thurmon et al., 1978), goats (Kumar et al., 1976; Monzaly, 1976; Keller, 1978), dogs (Kilde et al., 1975), cats (Kral et al., 1975; Hatch and Ruch, 1974; Cullen and Jones, 1977), laboratory animals (Mulder and Mulder, 1979; Gilroy and Varga, 1980) and in Zoo or wild animals (Mulling and Hanning, 1971; Drevemo and Karstad, 1974; Mottelib and El-Gindi, 1975). The effect of Xylazine in pigs has been said to be too fleeting to be of any practical value (Hall, 1971).

Various dosages of Xylazine have been used. These include dosages of 0.22 mg/100 kg in cattle (Campbell et al., 1979), 2-3 mg/kg in horses (Clarke and Hall, 1969) and 0.2 mg/kg in cattle and sheep (Eichner et al., 1979; Nowrouzian et al., 1981). The commonly used dosages in sheep and goats have been

0.2 mg/kg or 0.22 mg/kg (Kumar et al., 1976; Keller and Bauman, 1978; Nowrouzian et al., 1981). This has been possible because of the wide safety margin of Xylazine (Mulling and Henning, 1971; Lindley, 1980; Nowrouzian et al., 1981).

Xylazine does not appear to cause any reaction at the site of an intramuscular injection (Clarke and Hall, 1969; Kosuch, 1975; Gilroy and Varga, 1980). This is of great advantage especially where the drug has to be administered to intractable animals. Xylazine may lose potency with storage in multidose bottles especially when air is allowed into the bottle when a dose is being withdrawn (Clarke and Hall, 1969).

SEDATION

The sedation produced by Xylazine has been described, with reference to cattle, as similar to that produced by Chloral Hydrate (Clarke and Hall, 1969). This sedation is "profound" and with a greatly diminished response to the environment (Campbell et al., 1979). The depth of sedation that Xylazine produces does not increase with dosage but increased dosages will prolong the duration of sedation (Clarke and Hall, 1969). Clarke and Hall (1969) have also found cattle to be more sensitive to Xylazine than horses.

In the ruminants sternal recumbancy is common and the animals tend to deviate their necks and heads to lie on the flank. They also appear drowsy or sleepy (Clarke and Hall, 1969).

Sheep have been said to be more resistant and goats more susceptible than cattle to the effects of Xylazine (Hall, 1971).

Xylazine-induced sedation in the horse is characterised by the horse lowering its head, its eyelid and lower lip drooping, and swaying on its feed although recumbancy is uncommon (Clarke and Hall, 1969; Muir et al., 1977). The horse becomes reluctant to move.

The onset and duration of Xylazine-induced sedation differs both between species and within species (Thurmon et al., 1978). Sedation in the calf occurs within 3 minutes of an intramuscular injection, and lasts well over 30 minutes (Campbell et al., 1979). Adult cattle go into deep sedation lasting 15-30 minutes (Clarke and Hall, 1969), but according to Thurmon et al. (1978) sedation in cattle lasts about 2 hours.

In horses a slow intravenous injection produces immediate sedation lasting 15-20 minutes with normal behaviour returning within 30 minutes while with the intramuscular route sedation develops in 10-15 minutes and lasts longer than with the

intravenous route. Sedation in sheep occurs within 5-10 minutes after an intramascular injection (Kosuch, 1975). Some reports indicate that Xylazine produces analgesia while others indicate an absence of demonstrable analgesia (Hall, 1971).

ANALGESIA

Clarke and Hall (1969) found no significant analgesia attributable to Xylazine in their studies in cattle except those very deeply sedated animals. Other authors however have found some level of analgesia. DeMoor and Desmet, (1971) found that Xylazine was sufficient for laparotomies although insufficient for operations on the distal limbs of cattle. Kosuch, (1975), found that analgesia was indeed a feature of Xylazine-induced sedation in sheep though insufficient for major surgery.

In cattle Thurmon et al. (1978), also found that Xylazine had some analgesic effects which they suggested were dose dependent and of shorter duration than the sedation effect. These authors suggested that the analgesic effect was due to the effects of Xylazine on the Autonomic Nervous System. Sagner et al. (1970), have put it that the analgesia due to Xylazine is comparable to that produced by Morphine and that Xylazine produces sedation rather than true anaesthesia.

MUSCLE RELAXATION

The muscle relaxation produced by Xylazine has been described as very good to excellent (DeMoor and Desmet, 1971; Mulling and Henning, 1971; Kosuch, 1975). This muscle relaxation has been thought to be due to inhibition of neuromuscular transmission by Xylazine (Aziz and Martin, 1979) which the authors found to be neither depolarising nor competitive. Thurmon et al. (1978), have suggested that the muscle relaxation may be due partly to the partial interneural blockade in the Central Nervous System.

AGONIST AND LOCAL ANAESTHETIC PROPERTIES

Xylazine has been shown to have agonist as well as local anaesthetic properties (Aziz and Martin, 1979). In their experiments using laboratory animals and frogs, the authors found that Xylazine caused contraction of the aortic strip, the anococcygeous muscle and the vas deferens which actions were antagonised by Phentolamine (an Imidazole derivative which acts as an alpha adrenergic blocking agent (Jones, 1965). Apart from the already mentioned neuromuscular blockade the authors have also found that Xylazine seriously blocked conduction in the frog sciatic nerve. It was these observation that led to the authors conclusion that Xylazine had agonist and local anaesthetic properties. These local anaesthetic properties of Xylazine have been used to explain some of its effects on the cardiovascular system (Aziz and Carlyle, 1979).

RESPIRATORY SYSTEM

Xylazine has been shown to have a depressant effect on respiratory system. Aziz and Carlyle, (1979) working with sheep, observed apnoea lasting 3-5 minutes, followed by a subsequent increase in the respiratory rate and volume. The authors attributed some of these effects to the local anaesthetic effects of Xylazine. Kosuch, (1975), observed in sheep a dose-dependant fall in respiratory rate though at no time did he observe these effects to be dangerous.

Muir et al. (1977) noted a 33% decrease in the respiratory rate of horses sedated with Xylazine. Clarke and Hall (1969) observed heavy "snoring" type respiration in horses. This type of respiration appeared more commonly during the recovery period than during the period of deep sedation.

In cattle the same authors noticed a marked fall in respiratory rate and breathing became deep and sometimes laboured. Rickard et al. (1974) observed a reduced respiratory rate in bulls where Xylazine was used as a sedative for electroejaculation. Kumar and Singh (1979) working with buffaloes got a reduced respiration rate in that species.

Presidente et al. (1973), found that Xylazine depressed the respiratory rate of captive white-tailed deer. While Drevemo and Karstad, (1974) reported the respiratory frequency

in Eland and Impala to be unstable and sometimes involving apnoea especially when they used Xylazine alone.

BLOOD GLUCOSE

Eichner et al. (1979) found an increase in blood glucose levels in beef cattle sedated with Xylazine. The authors suggested that this increase was probably due to an increased hepatic amino acid breakdown and also to a decreased plasma insulin level. This increased hepatic amino acid breakdown was apparently to produce glucose as the plasma urea nitrogen also increased temporarily. However, this made the authors conclude that Xylazine was not the ideal sedative when assays are to be taken when carbohydrate metabolism studies are to be carried out. Eichner et al. (1979) also reported no change in plasma free fatty acids.

Symonds (1976) reported, in cattle, a 200 percent increase in plasma glucose levels with a maximum at 40 minutes postdosing which did not start to fall until 185 minutes. The author also found a 400 percent increase in hepatic glucose formation greatest at 20 minutes after Xylazine dosing and with a return to control values at 150 minutes. Visceral glucose utilisation was found to be increased and the blood flow rates in the Hepatic and Portal veins was reduced by 50-60 percent of predosing values. The report concludes that the prolonged hyperglycemia which persists beyond 150 minutes was produced either by continued glucose

production from sites other than the liver and viscera or by reduced utilisation of the blood glucose by peripheral tissue.

In another report on cattle Symonds and Mallinson (1978) also found a persistant hyperglycemia. The conclusion reached was that Xylazine induced hyperglycemia arose from a combination of increased hepatic glucose production and reduced plasma Insulin concentration. The authors also suggested that it was possible that Xylazine interfered with either the rate of secretion of Insulin or with the ability of peripheral tissues to respond to Insulin. However, when adequate Insulin was available, blood glucose concentration rapidly decreased.

UROGENITAL SYSTEM

Xylazine was shown to increase the frequency and volume of urination in cattle (Thurmon et al. 1978). The authors also found that the urine output increased greatly during the first two hours after Xylazine administration especially in higher dosage groups. They also detected glucose in the urine starting 15-30 minutes after the Xylazine injection with a a maximum at 2 hours and with no glucose detectable in urine after 5-6 hours. This could be associated with the Xylazine induced hyperglycemia observed by Eichner et al. (1979). Thurmon et al. (1978) went on to observe that the pH of the urine decreased in all their experimental groups but had increased within 2-3 hours in the groups given

Xylazine. They concluded that Xylazine was not to be recommended in hypovolemic or dehydrated animals or those with urinary tract obstruction since the increase urine output may rupture their bladders. In trying to explain their findings Thurmon et al. (1978) said that the increased urinary output observed may have been due to Xylazine effect on one or more of the animals water conserving mechanisms, such as Anti-diuretic Hormone (ADH) either through its formation or its release, or as a result of its action on the distal tubules. Another possible explanation they put forward was the increased osmotic attraction of water into the renal tubules by their failure to reabsorb glucose.

Clarke and Hall (1969) also observed urination occuring especially during recovery in horses.

Thurmon et al. (1978) stated that Xylazine may induce parturition when administered to cows during their last trimester of pregnancy.

GASTROINTESTINAL TRACT

Xylazine depresses ruminal motility in sheep (Seifelnasr et al., 1974; and Souza de et al., 1975) and in cattle (Wittke et al., 1973). Souza de et al., (1975) found in sheep a 40% decrease in motility in the first 5 minutes, an increase in motility in the second 5 minutes a further decrease in the third 5 minutes and a return to normal in the fourth set of 5 minutes. Seifelnasr et al. (1974),

reported the effect at 2 dosage levels in sheep. Using the lower dose (0.1 mg/kg) the authors found a transient initial increase in the rate and force of ruminal contraction followed, after about 3 minutes, by a decrease in both the rate and the force of ruminal contraction for 30 minutes with subsequent complete recovery within 2 hours. At the higher dosage (0.2 mg/kg) they recorded an increase in contractability of the rumen at about 10 minutes, the rate of which decreased at about 15 minutes.

Keller (1970) found Xylazine to have no effect on the intestinal movements in horses.

CARDIOVASCULAR EFFECTS

HEART RATE

Xylazine has been observed to cause a second degree heart block in sheep (atrioventricular) lasting 3-5 minutes (Aziz and Carlyle, 1979), and also causes a decrease in heartrate. in horses and cattle (Clarke and Hall, 1969), buffaloes (Kumar and Singh, 1979), bulls (Kosuch, 1975), sheep (Rickard et al, 1974; Aziz and Carlyle, 1979; Aziz and Martin, 1979) and in a calf (Campbell et al., 1979). This reduced heart rate is probably due to depression of the myocardium (Campbell et al., 1979) possibly as a result of the local anaesthetic properties of Xylazine (Aziz and Carlyle, 1979; Aziz and Martin, 1979). This depression also leads to a decrease in the cardiac output and stroke volume (Aziz and Carlyle, 1979; Campbell, 1979).

Other authors attributed the electrocardiographic changes caused by Xylazine on hypothermia and hypoxia (Kral et al., 1975) and also to the effects of Xylazine on the Autonomic Nervous System (Kral et al., 1975; Campbell et al., 1979). These effects on the Autonomic Nervous System were a withdrawl of sympathetic tone, an increase in parasympathetic tone and a direct depression of the cardiac pacemarker and cardiac tissue. There was also an increased total peripheral resistance (Campbell et al., 1979) and a fall in arterial blood pressure (Drevemo and Karstad, 1974; Aziz and Martin, 1979).

BLOOD GAS VALUES AND pH

Changes have been reported in the arterial Oxygen and Carbon Dioxide tensions. Aziz and Carlyle (1979) recorded a decrease in arterial Oxygen tension, a marginal increase in the Carbon Dioxide tension and a decrease in the pH in sheep. However, Kilde et al. (1975) working with dogs, found no changes in the arterial Oxygen and Carbon Dioxide tension and also recorded no change in pH.

Kumar et al. (1978) reported that Xylazine is rapidly transfered across the placenta in pregnant goats leading to an increased heart rate and blood pressure in the foetus and also a decrease in oxygen tension and arterial pH with an increase in Carbon Dioxide tension. These effects were similar to those the authors found in the dam.

EFFECT ON BLOOD

Some changes due to Xylazine have also been reported in the blood cellular elements. Eichner et al. (1975) found in cattle an abrupt fall in Packed Cell Volume (PCV), Hemoglobin concentration (Hb) and total Red Blood Cell Count (RBC) with parallel drops of 20% within 1-2 hours and subsequent returns to normal within 24 hours. Presidente et al. (1972), working with Xylazine and Etorphine combinations, in captive White-tailed deer also found a decrease in PCV, Hb and RBC which was similar to that found by Seal et al. (1972) working with Xylazine and Phencyclidine in the same species. Seal et al. (1972) noted that Mean Corpuscular Volume (MCV) and Mean Corpuscular Hemogloblin Concentration (MCHC) did not change during immobilisation.

Mottelib and El-Gindi, (1975), working with buffaloes, reported a decrease in RBC, Hb and total leucocytes (WBC) a half hour after injection with Xylazine. The white cells decreased were the lymphocytes and Eosinophils while the Neutrophils increased with a left shift. The authors also observed an increase in the Blood Urea Nitrogen (BUN), Bilirubin and Creatinine. Seal et al. (1972) reported a decrease in blood cholesterol, fibrinogen and total protein in white-tailed deer.

On the other hand Keller, (1970), working with horses, found no change in blood values although single injections on 10 successive days caused a transient effect.

Drevemo and Karstad (1974) attributed the fall in PCV and the other blood cellular elements to a decreased heart rate and low blood pressure with resultant hemodilution by intestinal fluids. Eichner et al. (1979) suggested that the uptake, by the vascular system, of extravascular fluids may explain the reduction in PCV and RBC but no changes had been observed in plasma Na^+, K^+ or protein concentration.

Presidente et al. . (1973) had a similar view to Drevemo and Karstad, (1974) that the decrease in blood cellular elements was due to hemodilution by infiltration of intestinal fluids during immobilisation and also due to the fall in heart rate and blood pressure during immobilisation. The authors also went on to state that an early rise in PCV may be due to excitment during restraint. The fall in PCV and RBC count may also be due to the lytic effects of Xylazine (De Moor and Desmet, 1971).

Working on the effect of immobilisation in the White-tailed deer, Seal et al. (1972) attributed the fall in PCV Hb and RBC to either an increased plasma volume with no change in the circulating RBC mass or to a decreased circulating RBC mass. This increased plasma volume may have been produced by the fall in blood chlolesterol, fibrinogen and total protein as Na^+ and K^+ are not affected.

METABOLISM

Xylazine has been reported to be rapidly metabolised and broken down into several metabolites, organic sulphate

and Carbon Dioxide (Bayer, Germany). The authors of the booklet thought the pathway to be probably via 1-amino-2, 6-dimethyl benzine (ADB) formed by the breakdown of the Thiazine ring.

DEATHS

Clarke and Hall, (1969), reported the death of a 2 year old thoroughbred horse which had undergon a Hobday operation with Xylazine as the premedication before inducing with thiopentone and maintaining with Halothane/oxygen mixture. The horse died of ventricular fibrillation. However, they stated that although Xylazine may have contributed to this reported death, it seemed unlikely.

KETAMINE HYDROCHLORIDE

"Ketamine" is a rapid but short acting non-barbiturate injectable general anaesthetic belonging to the phenylcyclohexylamine group of compounds and derived from phenycyclidine (Thurmon et al., 1972; Thurmon et al., 1973; Cullen and Jones, 1977). It is chemically designated 2-(O-Chlorophenyl)-2-(methylamino)-2 cyclohexanone as a hydrochloride (Thurmon et al., 1972; Thurmon et al., 1973; Muir et al., 1977). Ketalar^{R} is the trade name and supplied as a 10% slightly acidic solution (Parke-Davis, Madrid, Spain) for both intramuscular and intravenous injection.

The use of Ketamine has been reported in horses (Muir et al., 1977; Hall and Taylor, 1981), cattle (Fuentes and Tellez, 1974; Fuentes and Tellez, 1976; Pezzoli and M. del Bue, 1976; Mbiuki, 1981); sheep (Taylor et al., 1972; Thurmon et al., 1973; Waterman and Livingstone, 1978; Nowrouzian et al., 1981); goats (Kumar et al., 1976; Keller and Bouman, 1978), pigs (Thurmon et al., 1972), dogs (Humphrey, 1971; Ploumis, 1979), cats (Cullen and Jones, 1977) and Laboratory animals (Livingstone and Waterman, 1978; Mulder and Mulder, 1979; Gilroy and Varga, 1980).

Various dosages have been used in the various species such as 20.2 $\pm$ 0.92 mg/kg body weight in swine (Thurmon et al., 1972), 22 mg/kg in cats (Cullen and Jones, 1977), 2 mg/kg in the cow (Fuentes and Tellez, 1974), 2 mg/kg in sheep (Taylor et al.

1972) and 2.2 mg/kg in the horse (Hall and Taylor, 1981). Kumar et al. (1976) and Keller and Bauman (1978) used Ketamine at 11 mg/kg in goats. Thurmon et al. (1973) went as high as 44 mg/kg in sheep. The dosage used ranged mainly between 2 mg/kg and 44 mg/kg.

Pain at the site of intramuscular injection has been reported in the dog (Humphrey, 1971) and in the Guinea pig (Gilroy and Varga, 1980) though the latter authors reported no adverse sequalae at these injection sites.

METABOLISM

Ketamine is rapidly eliminated in the body and this is mainly by metabolism predominantly taking place in the liver (Livingstone and Waterman, 1978; Waterman and Livingstone, 1978). The authors stated the pattern of metabolism to be first N-demethylation to produce Metabolite I and then Oxidation to produce Metabolite II. The authors also reported a third unidentified metabolite.

ANAESTHESIA

Ketamine produces a cataleptoid-type of anaesthesia described as "Dissociative Anaesthesia" (Thurmon et al., 1972; Fuentes and Tellez, 1974; Fuentes and Tellez, 1976; Kumar et al., 1976; Pezzoli and M. del Bue, 1976; Cullen and Jones, 1977; Muir et al., 1977). "Dissociative Anaesthesia" is defined as a term given to the cataleptic-like state produced in a subject by the injection of Ketamine (Thurmon et al., 1972).

Kayama and Iwama (1972) however, challenge the concept of Ketamine as a"Dissociative anaesthetic" because of some induced sensitive activity they observed during electro-encephalographic studies in the cat.

Pezzoli and M. del Bue (1976) reported Ketamine to produce a loss of conciousness in cattle while Fuentes and Tellez (1974) found no appreciable loss of conciousness in the cows they used.

ONSET AND DURATION OF ANAESTHESIA

In the cow,Fuentes and Tellez (1974) reported a rapid onset of dissociative anaesthesia after Ketamine was injected intravenously with the cows standing within 30 minutes of a saline/Ketamine drip being disconnected. Pezzoli and M. del Bue (1976) found cattle to stand 10-30 minutes after the discontinuation of a similar drip. Under similar circumstances, Taylor et al. (1972) showed pregnant sheep to stand within 10-15 minutes of the drip being removed.

Keller and Bauman (1978) found that goats injected with Ketamine via the intramuscular route took 3-11 minutes to go into recumbency and that recovery took 30-90 minutes with surgical anaesthesia lasting 20-85 minutes. Nowrouzian et al. (1981) reported maximum anaesthesia at 11 ± 6.5 minutes with surgical anaesthesia lasting 23 ± 12.05 minutes and recovery being complete within 68 ± 21.4 minutes in sheep injected intravenously with Ketamine.

Waterman and Livingstone (1978) carried out some experiments using Ketamine at varying intervenous dosage levels. The authors reported that at 2 mg/kg the sheep did not go into lateral recumbancy nor was there any evidence of analgesia and the sheep stood within about 8 minutes. At the dosage rate of 5 mg/kg anaesthesia/analgesia was attained. At the higher dosages of 11.2 mg/kg and 22 mg/kg the authors found more prolonged anaesthetic/analgesic times.

Maximum anaesthesia was reported by Humphrey (1971) to be attained within 6-10 minutes of intermuscular injection in dogs and lasted 18-26 minutes.

ANALGESIA

Ketamine anaesthesia has been said to produce profound analgesia in cattle and sheep (Pezzoli and M. del Bue, 1976; Taylor et al., 1972). Keller and Bauman (1978) reported that Ketamine gave surgical anaesthesia and analgesia in the goat. Nowrouzian et al. (1981) also showed analgesia with Ketamine used alone in sheep.

On the other hand Ketamine used alone even at very high doses (200 mg/kg) was reported as being considered ineffective for producing analgesia in rodents (Mulder and Mulder, 1979).

DEVELOPMENT OF TOLERANCE

Livingstone and Waterman (1978) showed that tolerance to Ketamine could develop on repeated use in rats. This tolerance *in vivo* was seen as a reduction in both sleeping time and the time to loss of the righting reflex. The authors also reported a more rapid decline in plasma Ketamine levels in the tolerant rats and also noted that recovery occured at almost exactly the same plasma Ketamine concentrations in tolerant and normal rats.

MUSCLE RELAXATION

Nowrouzian *et al.* (1981) found that with Ketamine used alone 20% of the experimental sheep showed moderate muscle rigidity while the rest showed marked muscle rigidity. Muir *et al.* (1977) stated that Ketamine administered singly in horses was postulated to cause excessive muscle tremors and non-purposeful movements. Humphrey (1971) reported relatively normal skeletal muscle tone in dogs under Ketamine anaesthesia though mild seizures did occur in 3 dogs not previously tranquillized. Cullen and Jone (1977) observed a poor degree of muscle relaxation in cats where Ketamine was the sole anaesthetic and some had hypertonus.

REFLEXES

A great advantage found with Ketamine as an anaesthetic has been said to be that it does not eliminate the laryngeal and pharyngeal reflexes essential for swallowing and eructation and hence bloating does not occur in the bovine (Fuentes and Tellez, 1974; Fuentes and Tellez, 1976; Pezzoli

and M. del Bue, 1976) or in sheep (Taylor et al., 1972; Nowrouzian et al., 1981). However Thurmon et al. (1973) recorded some regurgitation in sheep. Nowrouzian et al. (1981) also found the corneal and palpaebral reflexes to be intact in sheep.

In cats, Cullen and Jones (1977) reported incidents of vomiting while Humphrey (1971) also found the corneal reflex to be intact in dogs.

The palpaebral and corneal reflexes were found to remain in horses (Muir et al., 1977).

Gilroy and Varga (1980) found that in Guinea pigs the corneal reflex was lost.

SALIVATION

Fuentes and Tellez (1974) found Ketamine not to produce salivation in cows while Nowrouzian et al. (1981) reported mild salivation in 40% of their sheep. Taylor et al. (1972) also reported no salivation in pregnant sheep. Thurmon et al. (1972) however observed excessive salivation in all pigs not pretrated with Atropine.

TEMPERATURE

Kumar et al. (1976) found a mild fall in the temperature of goats but this was within normal ranges. Muir et al.

(1977) reported no change in the rectal temperatures of horses and Nowrouzian et al. (1981) observed no considerable change in sheep.

RESPIRATION

Humphrey (1971) reported a mild respiratory stimulation in dogs under Ketamine anaesthesia. Thurmon et al. (1972) found Ketamine anaesthesia in Swine to have less depressant action on the respiration than Barbiturate anaesthesia. Pezzoli and M. del Bue (1976) stated that the respiratory system of cattle was not markedly influenced by Ketamine.

In horses, Muir et al. (1971) reported respiration under Ketamine anaesthesia to have an irregular apneustic pattern while Hall and Taylor (1981) found a minimal depression.

In sheep Nowrouzian et al. (1981) observed a slight fall in the respiratory rate when Ketamine was used alone. Waterman and Livingstone (1978) on the other hand reported respiratory stimulation by Ketamine in sheep. The authors went on to state that the stimulation was probably due either to direct stimulation of the Medullary respiratory centre, or to its indirect stimulation via peripheral chemoreceptors, or secondary to activation of higher centres.

CARDIOVASCULAR EFFECTS

HEART RATE

Waterman and Livingstone (1978) reported an initial increase in the heart rate of sheep under Ketamine anaesthesia with a return to normal within 10 minutes. Nowrouzian et al. (1981) showed sheep to have tachycardia when maximal anaesthesia was attained. Humphrey (1971) observed only a mild cardiac stimulation in dogs.

Kumar et al. (1976) found goats to have a mild decrease in heart rate which was however within normal ranges.

Hall and Taylor (1981) reported no arrhythmias on electrocardiography in horses under Ketamine anaesthesia.

BLOOD PRESSURE

Ketamine has been shown to produce an initial, dose-dependant decrease in arterial blood pressure in sheep after intravencus injections (Waterman and Livingstone, 1978). The authors stated that the fall was probably due to a direct action of Ketamine on the myocardium.

BLOOD GASES AND pH

Muir et al. (1977) found Ketamine to have little effect on the blood pH and Carbon Dioxide values. Waterman and Livingstone (1978) on the other hand reported an intial increase in pCO_2 and a decrease in p O_2 and pH with all

returning to normal within 15-20 minutes. The authors concluded that Ketamine had a minimal effect on acid-base balance and that the initial mild respiratory depression responsible for these changes was compensated for by the blood buffer system.

BLOOD GLUCOSE

A significant increase in the mean value for blood glucose during Ketamine anaesthesia has been reported by Nowrouzian et al. (1981).

EFFECTS ON BLOOD

Nowrouzian et al. (1981) reported that in sheep during maximal anaesthesia the mean values for RBC, WBC, PCV, Hb and total protein were slightly decreased but returned to normal after recovery. The authors also observed that the percentage of Neutrophils and Lymphocytes increased slightly while the percentage of Eosinophils decreased and no obvious change was noted in the percentage of Monocytes and Basophils.

BLOOD CLOTTING TIME

Ploumis (1979) found that Ketamine produced no significant change in the blood clotting time in dogs.

DEATHS

Two deaths were reported by Thurmon et al. (1972) as having occured in boars after Ketamine anaesthesia. The authors however attributed the death to the Porcine Stress

Syndrome (Topel et al., 1968) rather than to the anaesthesia as the boars had already stood up.

Taylor et al.,(1972) also reported 2 deaths in ewes one from unknown causes after 24 hours and another from a catheter that disappeared into a Jugular vein. These deaths could not be directly attributed to the anaesthesia.

XYLAZINE HYDROCHLORIDE AND KETAMINE HYDROCHLORIDE COMBINATIONS

Xylazine has commonly been used with Ketamine in many species such as cats (Kral et al., 1975; Cullen and Jones, 1977), cattle (Fuentes and Tellez, 1976, Mbiuki, 1981), sheep (Nowrouzian et al., 1981), goats (Kumar et al., 1976; Keller and Bauman, 1978), horses (Muir et al., 1977; Hall and Taylor 1981) and laboratory animals (Mulder and Mulder, 1979; Gilroy and Varga, 1980).

ANAESTHESIA

The combination of Xylazine and Ketamine produces the same cataleptoid anaesthesia previously reviewed for Ketamine, varying only in characteristics reviewed below.

ONSET AND DURATION OF ANAESTHESIA

Hall and Taylor (1981), working with horses, found that Ketamine given intravenously after premedication with Xylazine, produced recumbency within 1½-2 minutes with the horses standing again within 33 ± 10 minutes. The authors noted that operating conditions were available for 20 ± 7 minutes. Muir et al. (1977), also working with horses and using the same dosage and route of administration, reported horses to have become recumbent within 30-60 seconds, were standing in 26.11 ± 8.21 minutes and analgesia lasting for 16.7 ± 7.3 minutes. When Muir et al. (1977) injected the two drugs using the same syringe they found

the time to recumbancy to be the same but the horses took a somewhat shorter time to standing (23.31 ± 6.12 minutes) although this was not statistically significant.

A report by Fuentes and Tellez (1976) on a cow undergoing a Caesarean Section under Xylazine/Ketamine anaesthesia showed that the patient in question took 45 minutes to stand after withdrawl of a Saline/Ketamine drip. However in this case stress may have been important in delaying standing.

Using the intramuscular route in goats, Keller and Bauman (1978) found that when Xylazine and Ketamine were used together induction time was 3-10 minutes, recovery being within 90-120 minutes and surgical anaesthesia lasting 50-85 minutes. Kumar et al. (1976), working with the same species, reported that the combination gave surgical anaesthesia lasting 40-45 minutes and that optimal results were to be obtained when Xylazine and Ketamine were used in the same syringe and supplemented with Ketamine alone.

Nowrouzian et al.,(1981) observed that in sheep premedicated with Xylazine induction took 3.2 ± 1.8 minutes with surgical anaesthesia lasting 67 ± 21.6 minutes and recovery being complete within 147 ± 40.2 minutes. In a futher experiment where the sheep were premedicated with both Xylazine and Atropine the authors noted no change in the induction time but the duration of anaesthesia and the time to recovery were reduced. Overall

the authors have shown that with premedication with Xylazine, induction time was reduced and the anaesthetic time and the time to recovery were prolonged.

In cats, Cullen and Jones (1977), showed an onset of anaesthesia of 6 minutes with Ketamine injected intramuscularly when the cats were premedicated with Xylazine and with or without Atropine. The authors also reported that supplementation of anaesthesiawas not necessary within 30 minutes of the Ketamine injection. The authors also noted that recovery from anaesthesia, when it began, was rapid.

Work in the Guinea pigs by Gilroy and Varga (1980) showed that the Ketamine and Xylazine combination produced an immobilisation time of 77.3 ± 14.6 minutes. The authors, however, stated that the extent of analgesia was questionable and did not recommend the combination in that species. Mulder and Mulder (1979) found the combination to produce adequate anaesthesia lasting 60-100 minutes in mice. These authors also reported that the mean anaesthetic time was 22 minutes longer in the females than in the males.

ANALGESIA

Kumar et al. (1976) found Ketamine with Xylazine premedication to be adequate for surgical interventions in the domestic goat. The same combination has been reported to provide excellent analgesia in the horse (Muir et al., 1977). Keller and Bauman

(1978) observed no pain response under Ketamine and Xylazine anaesthesia in goats. Fuentes and Tellez (1976) found the combination adequate for a Caesarean section in a cow.

MUSCLE RELAXATION

Xylazine greatly aids Ketamine in the attainment of good muscle relaxation essential for surgical intervention (Kumar et al., 1976; Cullen and Jones, 1977; Mulder and Mulder 1979; Nowrouzian et al., 1981). This muscle relaxant effect of Xylazine is not overriden by the central stimulation effect of Ketamine (Kumar et al., 1976).

Hall and Taylor (1981), however, reported that muscle relaxation was incomplete with Xylazine/Ketamine anaesthesia in horses.

Nowrouzian et al. (1981) observed complete muscle relaxation in all sheep treated with the Xylazine/Ketamine combination.

REFLEXES

Swallowing and eructation reflexes are maintained as with Ketamine and Xylazine used alone.

The palpaebral reflex has been reported to be maintained when the Xylazine/Ketamine combinations were used in cats (Cullen and Jones, 1977). Muir et al. (1977) observed that the palpaebral and corneal reflexes were maintained in horses. Nowrouzian et al.

(1981) noted the presence of the corneal reflex in 20% of sheep but also the loss of the eyelid and pedal reflexes. The authors also reported that the eyelid, corneal and pedal reflexes were intact when Atropine was used in the combination.

TEMPERATURE

Kumar et al. (1976) recorded a reduction in the temperature in goats but this was within normal range. Muir et al. (1977) noted a rise in the temperature of horses occuring during the recovery period. Nowrouzian et al. (1981) found no change in the body temperature in sheep.

RESPIRATION

Kumar et al. (1976) reported that a Xylazine/Ketamine combination produced a fall in the respiratory rate in goats though this was within normal range. Hall and Taylor (1981) showed only a minimal depression in the respiratory rates of horses. Nowrouzian et al. (1981), working with sheep, also found only a minimal depression; though at maximal anaesthesia the decrease was significant.

The respiratory depression has been suspected to be due to the effect of the Xylazine (Kumar et al., 1976).

Fuentes and Tellez (1976) found a marked tachypnoea in a calf born by Caesarean Section where Xylazine and Ketamine were the anaesthetics. This tachypnoea, however, soon returned to normal.

CARDIOVASCULAR EFFECTS

HEART RATE AND CARDIAC OUTPUT

Both Xylazine and Ketamine have a depressant action on the heart. Nowrouzian et al. (1981) showed that in sheep the combination also causes a fall in the heart rate but observed a rise in heart rate when Atropine was used in the same combination. The authors showed that the greatest fall was at maximal anaesthesia and was significant.

When the combination was used in horses by Muir et al. (1977) they recorded no depression of cardiac output.

BLOOD GASES AND pH

Muir et al. (1977) found the Xylazine/Ketamine combination to have little effect on pH and blood gas values other than a mild shortlived fall in arterial p O_2 5 minutes after the Ketamine injection and an equal mild and shortlived rise in p CO_2 at the same time.

EFFECTS ON BLOOD

Nowrouzian et al. (1981) using sheep showed that Ketamine and Xylazine produced a significant fall in the mean values of RBC, WBC, PCV and Hb at maximal anaesthesia and that these values did not return to normal as fast as when Ketamine was used alone. The authors also observed a slight neutrophilia and lymphopenia resulting in a significant decrease in the total WBC.

BLOOD PRESSURE

Hall and Taylor (1981) found the combination to maintain a good mean arterial blood pressure in horses.

A BRIEF REVIEW ON SOME OF THE OTHER INJECTABLE GENERAL ANAESTHETICS THAT HAVE BEEN TRIED IN SHEEP

THE BARBITURATES

The Barbiturates are a group of drugs derived from Barbituric acid (Booth, 1965; Hall, 1971) and divided into four groups namely long acting, intermediate acting, short acting and ultrashort acting depending on their duration of action (Booth, 1965).

Theories as to their mode of action fall into two main groups one involving the Cytochrome C-flavoprotein mechanism whereby Barbiturates are believed to inhibit the action of Cytochrome Oxidase and the other involving the Barbiturates preventing the synthesis of Acetylcholine (Booth, 1965).

In general, Booth (1965) stated that Barbiturates depress the cortex and possibly the Thalamus. The author went on to say that the Barbiturates cause only a slight depression of respiration in small doses but a marked depression in large doses, while at the same time they were unlikely to cause direct myocardial toxicity although a fall in blood pressure was present. Furthermore, the author reported that while the Barbiturates did cause a depression in gut motility, they did not completely relax the abdominal musculature. The author also contends that the drugs have no direct or significant effects on the kidneys or liver.

Those Barbiturates that have been used in sheep include Methohexital Sodium (Stewart, 1965; Robertshaw, 1966; Hall, 1971), Pentobarbitone Sodium (Rae, 1962; Kraner et al., 1964; Booth, 1966, Irwin and Briel, 1966; Hall, 1971) and Thiopentone Sodium (Rae, 1962; Kraner et al., 1964; Hall, 1971).

1. METHOHEXITAL SODIUM

Methohexitore is an Oxybarbiturate (Robertshaw, 1966). Robertshaw (1966) and Hall (1971) reported its use as being given by rapid intravenous injection as a 2.5% solution while Steward (1965) applied it as an intravenous infusion. The former authors found induction of anaesthesia to be smooth and rapid occuring within 10-15 seconds, lasting 5-7 minutes and with the sheep standing within 10-14 minutes.

Hall (1971) stated that recovery may be accompanied by jerking and convulsive movements and both Robertshaw (1966) and Hall (1971) stated that the animals were very sensitive to noise during recovery.

All the authors above found Methohexitone to be a safe anaesthetic in sheep and Robertshaw (1966) reported that he never observed apnoea. Steward (1965) suggested that an endotracheal tube with an inflatable cuff be used.

2. PENTOBARBITONE SODIUM

Pentobarbitone is a short acting Barbiturate (Booth, 1965) whose use in sheep and goats has been reported by several authors

(Rae, 1962; Kraner et al., 1964; Booth, 1965; Irwin and Briel, 1966, Hall, 1971; Garner and Coffman, 1974).

Rae (1962) using a dosage of 20 mg/kg found sleeping time to be 25 ± 4 minutes while Irwin and Briel (1966) using a dosage of 6.8-34.3 mg/kg observed surgical anaesthesia to last 3-60 minutes. Garner and Coffman (1974) applied Pentobarbitone at a rate of 1-2 mg/lb and reported that the drug was not a potent analgesic. Booth (1965) working with goats, found that satisfactory surgical anaesthesia was obtained with about 600 mg Pentobarbitone intravenously and that the goats were standing within 2-3 hours.

Irwin and Briel (1966) believed that starving of sheep for over 24 hours increased the hazard of regurgitation without further relief of pressure on the diaphragm. The authors went on to state that it was difficult to predict the exact dosage for adequate surgical anaesthesis but never-theless the drug was both safe and reliable.

Hall (1971) wrote that Pentobarbitone was satisfactory for short operations but inadequate, when used alone, for abdominal surgery. The author also stated that most preperations of Pentobarbitone contained Propylene Glycol which caused hemolysis and hematuria in goats and sheep.

Detoxification of Pentobarbitone occurs especially in the liver and is rapid (Hall, 1971).

3. THIOPENTONE SODIUM

Thiopentone is an ultra-short acting Sulphur-containing Barbiturate (Booth, 1965, Hall, 1971). It is used only via the intravenous route and preferably as a 5% solution (Booth, 1966).

Anaesthesia produced by Thiopentone has been described as being smooth, rapid and not accompanied by exitement on induction (Hall, 1971). The author recommended that the intravenous injection be done over a period of 30-60 seconds until apnoea, which was said to last about 15 seconds, occured. The author also reported a progressive onset of muscle relaxation.

Garner and Coffman (1974) used a dosage of 1-4 mg/lb and warned that the drug was more dangerous in lambs under 3-4 months old.

Booth (1965) writing on goats, suggested a dosage of 9-10 mg/lb and that salivation be controlled using Atropine sulphate at 15 mg/50 lb intramuscularly. The author stated that Thiopentone, and all the ultra-short acting Barbiturates, have their actions terminated by redistribution.

CHLORAL HYDRATE

Chloral Hydrate was the first injectable anaesthetic to be used (Garner and Coffman, 1974). The drug is derived

from the chlorination of Acetic Aldehyde followed by the hydration of the product, Trichloracetaldehyde (Booth, 1965).

Chloral Hydrate has been used in general anaesthesia mainly for induction, and most often in horses (Hall, 1971). Booth (1965) maintains that the drug is best used as a hypnotic since the anaesthetic dose approaches the Minimum Lethal Dose (MLD) and causes severe depression of the respiratory and Vasomotor Centres.

Garner and Coffman (1974) wrote that a small dose of Chloral Hydrate would produce sedation or hypnosis while a large dose would produce basal narcosis with depression of the respiratory centre and finally the myocardium. The authors also believed that high doses may cause mild liver damage.

Being alkaline, Chloral Hydrate has been reported to be irritant to extravascular tissues (Booth, 1965; Hall, 1971; Garner and Coffman, 1974). Hall (1971) also reported the disadvantage of prolonged recumbancy in anaesthetic cases in horses of up to 2 hours, and Booth (1965) maintains that the drug has a low pain-relieving power. The latter author also suggested that a concentration of not more than 7% be used while the former author used a 20% solution.

Garner and Coffman (1974) described the metabolism of Chloral Hydrate as being conjugation, especially in the liver, with Glucuronic acid into Urochloric acid which, the authors stated, was excreted in urine within 2-18 hours.

Chloral Hydrate has been used in cojunction with other injectable anaesthetics such as Magnesium Sulphate and Pentobarbitone (Hall, 1971; Rebesko and Mahmood, 1975).

Rebesko and Mahmood (1975) used a mixutre of a 10% solution of Chloral Hydrate and a 10% solution of Magnesium Sulphate and found that a dose of 2.5 ml/kg was adequate to produce surgical anaesthesia with only a slight transient phase of excitement. The authors believed this mixture to be relatively non-toxic and non-irritant and without serious depressant effect on respiration or heart action.

Hall (1971) recorded that a Chloral Hydrate-Magnesium Sulphate -Pentobarbitone mixture in minimal doses produced surgical anaesthesia in horses lasting 15-30 minutes while an extra 15% of the dose prolonged anaesthesia for 40-60 minutes. The author also reported that muscle relaxation in such cases was good and that recovery was rapid.

MAGNESIUM SULPHATE

Magnesium Sulphate is chemically $MgSO_4.7H_2O$ (Garner and Coffman, 1974).

Magnesium sulphate has been said to produce a complete loss of excitability in the Central Nervous System (Booth, 1965), analgesia and, in high doses, anaesthesia by action on the entire Central Nervous System (Garner and Coffman, 1974). The drugs muscle relaxant properties have been attributed to its blocking the neuromuscular junction (Garner and Coffman,

1974) while its general anaesthetic action has been said to be different from that of other general anaesthetics (Booth, 1965).

Booth (1965) regarded Magnesium Sulphate as being unsatisfactory alone although the author conceeded that anaesthesia does occur and also contended that the drugs margin of safety was narrow.

Booth (1965) reported that an intravenous injection of Magnesium Sulphate produced an immediate severe and often fatal respiratory and cardiac depression although the cardiac effects were only serious after doses that caused respiratory arrest. Garner and Coffman (1974) stated that an overdose of Magnesium Sulphate resulted in a marked myocardial depression which disturbed intraventricular conduction causing peripheral vasodilation and hence a dramatic fall in blood pressure.

Magnesium sulphate has been used with other injectable general anaesthetics such as Chloral Hydrate (Hall, 1971; Rebesko and Mahmood, 1975), and with both Chloral Hydrate and Pentobarbitone (Hall, 1971).

MATERIALS AND METHODS

1. LOCATION

Experimental work took place at the University of Nairobi Faculty of Veterinary Medicine, Veterinary Clinic located at Kabete, Nairobi.

Kabete lies at approximately $1^{o}16$ 'S and $36^{o}44$ 'E at an altitude of 1,932 meters above sea level. Average daily temperature during the experimental period, January to July was $19^{o}C$ while the relative humidity had a daily average of 63 percent.

2. EXPERIMENTAL ANIMALS

The experimental animals used were sheep of the Dorper breed purchased from Katheka-Kai Co-operative Society Limited and from Mr. Musau both of Machakos District, Kenya. The sheep were then transported by lorry to Kabete some 48 kilometers away.

Sixty (60) sheep were purchased for the experiments 30 being castrated males and 30 being female. The sheep aged between 9 and 15 months and weighed between 16 and 36 kg.

These sheep were then randomly seperated into 6 groups designated 1, 2, 3, 4, 5 and 6 each group having an equal number of males and females. The sheep were ear-tagged within their groups such that the first in group A bore the ear-tag number 1 while the last in group F bore the ear-tag number 60.

The sheep were housed in seperate stalls each group having its own stall.

Each sheep then underwent a thorough physical examination to ensure that it was in good health. Blood and fecal samples were taken for laboratory screening. The blood results showed healthy sheep but fecal samples revealed the presence of round-worm eggs and tapeworm segments which were dealt with as is shown later.

3. HOUSING, FEEDING AND ROUTINE TREATMENTS

Each group of ten animals was housed in a stall 3 x 3.75 meters of floor space, 2.5 meters as the shortest height from the ground to the roof, and having at least one open window of dimensions 0.6 x 0.85 meters and located above the half- door.

The feeding regime consisted entirely of Hay[1/] (the predominant grass type being (Chloris gayana) with Maize Bran[2/] fed then twice daily. Water and Mineral Bricks[3/] (one per stall) were available ad libitum.

On arrival each sheep was dosed with Thibenzole[R] [4/] to decrease the worm burden and then dosed with Mansonil[R] [5/] against tapeworms.

1/ Hay - Vet. Faculty Farm, Kabete, Nairobi

2/ Maize Bran - Unga Ltd., Industrial Area, Nairobi

3/ Mineral Bricks (Maclick[R]) - Twiga Chemical Industries Ltd. P.O. Box 30172, Nairobi.

4/ Thibenzole[R] (Thiabendazole) - Merck Sharp and Dohme Ltd., Hoddesdon, Hertfordshire EN11 9BU, England.

5/ Mansonil[R] (Piperazine) - Bayer, Germany.

On the day of arrival and for a total of 3 consecutive days the sheep were treated prophyllactically with Combiotic[R] 6/ as a precaution against Pneumonia which was commonly observed in other sheep transferred from warm to cooler areas.

From then on deworming with Thibenzole[R] was done at least once a month. Enteritis due to Coccidia was observed in a few of the sheep and these were treated with Vesadin[R] 7/ 5 gm tablets.

4. EXPERIMENTAL DRUGS

4.1 ROMPUN[R] (XYLAZINE HYDROCHLORIDE)

Rompun[R] is manufactured by Bayer, Germany. It is chemically designated 2- (2, 6 dimethylphenylamine) 5-6-dihydro -4H-1, 3-thiazine hydrochloride (B. Vet. C.) and is supplied as a 2 percent solution for either intramuscular or intravenous injection in ruminants, horses, cats and dogs. Xylazine is classified as a sedative. In these experiments Xylazine was used at a dosage rate of 0.22 mg/kg. body weight.

4.2 KETALAR[R] (KETAMINE HYDROCHLORIDE)

Ketalar[R] is manufactured by Parke-Davis Laboratories, S.A.E., Madrid, Spain. It is chemically designated dl-2-

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6/ Combiotic[R] (200,000 i.u. Procaine Penicillin G plus 250 mg Dihydrostreptomycin sulphate per millilitre of aqueous suspension).
Agricultural Division, Pfizer Inc., New York 10017, U.S.A.

7/ Vesadin[R] Sulphadimidine B.P. (Vet.) and Sulphadimidine Sodium B.P. (Vet.) - May and Baker Ltd., Dagenham, England.

(O-Chlorophenyl) -2(Methylamino) cyclohexanone hydrochloride. The preparation used was a slightly acidic (pH 3.5-5.5) solution at a concentration of 100 mg/ml. This preparation can be used for both intramuscular and intravenous injection or infusion. Ketamine is classified as a non-Barbiturate parentral general anaesthetic. In these experiments Ketamine was used at a dosage rate of 11 mg/kg body weight.

5. EXPERIMENTAL PARAMETERS

At no time prior to the administration of the relevant drug(s) were the sheep put off-feed (starved).

Each sheep was subjected to only one trial with any given drug. However group A was subjected to trials with Rompun^{R} alone intramuscularly and then after a rest of at least 2 weeks they were subjected to trials with Ketamine alone via the same route. The same was done with group D but this time intravenously. By this method the total number of trials was brought up to eighty (80).

"Time zero" was taken as the time when the first drug was injected.

5.1 BLOOD SAMPLES

3 ml EDTA [8] blood was collected from the Jugular vein 15 minutes prior to time zero, 15 minutes after time zero, 30 minutes after the sheep was able to stand unaided and 24 hours after the experiment. Slides for differential white cell count were made from each of the samples and stained with 1:5 Giemsa stain and stored for later study when time, was available. Cell counts and other hematological determinations were done as soon as possible and in any case not more than 24 hours later in which case samples were refrigerated at + 4^{o}C. Analytical methods are discussed later in this text.

5.2 NATURAL PARAMETERS

5.2.1 TEMPERATURE

Rectal temperatures were taken 15 minutes before time zero and at 15 minutes intervals after time zero until the sheep stood up. Temperatures were taken using a Centigrade thermometer.

5.2.2. HEART RATE

Heart rate in beats/minute was taken 15 minutes before time zero and at 5 minute intervals after time zero until the sheep stood up. Heart rate was taken using a Stethoscope [9] on the cardiac region of the chest.

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[8] EDTA (Ethylene-diamine Tetra-acetic acid Sodium salt - an anticoagulant) - Howse and McGeorge Ltd., P.O. Box 72030 Nairobi.

[9] Stethoscope - Litman^{R} - U.S.A.

5.2.3 RESPIRATORY RATE

The respiratory rate was taken by observation of flank movements corresponding to inspiration and expiration and recorded as breaths/minute. The rate was taken 15 minutes before time zero and at 5 minutes intervals after time zero until the sheep stood up.

5.3 PAIN SENSATION

Pain sensation was tested for 15 minutes prior to time zero and at 5 minute intervals from time zero until all pain sensation returned. The testing criterion used was reaction to pain inflicted by pin-pricks using a regular 19 Gauge 1½ inch needle at the base of the horn (either left or right) in the paralumbar fossa and at the coronet of a foot. At the horn-base movement of the head constituted a reaction. At the flank of tensing of the flank muscles was taken as a reaction while at the coronet a limb withdrawal reflex constistuted a reaction.

5.4 MUSCLE RELAXATION

Muscle relaxation was tested for by flexing the uppermost hindlimb and levels of relaxation were designated -, +, ++ and +++ indicating Absent, Weak, Fair and Good respectively.

5.5 NYSTAGMUS

The position of the eyeball was noted every 5 minutes after time zero until the sheep stood up.

5.6 TIMES RECORDED

5.6.1 WEAK TIME

This was taken as the time from time zero to when the sheep started staggering.

5.6.2 STERNAL TIME

This was taken as the time from time zero to the time when the sheep progressed to sternal recumbency.

5.6.3 LATERAL TIME

This was taken as the time from time zero to the time when the sheep progressed to lateral recumbency.

5.6.4 UP TO STERNAL TIME

This was taken as the time from time zero to the time when the sheep returned to sternal recumbency after having been in lateral recumbency.

5.6.5 ATTEMPT TO RISE (FROM INJECTION) TIME

This was taken as the time from time zero to when the sheep first attempted to rise.

5.6.6 ATTEMPT TO RISE (FROM STERNAL) TIME

This was taken as the time from when the sheep went down to sternal recumbency to the time when it attempted to rise.

5.6.7 STANDING TIME

This was taken as the time from time zero to the time when the sheep was able to stand unaided.

5.6.8 DOWN TIME

This was taken as the time from when the sheep progressed down to sternal recumbency to when the sheep was able to stand unaided.

5.6.9 SALIVATION TIME

This was taken as the time from the onset of salivation to the cessation of salivation.

6. EXPERIMENTAL PROCEDURE

6.1 GENERAL PROCEDURE

20 minutes or so prior to the administration of any drug the sheep in question was isolated from its group, weighed and placed in a stall left vacant for this purpose. The stall was devoid of all else except a table in one corner on which all essential equipment and data sheets were placed, and some hay in another corner where over-excited sheep were first allowed to graze to calm down.

At 15 minutes before time zero an EDTA-blood sample was taken from one of the Jugular veins. The temperature, heart rate, respiratory rate and pain sensation were noted as previously described.

At time zero the first drug or mixture of first and second drug was injected via the appropriate route. Thereafter until the sheep stood up heart rate, respiratory rate, pain sensation and the position of the eyeball were noted every 5 minutes while rectal temperatures were taken every 15 minutes.

If the second drug was to be injected after the first then this was done at 10 minutes. At 15 minutes another EDTA blood sample was taken and then another 30 minutes after the sheep was able to stand unaided and the final sample taken 24 hours later.

6.2 EXPERIMENTAL GROUPS AND TREATMENTS

The 60 sheep were divided into the groups as previously stated and subjected to trials as follows:-

6.2.1 GROUP A

6.2.1.1 These sheep were first subjected to trials using Xylazine alone via the intramuscular route.

6.2.1.2 After a period of rest of at least 2 weeks these sheep were then subjected to trials using Ketamine alone intramuscularly.

6.2.2 GROUP B

These sheep were subjected to trials using first Xylazine intramuscularly followed 10 minutes later by Ketamine also intramuscularly.

6.2.3 GROUP C

These sheep were subjected to trials using Xylazine and Ketamine combined in the same syringe and injected intramuscularly.

6.2.4 GROUP D

6.2.4.1 These sheep were first subjected to trials using Xylazine alone via the intravenous route.

6.2.4.2 After a period of rest of at least 2 weeks these same sheep were then subjected to trials using Ketamine alone intravenously.

6.2.5 GROUP E

These sheep were subjected to trials using first Xylazine intravenously followed 10 minutes later by Ketamine also intravenously.

6.2.6 GROUP F

These sheep were subjected to trials using . Xylazine and Ketamine combined in the same syringe and injected intravenously.

Table 1 shows a summary of the treatments.

7. BLOOD ANALYSIS

7.1 PCV:- Packed Cell Volume in percent was obtained using the Microhematocrit method and read off using the Hawksley Micro-hematocrit reader. This method was described by Benjamin, (1961).

7.2 TP:- Total Protein in g/100 ml was obtained using the Atago Refractometer Model SPR-T2 made in Japan.

TABLE 1 TABLE OF TREATMENTS

GROUP	DRUG COMBINATION	A or T or M
1.	XYLAZINE	A
2	XYLAZINE KETAMINE	M
3	XYLAZINE KETAMINE	T
4	KETAMINE	A
5	XYLAZINE	A
6	XYLAZINE KETAMINE	M
7	XYLAZINE KETAMINE	T
8	KETAMINE	A

A = Alone
T = Together in same syringe
M = Ketamine 10 minutes after Xylazine
IM = Intramuscular
IV = Intravenous

DOSAGE (mg/kg)	ROUTE	NUMBER OF TRIALS
0.22	IM	10
0.22	IM	10
"	IM	
0.22	IM	10
"	IM	
"	IM	10
0.22	IV	10
0.22	IV	10
"	IV	
0.22	IV	10
"	IV	
"	IV	10

7.3. HB:- Hemoglobin in g/100 ml was obtained using a Coulter Counter. Hemoglobinometer Model HGBR of Coulter Electronics Inc. 590 W. 20TH. ST/HIALEAH, FLA. 33010 U.S.A.

7.4 MCV:- Mean Corpuscular Volume in cubic microns (μ^3) was obtained using the Coulter Counter Model Z_B of Coulter Electronics Inc.

7.5 RBC:- Red Blood Cell Count in Millions per cubic millimeter ($10^6/mm^3$) was also obtained using the Coulter Counter as above.

7.6 WBC:- White Blood Cells count in Thousands per cubic millimeter ($10^3/mm^3$) was also obtained using the Coulter Counter as above.

7.7 MCHC:- Mean Corpuscular Hemoglobin Concentration in grams per 100 ml of cells (g/100 ml cells) was obtained by dividing Hemoglobin by PCV and multiplying by 100.

$$MCHC = \frac{Hb}{PCV} \times 100$$

7.8 DIFFERENTIAL CELL COUNT

The differential white cell count was obtained by making blood smears, staining them with 1:5 Giemsa stain and using a Microscope [10/] at X1000 magnification and oil

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10/ Microscrope - Leitz Model SM-LUX, Wetzlau, Germany.

emersion counting 100 white cells in total and finding the percentage of each of the various white cells i.e. Neutrophils (TN), Immature Neutrophils (ST), Lymphocytes (L), Monocytes (M), Eosinophils (E) and Basophils (B). Identification of the various white cells was done according to Freeman and Bracegirdle (1976).

8. FECAL SAMPLE ANALYSIS

8.1 TAPE WORM SEGMENTS

These were observed in some fecal samples using the naked eye. Microscopy identified the Genera.

8.2 ROUND WORM EGGS

These were counted to get the EPG (Egg Per Gram of fresh feces) as a measure of internal parasitism. The method used was the McMaster Egg-counting Technique as described by Soulsby (1968).

8.3 COCCIDIA

These were presented in some fecal samples and were noticed during routine EPG using the McMaster technique.

9. POSTMORTEMS

Routine postmortems were performed on only two of the three sheep which died. This was due to a breakdown of the cold-room over a week-end such that the dead sheep kept there over that particular weekend was too decomposed for useful postmortem the following Monday.

Samples for Histopathology were sent to the Histopathology Laboratory, University of Nairobi, Kabete and in one sheep changes were observed in the Thymus and Liver.

RESULTS

GENERAL OBSERVATIONS

Individual variation

Injection via the intravenous route produced shorter weak time than those via the intramuscular route. This was also found to be generally true for most times such as standing and down time. However, with the intravenous route, pain sensation was not always lost especially when Ketamine was given alone intravenously (Table 2).

Xylazine or Ketamine when administered alone either intramuscularly or intravenously failed to cause loss of pain sensation at the coronet of the feet. Ketamine alone intravenously did not also cause any loss of pain sensation or increased salivation.

Xylazine alone by either route failed to produce muscle relaxation as did Ketamine alone intravenously. The combination of the drugs produced muscle relaxation ranging from fair to good.

The experiments revealed that there was a lot of individual variation in the response of sheep to Xylazine and Ketamine. This was clearly shown in the ranges of the standard deviations.

The variation was seen as both the failure of some sheep to react to the drugs and as an over-reaction of other sheep. An example (cf appendix) can be seen in

Group 1 given Xylazine alone intramuscularly. While sheep No. 3 did not go into recumbency, sheep No. 6 stayed in recumbency for 57 minutes. Another example is Group 6 given Xylazine intravenously followed 10 minutes later by Ketamine via the same route. While sheep No. 2 lost its pain sensation at the horn base for 30 minutes, sheep No. 10 lost pain sensation in the same area for 75 minutes. These variations were seen in virtually all aspects tested for.

ANAESTHETIC TIMES

Table 2 shows the means (in minutes) of the results of all 8 experimental groups plus their standard deviation. Where dashes appear in this and subsequent tables this implies that the factor tested for did not occur or, as in the statistical tables, too few animals reacted to be able to do a satisfactory t-test.

The results shown in Table 2 are further explained in subsequent tables together with the statistical analysis. The table also shows that deaths occured one each in groups 5, 6 and 7 which were Xylazine alone, Xylazine followed 10 minutes later by Ketamine and Ketamine and Xylazine in the same syringe (all intravenously) respectively.

Table 2 further goes on to show the extent of the muscle relaxation obtained by the various combinations and routes. Muscle relaxation was observed when Xylazine was used alone intramuscularly and when Ketamine was used alone both intramuscularly and intravenously.

TABLE 2: TABLE OF GROUP MEANS ± S.D. IN MINUTES: COMPOSITE TABLE OF ALL 8 GROUPS

	1	2	3	4	5	6	7	8
Weak time	6.20±3.26	4.00±1.05	1.50±0.33	1.70±0.48	0.53±0.18	0.38±0.13	0.28±0.08	0.25
Down to sternal	13.60±8.75	9.60±3.47	2.48±0.96	1.10±1.52	1.78±1.23	2.05±2.25	0.28±0.08	0.25
Down to lateral	2.10±6.72	8.95±6.57	3.48±1.22	2.53±1.77	3.60±3.89	3.05±3.01	0.28±0.08	0.25
Up to sternal	7.60±6.12	36.70±29.75	50.30±6.53	13.05±6.95	24.55±12.11	45.22±13.20	42.56±17.36	11.60±4.22
Attempt to rise (from injection)	31.35±19.19	55.75±18.30	52.50±7.38	16.50±7.25	25.61±13.20	46.17±13.34	45.61±18.41	14.45±5.38
Attempt to rise (from sternal)	17.35±16.40	46.15±18.90	50.00±6.84	14.60±6.85	23.75±13.79	44.00±13.32	45.33±18.39	14.20±5.68
Standing	31.70±18.90	57.20±18.50	54.80±7.21	19.40±7.89	26.22±13.99	48.28±14.64	48.56±17.02	17.60±5.98
Down time	18.10±16.72	47.60±19.30	52.40±6.43	17.05±7.23	24.36±14.57	45.06±13.08	48.28±17.00	16.85±5.93
Pain at horn base lost	12.00±8.34	9.50±3.69	3.20±1.05	2.50±3.54	5.00	5.00	5.00	
Pain at horn base gained	34.00±17.90	52.00±21.10	50.00±8.16	8.50±9.14	27.22± 8.70	47.22±13.25	44.44±15.70	
Duration of loss of pain at horn base	22.00±18.54	42.50±21.40	46.80±7.53	6.00±6.99	22.22±8.70	42.22±13.25	39.44±15.70	
Pain at flank lost	12.00±14.37	15.00±2.36	6.30±2.63	1.00±3.16	4.44±3.01	12.22±4.41	5.00±	
Pain at flank gained	21.00±19.11	44.00±19.10	39.00±7.38	2.00±6.32	15.55±11.02	37.78±11.76	31.67±7.90	
Duration of loss of pain at flank	9.00±9.94	29.00±19.55	32.70±8.98	1.00±6.32	11.11±9.28	15.56±12.36	26.67±7.90	
Pain at coronet lost	-	5.00±8.16	5.50±3.69	-	-	1.67±5.00	0.56±1.67	
Pain at coronet gained	-	11.50±18.57	21.50±12.03	-	-	2.22±6.67	1.67±1.67	
Duration of loss of pain at coronet	-	6.50±10.55	16.00±9.07	-	-	0.55±1.67	1.11±3.39	
Onset of salivation	11.50±9.44	12.50±4.25	15.00±4.71	-	10.00±2.04	12.22±6.18	11.67±2.50	
Cessation of salivation	37.50±13.99	46.55±12.50	48.00±12.06	-	26.67±4.25	40.56±17.40	43.33±13.23	
Duration of salivation	26.00±11.49	33.50±12.50	33.00±10.32	-	16.67±11.18	28.33±15.00	31.67±13.92	
Muscle relaxation	Poor	Fair	Fair	Absent	Fair	Good	Good	Poor
Deaths	Nil	Nil	Nil	Nil	1	1	1	Nil

All pain sensation retained

Table 3 shows the statistical comparison carried out on the results of the times at 5% significance level.

Table 4 shows a comparison of the times in minutes obtained via the intramuscular route and the calculated significant at 5% significance level.

Significant differences were found (Table 4) in the weak time whereby weak time was longest when Xylazine alone was used (6.20 ± 3.26) next was when Xylazine was followed by Ketamine at a 10 minute interval (4.00 ± 1.05) and finally shortest when Ketamine was used alone (1.70 ± 0.48) and when Ketamine was used at the same time as Xylazine (1.50 ± 0.33) intramuscularly.

The animals treated with Xylazine alone took a shorter time (31.70 ± 18.70), on average to stand than those treated with either combination of Xylazine and Ketamine. Those treated with Ketamine alone (19.40 ± 7.89) followed the same trend of rising faster than the animals treated with the combinations.

Pain at the horn base was lost faster when Ketamine was used alone and when Ketamine was combined with Xylazine in the same syringe (2.50 ± 3.5 and 3.20 ± 1.05) respectively. The duration of the loss of pain was greatest with the drug combinations compared to the individual drugs. The same trend was shown by loss of pain at the flank. Only those animals

TABLE 3: TABLE OF COMPARISONS CARRIED OUT (T-TESTS)

(All t-tests carried out to 5% significance level)

COMPARISONS	IM	IV	IM VRS IV
(1)	A VRS B		
(2)	A VRS C		
(3)	A VRS D		
(4)	B VRS C		
(5)	B VRS D		
(6)	C VRS D		
(7)		A VRS B	
(8)		A VRS C	
(9)		A VRS D	
(10)		B VRS C	
(11)		B VRS D	
(12)		C RS D	
(13)			A (1 VRS 5)
(14)			B (2 VRS 6)
(15)			C (3 VRS 7)
(16)			D (4 VRS 8)

A = Xylazine alone

B = Xylazine followed by Ketamine 10 minutes later

C = Xylazine and Ketamine in the same syringe

D = Ketamine alone

1-8 = Experimental groups

TABLE 4: COMPARISON OF TIMES OBTAINED VIA THE INTRAMUSCULAR ROUTE GROUPS 1, 2, 3 AND 4.

	A (GROUP 1)	B (GROUP 2)	C (GROUP 3)	D (GROUP 4)	SIGNIFICANCE (P< 0.05) AB	AC	AD	BC	BD	CD
Weak time	6.20±3.26	4.00±1.05	1.50±0.33	1.70±0.48	Sig.	Sig.	Sig.	Sig.	Sig.	NS
Down to sternal	13.60±8.75	9.60±3.47	2.48±0.96	1.10±1.52	NS	Sig.	-	Sig.	-	-
Down to lateral	2.10±6.75	8.95±6.57	3.48±1.22	2.53±1.77=	-	-	-	Sig.	Sig.	-
Up to sternal	7.60±6.12	36.70±29.75	50.3±6.53	13.05±6.95	-	-	-	NS	Sig.	Sig.
Attempt to rise (from injection)	31.35±10.19	55.75±18.30	52.5±7.38	16.50±7.25	Sig.	Sig.	Sig.	NS		
Attempt to rise (from sternal time)	17.35±16.40	46.15±18.90	50.00±6.84	14.60±6.85	Sig.	Sig.	NS	NS	Sig.	Sig.
Standing	31.70±18.90	57.20±18.50	54.40±7.21	19.40±7.89	Sig.	Sig.	NS	NS	Sig.	Sig.
Down time	18.10±16.72	47.60±19.30	54.40±6.43	17.05±7.23	Sig.	Sig.	NS	NS	Sig.	Sig.
Pain at horn base lost	12.00±8.34	9.50±3.69	3.20±1.05	2.50±3.54	NS	Sig.	-	Sig.	NS	NS
Pain at horn base gained	34.00±17.90	52.00±21.10	50.00±8.16	8.50±9.14	NS	NS	-	NS	Sig.	Sig.
Duration of loss of pain at horn base	22.00±18.58	42.55±21.40	46.80±7.53	6.00±6.99	Sig.	Sig.	-	NS	Sig.	Sig.
Pain at flank lost	12.00±14.37	15.00±2.36	6.30±2.63	1.00±3.16	NS	Sig.	-	Sig.	-	-
Pain at flank gained	21.00±19.11	44.00±19.10	39.00±7.38	2.00±6.32	NS	NS	-	NS	-	-
Duration of loss of pain at flank	9.00±9.94	29.00±19.55	32.70±8.98	1.00±6.32	NS	NS	-	NS	-	-
Pain at coronet lost	-	5.00±8.16	5.50±3.69	-	-		-	-	-	-
Pain at coronet gained	-	11.50±18.57	21.50±12.03	-	-		-	-	-	-
Duration of loss of pain at coronet	-	6.50±10.55	16.00±9.07	-	-		-	-	-	-
Onset of salivation	11.50±9.44	12.50±4.25	15.00±4.71	-	NS	NS	-	NS	-	-
Cessation of salivation	37.50±13.99	46.50±12.50	48.00±12.06	-	NS	NS	--	NS	-	-
Duration of salivation	26.00±11.49	33.50±12.50	32.00±10.32	-	NS	NS	-	NS	-	-

where the combination of Xylazine and Ketamine was used lost pain sensation at the coronet.

Ketamine alone did not produce salivation. However whenever Xylazine was used (alone or in combination) salivation occurred starting at 11.50 ± 9.44 minutes and lasting 26.00 ± 11.49 minutes when Xylazine was used alone. When Xylazine was used in the same syringe with Ketamine salivation started at 15.00 ± 4.71 minutes and lasted 33.00 ± 10.32 minutes.

Table 5 shows the comparison of times in minutes obtained with the intravenous route together with their significance at 5%. Weak time was very short with all combinations though significantly ($P< 0.05$) faster when Ketamine was used alone (0.25 minutes) or with Xylazine in the same syringe (0.28 ± 0.08 minutes).

The animals stayed down longer when Ketamine was used together with Xylaxine simultaneously (48.28 ± 17.00 minutes) or with a 10 minute interval (45.06 ± 13.08 minutes) than when either drug was used separately. Also the animals were down longer with Xylazine (24.36 ± 14.57 minutes) than with Ketamine (16.85 ± 5.93 minutes).

The results showed a clear difference in the weak times obtained by the intramuscular and the intravenous routes (Table 6). The intravenous times were significantly ($P< 0.05$)

TABLE 5: COMPARISON OF TIMES OBTAINED VIA THE INTRAVENOUS ROUTE GROUPS 5, 6, 7 AND 8

	A (GROUP 5)	B (GROUP 6)	C (GROUP 7)	D (GROUP 8)	SIGNIFICANCE (P< 0.05) AB	AC	AD	BC	BD	CD
Weak time	0.53±0.18	0.38±0.13	0.28±0.08	0.25	NS	Sig.	Sig.	Sig.	Sig.	NS
Down to sternal	1.78±1.23	2.05±2.25	0.28±0.08	0.25	NS	Sig.	Sig.	Sig.	Sig.	NS
Down to lateral	3.60±3.89	3.05±3.01	0.28±0.08	0.25	NS	Sig.	Sig.	Sig.	Sig	NS
Up to sternal	24.55±12.11	45.22±13.20	42.56±17.36	11.60±4.22	Sig.	Sig.	Sig.	NS	Sig	Sig.
Attempt to rise (from injection)	25.61±13.20	46.17±13.34	45.61±18.41	14.45±5.88	Sig.	Sig.	Sig.	NS	Sig.	Sig.
Attempt to rise (from sternal)	23.75±13.79	44.00±13.22	45.33±18.39	14.20±5.88	Sig.	Sig.	Sig.	NS	Sig.	Sig.
Standing	26.22±13.99	48.28±14.64	48.56±17.00	16.85±5.93	Sig.	Sig.	Sig.	NS	Sig.	Sig.
Down time	24.36±14.57	45.06±13.08	48.28±17.00	16.85±5.93	Sig.	Sig.	Sig.	NS	Sig.	Sig.
Pain at horn base lost	5.00	5.00	5.00	- All pain sensation retained	-	-	-	-	-	-
Pain at horn base gained	27.22±8.70	47.22±13.25	44.44±15.70		Sig.	Sig.	-	NS	-	-
Duration of loss of pain at horn base	22.22±8.70	42.22±13.25	39.44±15.70		Sig.	Sig.	-	NS	-	-
Pain at flank lost	4.44±3.01	12.22±4.41	5.00		Sig.	NS	-	Sig	-	-
Pain at flank gained	15.55±11.02	37.78±11.76	31.67±7.90		Sig.	Sig.	-	NS	-	-
Duration of loss of pain at flank	11.11±9.28	25.56±12.36	26.67±7.90		NS	Sig.	-	NS	-	-
Pain at coronet lost	-	1.67±5.00	0.56±1.67		-	-	-	-	-	-
Pain at coronet gained	-	2.22±6.67	1.67±1.67		-	-	-	-	-	-
Duration of loss of pain at coronet	-	0.55±1.67	1.11±3.39		-	-	-	-	-	-
Onset of salivation	10.00±2.04	12.22±6.18	11.67±2.50		NS	NS	-	Sig.	-	-
Cessation of salivation	26.67±4.25	40.56±17.40	43.33±13.23	-	Sig.	Sig.	-	NS	-	-
Duration of salivation	16.67±11.10	30.33±15.00	31.67±13.92	-	NS	Sig.	-	NS	-	-

TABLE 6 COMPARISON OF TIMES OBTAINED VIA THE INTRAMUSCULAR AND INTRAVENOUS ROUTES

	A		B		C		D	
	1	5	2	6	3	7	4	8
Weak time	6.20±3.26*	0.53±0.18	4.00±1.05*	0.38±0.13	1.50±0.33*	0.28±0.08	1.70±0.48*	0.25±
Down to sternal	13.60±8.75*	1.78±1.23	9.60±3.47*	2.05±2.25	2.48±0.96*	0.28±0.08	1.10±1.52*	0.25±
Down to lateral	2.10±6.72	3.60±3.89*	8.95±6.57*	3.05±3.01	3.48±1.22*	0.28±0.08	2.52±1.77*	0.25±
Upto sternal	7.60±6.12	24.55±12.11*	36.70±29.75	45.22±13.20*	50.30±6.53*	42.56±17.36	13.05±6.95*	11.60±4.22
Attempts to rise (from injection)	31.35±19.19*	25.61±13.20	55.75±18.30*	46.17±13.34	52.50±7.38*	45.61±18.41	16.50±7.25*	14.45±5.89
Attempt to rise (from sternal)	17.35±16.40	23.75±13.79*	46.15±18.90*	44.00±13.32	50.00±6.84*	45.33±18.39	14.60±6.85*	14.20±5.83
Standing	31.70±18.90*	26.22±13.99	57.20±18.50	48.28±14.64	54.80±7.21	48.56±17.02	19.40±7.89*	17.10±5.93
Down time	18.10±16.72	24.35±14.57	47.60±19.30	45.06±13.08	52.40±6.43	48.28±17.00	17.05±7.23	16.85±5.93
Pain at horn base lost	12.00±8.34*	5.00±	9.50±3.69*	5.00±	3.20±1.05*	5.00±	2.50±3.54	-
Pain at horn base gained	34.00±17.90*	27.22±8.70	56.00±21.10*	47.22±13.25	50.00±8.15*	44.44±15.70	8.50±9.14	-
Duration of loss of pain at horn base	22.00±18.54	22.22±8.70	42.50±21.40	42.22±13.25	46.80±7.53*	39.44±15.70	8.50±9.14	-
Pain at flank lost	12.00±14.37	4.44±3.01	15.00±2.36	12.22±4.41	6.30±2.63*	5.00±	1.00±3.16	-
Pain at flank gained	21.00±19.11	15.56±11.02	44.00±19.10	37.78±11.76	39.00±7.38*	31.67±7.90	2.00±6.32	-
Duration of loss of pain at flank	9.00±9.94	11.11±9.28	29.00±19.55*	25.56±12.36	32.70±3.38	26.67±7.90	1.00±6.32	
Pain at coronet lost	-	-	5.00±8.16*	1.67±5.00	5.50±3.69*	0.56±1.67	-	-
Pain at coronet gained	-	-	11.50±18.57*	2.22±6.67	21.50±12.03*	1.67±1.67	-	-
Duration of loss of pain at coronet	-	-	6.50±10.55	0.55±1.67	16.00±9.07*	1.11±3.39	-	-
Onset of salivation	11.50±9.44	10.00±2.04	12.50±4.25	12.22±6.18*	15.00±4.71*	11.67±2.50	-	-
Cessation of salivation	37.50±13.99	26.67±4.25	46.55±12.50*	40.56±17.40	48.00±12.06	43.33±13.23	-	-
Duration of salivation	26.00±11.49	18.67±11.18	33.50±12.50*	28.33±15.00	33.00±10.32*	31.67±13.92	-	-

* Significant ($P < 0.05$)

shorter than the intramuscular times. The same trend was shown by the down to sternal times. However there was no statistical difference between the down time of the intramuscular and intravenous routes although there was a significant ($P< 0.05$) difference between the standing times obtained by Ketamine alone intramuscularly (19.40 $\pm$ 7.89 minutes) and intravenously (17.10 $\pm$ 5.98 minutes) (group 4 and 8 respectively).

The duration of loss of pain at the horn base and at the coronet were not significantly ($P >0.05$) different when either route was used except that Ketamine alone intravenously did not cause loss of pain sensation in these areas. When Ketamine was administered 10 minutes after Xylazine no significant ($P >0.05$) difference was found either in the onset of loss of pain at the coronet, its time of regaining pain sensation or its duration.

Where salivation did occur no significant ($P >0.05$) difference was found in its onset, cessation or duration between the two administration routes.

The results also showed that Ketamine alone intravenously did not relieve pain sensation at all, and Xylazine alone intravenously did not relieve paid sensation at the coronet. Furthermore pain at the coronet was only barely relieved when Xylazine and Ketamine were used together either with 10 minute

intervals or simultaneously. The pain relief was short lived (0.55 ± 1.67 and 1.11 ± 3.59 respectively).

The animals stayed down longer when Ketamine was used together with Xylazine simultaneously (48.28 ± 17.00 minutes) or with a 10 minute interval (45.06 ± 13.08 minutes) than when either drug was used separately. Also the animals were down longer with Xylazine alone (24.36 ± 14.57 minutes) than with Ketamine alone (16.85 ± 5.93 minutes).

Xylazine alone and in combination with Ketamine did cause salivation lasting 16.67 ± 11.18 minutes when Xylazine was used alone, 28.33 ± 15.00 minutes when Xylazine was followed 10 minutes later by Ketamine and 31.67 ± 13.92 minutes when both drugs were simultaneously administered.

A comparison of the times obtained by the intramuscular and intravenous routes is shown in Table 6. The table also shows the statistical significance at 5% level between the groups.

TEMPERATURE VARIATIONS

The variation in temperature was analysed using Analysis of Variance (Equal or Unequal Group Sizes, ANOVA) at P = 0.05. Table 7 shows the results of the analyses. The table shows that a significant ($P< 0.05$) change occured in the temperature of Groups 1 and 5 - 8. The groups, 1 and 2, show the mean temperature variations in the intramuscular and intravenous injection respectively.

Other than group 8, which showed a rise in body temperature, all other groups showed a decline, the intramuscular injections showing an initial rise. The greatest fall in body temperatures was shown by Groups 2 to 37.8^{o}C 90 minutes after the first injection, but this was found not be statistically significant ($P> 0.05$). (Figures 1 and 2).

HEART RATE

The results for heart rates were analysed using ANOVA at P = 0.05 (Table 8).

All the drugs and drug combinations in the experiments caused a significant fall at 5% level in heart rate except when Ketamine was used alone intravenously (Group 8). The individual results can also be found in the appendix.

FIG. 1: MEAN TEMPERATURE VARIATIONS - INTRAMUSCULAR INJECTIONS

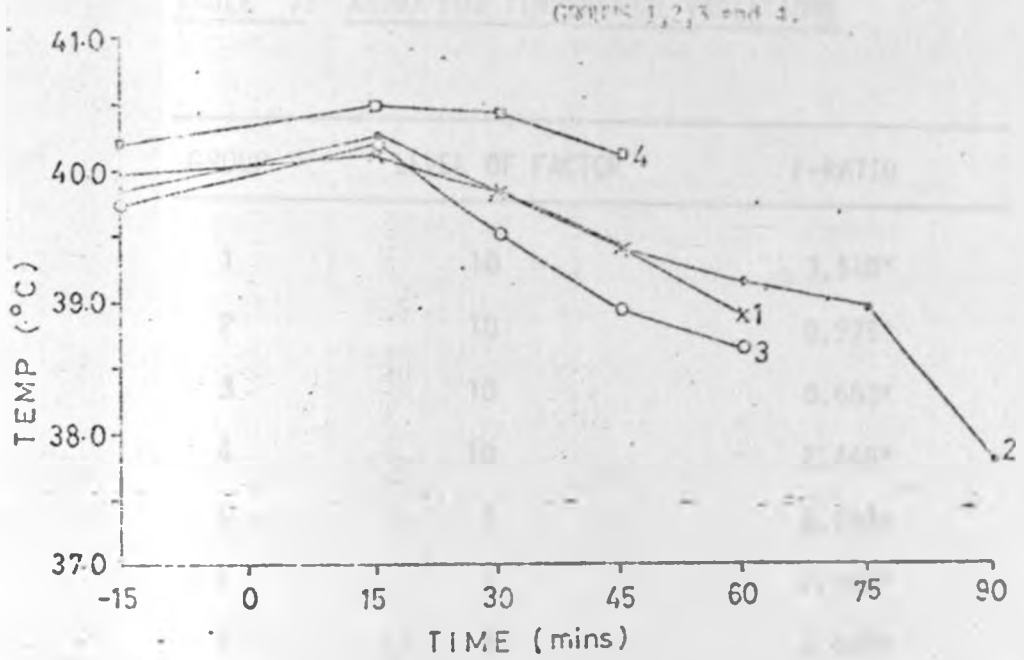

FIG. 2: MEAN TEMPERATURE VARIATIONS - INTRAVENOUS INJECTIONS

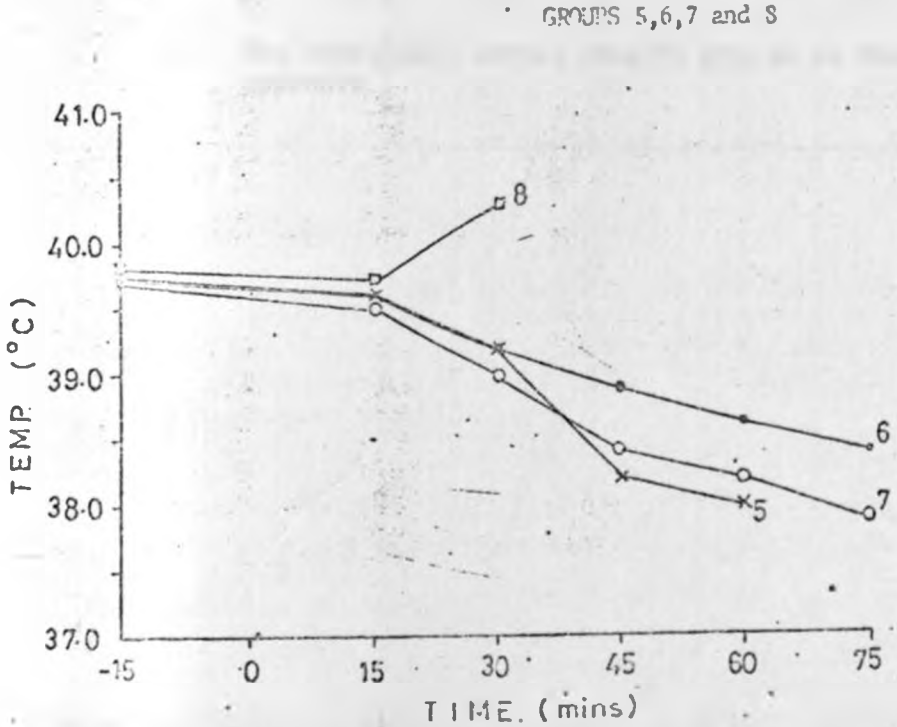

TABLE 7: ANOVA FOR TEMPERATURE VARIATIONS

GROUP	LEVEL OF FACTOR	F-RATIO
1	10	3.510*
2	10	0.975*
3	10	0.683*
4	10	2.448*
5	9	8.233*
6	9	2.567*
7	9	4.446*
8	10	5.940*

*Significant ($P < 0.05$).

NB: The individual animal results are to be found in the appendix

TABLE 8: ANOVA FOR VARIATIONS IN HEART RATE

GROUP	LEVEL OF FACTOR	F-RATIO
1	10	15.857*
2	10	5.701*
3	10	10.147*
4	10	12.205*
5	9	4.484*
6	9	8.978*
7	9	15.484*
8	10	1.488*

*Significant ($P < 0.05$).

NB: The individual animal results are to be found in the appendix.

TABLE 9: ANOVA FOR VARIATIONS IN RESPIRATORY RATES

GROUP	LEVEL OF FACTOR	F- RATIO
1	10	13.279*
2	10	8.308*
3	10	15.600*
4	10	2.820*
5	9	5.369*
6	9	4.010*
7	9	7.075*
8	10	3.869*

*Significant ($P < 0.05$).

NB: The individual animal results are to be found in the appendix.

RESPIRATORY RATE

The respiratory rates were also analysed using ANOVA at $P = 0.05$. The group results are shown in Table 9 while the individual results are shown in the appendix.

All 8 groups showed a significant ($P < 0.05$) rise in the respiratory rates of the experimental animals. Group 5 however also showed a significant ($P < 0.05$) fall in respiratory rates after the significant ($P < 0.05$) rise.

EFFECTS ON BLOOD

Tables 10 to 13 show the mean values ($\pm$ SD) of the various blood constituents at: (a) 15 minutes prior to anaesthesia; (b) 15 minutes after the first injection; (c) 30 minutes after the animal had stood up and (d) 24 hours after the experiment. Tables 10 and 11 show the results through the intramuscular route and Table 12 and 13 through the intravenous route. The tables also show the significance at 5% level. However analysis by t-test was not done for those values (i.e. Immature Neutrophils, Monocytes, Basophils and Eosinophils) whose number were too few to be statistically meaningful.

The individual results are to be found in the appendix.

On average the results showed a decline within 15 minutes after the first injection which remained the same or started to rise again at 30 minutes after standing with a return to pre-anaesthetic values at 24 hours.

TABLE 10 MEAN VALUES (± SD) FOR BLOOD CONSTITUENTS AT THE VARIOUS TIMES: GROUPS 1 AND 2 (INTRAMUSCULAR ROUTE)

	GROUP 1				GROUP 2			
	a	b	c	d	a	b	c	d
PCV (%)	31±3.54	25±2.20*	26±3.32*	32±2.92	32±4.29	26±2.99*	26±3.34*	32±4.09
TP (g/100 ml)	6.4±0.57	5.7±0.45*	5.6±0.38*	6.4±0.55	6.4±0.44	6.1±1.44*	5.6±0.47*	6.1±0.56*
HB (g/100 ml)	10.7±1.21	8.9±0.94*	8.7±1.15*	10.8±1.39	11.10±1.43	9.23±1.20*	9.58±1.25*	11.00 1.31
RBC (10^6/mm^3)	11.31±1.59	9.46±0.85*	9.54±1.05*	12.39±1.87*	12.79±2.09	10.65±1.68*	11.10±1.92*	12.97±1.75
WBC (10^3/mm^3)	14.9±3.68	11.6±3.27	10.9±2.86*	14.2±4.17	22.5±12.16	15.1±5.86*	17.27±6.30	19.7±6.81
MCV (^{3})	28 ±2.91	27± 2.13	27± 2.47	26± 2.75*	25± 2.56	24 ±2.15	23 ±2.11*	25± 1.56
MCHC (g/100 ml cells)	34.7±1.64	34.2±1.64	34.1±1.92	33.9±2.05	35.6±1.50	36.0±2.28	37.6±2.46	35.0±1.13
TN (%)	23 ±11.18	20± 9.23	24± 10.07	25± 9.77	24± 10.90	24± 11.58	20 ±11.70	27 ±14.56
ST (%)	0	0	0	0	0	0	0	0
L (%)	77 ±11.60	80± 8.90	75± 10.49	75 ±10.10	75 ±10.73	76 ±11.52	77 ±12.10	73± 14.44
M (%)	0	0	0	0	0	0	0	0
E (%)	1 ±0.70	1.±0.73	1 ±0.83	1 ±0.71	1 ±1.08	1± 0.97	0.2±0.63	1± 0.81
B (%)	0	0	0	0	0	0	0	0

*Significant difference from a at 5% significance level
(For abbreviation refer to pages 50 to 53 of Materials and Methods)

TABLE 11 MEAN VALUES (± SD) FOR BLOOD CONSTITUENTS AT THE VARIOUS TIMES: GROUPS 3 and 4 (INTRAMUSCULAR ROUTE)

	GROUP 3				GROUP 4			
	a	b	c	d	a	b	c	d
PCV (%)	31± 3.05	25 ±1.75*	24 ±2.36*	31± 2.79	30 ±2.41	27 ±2.59	27 ±2.56	30 ±2.3[illegible]
TP (g/100 ml)	6.6±0.54	6.8 ±1.47*	5.9 ±0.69*	6.5 ±0.70	6.2 ±0.39	5.9±0.37*	6.1± 0.49	6.1±0.33
Hb (g/100 ml)	10.8±0.98	9.2±0.64*	9.2± 0.99	11.1 ±0.81	10.3 ±1.01	9.8±1.18	9.7± 1.16	10.6±1.13*
RBC ($10^6/mm^3$)	11.86±1.53	9.85±1.05	9.71±1.33	12.20±2.57	12.04±1.63	11.05±1.67	11.46±1.68	12.42±1.87
WBC ($10^3/mm^3$)	18.3±9.22	16.2±5.96*	14.3±4.85	20.0±4.81	15.7±5.10	14.7±4.35*	15.6±4.09	16.8±4.83
MCV (^{3})	26 ±2.63	26 ±1.73	26± 3.30	27±3.94	25± 2.04	25± 2.56	24 ±2.71	26 ±2.41
MCHC (g/100 ml cells)	35.8±1.35	36.4±1.21	37.8±3.16	36.0±1.71	34.6±1.59	35.9±1.83*	36.1±1.79*	35.1±2.27
TN (%)	29 ±9.65	32±10.83	33±7.13	40± 12.97*	26 ±9.70	30 ±15.13	33± 17.15	32± 8.32
ST (%)	0	0	0	0	0	0	0	0
L (%)	70 ±9.50	69 ±10.91	65±13.30	60 ±12.85	73 ±10.41	69 ±16.41	67± 17.41	67 ±9.5[illegible]
M (%)	0	0	0	0	0	0	0	0
E (%)	1± 0.70	0.2± 0.42	1± 0.70	0.4±0.70	1 ±1.26	1 ±1.85	1± 0.84	0.4 ±0.97
B (%)	0	0	0	0	0	0	0	0

*Significant differences from a to 5% significance level
(For abbreviation refer to pages 50 to 53 of Materials and Methods).

TABLE 12: MEAN VALUES (± SD) FOR BLOOD CONSTITUENTS AT THE VARIOUS TIMES: GROUPS 5 AND 6 (INTRAVENOUS ROUTE)

	GROUP 5				GROUP 6			
	a	b	c	d	a	b	c	d
PCV (%)	31± 3.87	27± 4.38	26± 3.54*	31± 1.79	32 ±3.84	29 ±4.71*	27 ±3.21*	33 ±2.5
TP (g/100 ml)	6.90±0.50	6.50±0.70*	6.32±0.55*	6.82±0.46	6.05±0.62	5.80±0.53	5.44±0.29*	6.46±0.73
Hb (g/100 ml)	11.79±1.69	10.13±1.62*	8.56± 1.87*	11.46± 1.16	11.77±0.97	10.39±1.31*	10.01±1.29*	11.76±1.10
RBC (10^6/mm^3)	8.82±1.10	7.42±1.06	7.21±0.77*	6.96±2.29	9.00±0.62	8.44±0.92*	7.21±0.79*	9.40 ±1.37
WBC (10^3/mm^3)	11.05±4.66	8.29± 2.29*	8.58±2.02	12.91±4.69	13.15±3.98	11.89±2.89*	10.41±2.39*	20.28±5.77*
MCV (^{3})	31 ±4.38	30 ±3.08	29± 3.54*	41± 7.20*	34± 5.32	32± 3.92	33± 6.82	36 ±4.2
MCHC (g/100 ml cells)	38 ±2.39	37± 1.64	35± 4.26	36± 3.98	34 ±5.34	32 ±4.78	35± 8.61	33 ±5.3
TN (%)	31 ±11.57	34 ±13.59	41± 12.29	43± 15.87	42 ±12.51	44 ±11.73	48 ±17.12	51 ±12.5
ST (%)	0	0.1±0.32	0.1± 0.32	0.1± 0.32	0	0	0.1± 0.32	0
L (%)	62± 15.31	61± 13.88	55± 14.88*	54 ±15.07	55 ±11.80	55 ±11.46	52 ±15.81	48 ±12.16
M (%)	1.1± 1.39	1.7± 2.16	1.9± 3.06	0.1± 0.33	0	0	0	0
E (%)	3.8± 3.58	2.6± 2.37	3.1 ±3.02	3.6 ±3.43	3.1± 2.28	0.33 ±0.71	1.67 ±1.94	0.67 ±1.00
B (%)	0.1± 0.33	0	0	0	0	0	0	0

*Significant difference from a at 5% significance level

(For abbreviation refer to pages 50 & 53 of Materials and Methods)

TABLE 13 MEAN VALUES (± SD) FOR BLOOD CONSTITUENTS AT THE VARIOUS TIMES: GROUPS 7 and 8 (INTRAVENOUS ROUTE)

	GROUP 7				GROUP 8			
	a	b	c	d	a	b	c	d
PCV (%)	33 ±2.63	30 ±2.99	16± 3.31	31 ± 2.96	32 ± 2.72	30± 3.47	30± 1.96*	32 ± 3.41
TP (g/100 ml)	5.88±0.47	5.69±0.36	5.52±0.80	6.20±0.81	6.00±0.46	6.04±0.39	5.65±0.41*	6.28±0.38*
Hb (g/100 ml)	11.52±1.88	11.22±1.40	9.94±1.10	12.04±1.31	11.58±0.70	10.84±1.25	10.77±0.74	11.41 1.14
RBC (10^6/mm^3)	9.70±1.60	8.49±0.82	7.49±0.66	9.69± 1.74	9.40±0.85	9.00±1.14	8.88±0.74	10.25 2.03
WBC (10^3/mm^3)	14.18±7.69	13.50±9.58	10.30±4.60*	17.77±9.76	11.52±3.41	12.00±7.45	10.42±2.21	11.49 3.38
MCV (u^3)	35± 3.81	35± 3.27	34 ±5.04	32 ±3.54*	34 ±3.68	33 ±3.52	34± 3.09	32 ±3.20
MCHC (g/100 micells)	37 ±2.04	37 ±3.17	37 ±6.09	38 ±2.99	35 ±1.81	35 ±2.35	36± 3.56	32± 3.45
TN (%)	41±13.51	42±14.16	51±11.97*	54±10.81*	45±7.98	42±7.24	46±8.40	45±8.9
ST (%)	0	0	0	0	0	0	0	0
L (%)	58±14.86	58±14.30	47±12.49*	45±11.09	55± 8.04	58± 6.93	53 ±8.71	54± 9.07
M (%)	1.10±2.60	0.56±0.88	1.00±1.54	0.56±1.33	0	0	0	0
E (%)	0.67±1.00	1.22±2.59	1.33±0.87	0.67±0.87	0.5±10.85	0.4± 0.70	0.7±1.06	0.8±0.92
B (%)	0	0	0	0	0.1±0.32	0	0	0

*Significant difference from a at 5% significant level

(for abbreviations refer to pages 50 to 53 of Materials and Methods).

Group 3 was also similar to Group 1 except that there was a significant ($P< 0.05$) rise in Total Neutrophils (TN) at 24 hours although there was no corresponding change in the lymphocytic count.

Group 4 varied somewhat more in that it was only the PCV, TP and WBC counts that showed significant ($P< 0.05$) falls at 15 minutes after the first injection although Hb and RBC did also fall. The PCV was also significantly ($P< 0.05$) lower at 30 minutes after standing. MCHC showed significant ($P <0.05$) rises both at 15 minutes after the first injection and at 30 minutes after standing. Hb showed a significant ($P< 0.05$) rise at 24 hours.

INTRAVENOUS INJECTIONS

All groups showed a fall in PCV, TP, Hb, RBC and WBC at 15 minutes after the first injection and at 30 minutes after standing. This fall was significant ($P< 0.05$) except for 15 minutes after the first injection in groups 7 and 8. Falls were also not significant ($P> 0.05$) at 15 minutes after the first injection for RBC in Group 5 and TP in Group 6. No significant ($P> 0.05$) difference was found at 30 minutes after standing for WBC in Group 5, TP in Group 7 and for both RBC and WBC in Group 8.

Significant ($P< 0.05$) rises were noted for MCV in Group 5 WBC in Group 6, TN in Group 7 and TP in Group 8 at 24 hours TN in Group 7 at 30 minutes also showed a significant ($P< 0.05$) rise but there was also a corresponding significant ($P <0.05$)

Mean corpuscular volume (MCV in μ^3) and Mean Corpuscular Hemoglobin concentration (MCHC in gm/100 ml cells) tended to remain about the same at all times with the few significant [illegible] rises or falls occuring mainly at 30 minutes after the animals stood up and at 24 hours.

The white cell count varied as with the other parameters but the percentages of the various white cells themselves remained unchanged except in a few instances.

When PCV determinations were being done, after centrifugation the serum appeared normal and clear.

INTRAMUSCULAR INJECTIONS

Group 1

PCV, TP, Hb, RBC and WBC all showed a significant ($P< 0.05$) fall at 15 minutes after the first injection and at 30 minutes after standing up. The RBC count, however, showed a significant rise 24 hours later while the other parameters had returned to normal. The percentages of the individual white cells remained unchanged. The MCV was significantly ($P< 0.05$) lower at 24 hours than preanaesthetic values.

Group 2 showed the same trend except that TP remained significantly ($P< 0.05$) lower at 24 hours and MCV was significantly ($P< 0.05$) lower at 30 minutes after standing but was at preanaesthetic values at 24 hours.

Group 3 was also similar to Group 1 except that there was a significant ($P< 0.05$) rise in Total Neutrophils (TN) at 24 hours although there was no corresponding change in the lymphocytic count.

Group 4 varied somewhat more in that it was only the PCV, TP and WBC counts that showed significant ($P< 0.05$) falls at 15 minutes after the first injection although Hb and RBC did also fall. The PCV was also significantly ($P< 0.05$) lower at 30 minutes after standing. MCHC showed significant ($P <0.05$) rises both at 15 minutes after the first injection and at 30 minutes after standing. Hb showed a significant ($P< 0.05$) rise at 24 hours.

INTRAVENOUS INJECTIONS

All groups showed a fall in PCV, TP, Hb, RBC and WBC at 15 minutes after the first injection and at 30 minutes after standing. This fall was significant ($P< 0.05$) except for 15 minutes after the first injection in groups 7 and 8. Falls were also not significant ($P> 0.05$) at 15 minutes after the first injection for RBC in Group 5 and TP in Group 6. No significant ($P> 0.05$) difference was found at 30 minutes after standing for WBC in Group 5, TP in Group 7 and for both RBC and WBC in Group 8.

Significant ($P< 0.05$) rises were noted for MCV in Group 5 WBC in Group 6, TN in Group 7 and TP in Group 8 at 24 hours TN in Group 7 at 30 minutes also showed a significant ($P< 0.05$) rise but there was also a corresponding significant ($P <0.05$)

fall in lymphocytes at the same time. MCV showed a significant ($P < 0.05$) fall at 24 hours for both Groups 7 and 8.

The lymphocytes of Groups 5 and 7 showed a significant ($P < 0.05$) fall at 30 minutes after standing.

DISCUSSION

Xylazine hydrochloride (Kompun^{R}) and Ketamine hydrochloride (Ketalar^{R}) were evaluated for their anaesthetic properties and their effects on the respiratory rate, heart rate, temperature and on the blood picture of sheep. Xylazine was used at a dosage rate of 0.22 mg/kg body weight as was used by Kumar et al. (1976) and Keller and Bauman (1978) in goats and Nowrouzian et al (1981) in sheep, while Ketamine was used at a dosage rate of 11 mg/kg body weight (Keller and Bauman, 1978).

INTRAMUSCULAR ROUTE

ANAESTHETIC TIMES

GROUP 1

Sheep injected with Xylazine alone tended to flex the neck to the sides while some progressed to lateral recumbency. Xylazine injected alone by the intramuscular route produced a weak time of 6.20 ± 3.26 minutes. This was in agreement with the findings of Kosuch (1975). The sheep attempted to rise (from the time of injection) in 31.35 ± 19.19 minutes and were standing unaided in 31.70 ± 18.90 minutes, down time being 18.10 ± 16.72 minutes. In adult cattle Clarke and Hall (1969) found "deep sedation" to last 15- 30 minutes which is comparable to the results found in these experiments but contradicts Thurmon et al. (1978) who found "sedation" to last about 2 hours in cattle.

These experiments show that analgesia is indeed a feature of Xylazine induced sedation in sheep. Analgesia was present at the horn base within 12.00 ± 18.34 minutes of an intramuscular injection and lasted 22.00 ± 18.54 minutes. At the flank, pain sensation was lost at 12.00 ± 14.37 minutes and regained at 21.00 ± 19.11 minutes. Pain at the coronet of the foot was not lost. These results are consistent with the findings of several authors (Kosuch, 1975; Thurmon et al., 1978) and even more consistent with the findings of De Moor and Desmet (1971) who also reported that Xylazine gave insufficient analgesia to the distal limbs. Clarke and Hall (1969) however found no significant analgesia attributable to Xylazine and Hall (1971) mentioned that some reports indicated an absence of demonstrable analgesia. Sagner et al. (1970) referred to the analgesia produced by Xylazine as being similar to that produced by Morphine while Thurmon et al. (1978) attributed the analgesia to an effect on the central nervous system.

Salivation occured in all the animals given Xylazine. The salivation when Xylazine was used alone begun at 11.50 ± 9.44 minutes, ceased at 37.50 ± 13.99 minutes and lasted 26.00 ± 11.49 minutes.

Contrary to many authors (De Moor and Desmet, 1971; Mulling and Henning, 1971; Kosuch, 1975; Thurmon et al., 1978; Aziz and Martin, 1979) these experiments revealed muscle relaxation to be absent or rather poor at best, even when Xylazine was used intravenously. The sheep, even in

lateral recumbancy, had their limbs stretched out and would spring back to the extended position when flexed and at the same time the withdrawl reflex to pain was always present.

Xylazine alone did not cause any death.

GROUP 2

In this group Ketamine was injected 10 minutes after Xylazine. Down time was found to be 4.00 ± 1.05 minutes which was significantly shorter ($P < 0.05$) than in the previous group. This group of animals did not attempt to rise (from the injection time) until 55.75 ± 18.30 minutes which was significantly longer ($P < 0.05$) than when Xylazine was used alone. The sheep were down (47.60 ± 19.30 minutes) significantly longer ($P < 0.05$) than with the sheep treated with Xylazine alone.

Though pain at the horn base was lost earlier and gained later in this group of sheep this was not statistically significant ($P > 0.05$). However the duration of loss of pain in the area, 42.55 ± 21.40 minutes was significantly longer ($P < 0.05$) than when Xylazine was used alone. At the flank pain sensation was lost more abruptly than when Xylazine was used alone (15.00 ± 2.36 minutes as compared to 12.00 ± 14.37 minutes) and took longer to regain although again there was no statistically significant difference ($P > 0.05$) in the duration of the pain loss at the flank between these 2 groups.

The combination of Ketamine 10 minutes after Xylazine did cause a loss of pain sensation at the coronet of the feet. The pain sensation was lost within 5.00 ± 8.16 minutes, gained at 11.50 ± 18.5 minutes the duration of loss being 6.50 ± 10.55 minutes. The loss was most probably due to the combination as (Table 4) neither Xylazine nor Ketamine produced a loss of pain sensation in the area when used alone intramuscularly. The loss of all pain when Xylazine was used as a premedicant to Ketamine is consistent with the observation of Kumar et al. (1976) and Keller and Bauman (1978) in goats, and with Muir et al. (1977) in horses.

The onset, cessation and duration of salivation in this group showed no statistically significant ($P > 0.05$) differences to where Xylazine was used alone and therefore the salivation here can be attributed to the effects of Xylazine alone. Furthermore Taylor et al. (1972) and Fuentez and Tellez (1972) found no salivation with Ketamine in pregnant sheep and cows respectively. On the other hand, Nowrouzian et al. (1981) reported mild salivation in 40% of the sheep the authors were working on.

Muscle relaxation with Ketamine after Xylazine premedication was found to be fair. This was seen to be consistent with the observation of other authors who stated that Xylazine greatly aided Ketamine in the attainment of good muscle relaxation (Kumar et al. 1976; Cullen and Jone, 1977; Mulder and Mulder 1979; Nowrouzian et al., 1981).

Kumar et al. (1976) went on to say that the muscle relaxant effect of Xylazine was not overidden by the central stimulant effect of Ketamine.

No deaths were recorded in this group of animals.

GROUP 3

The sheep injected with both Xylazine and Ketamine in the samse syringe went down significantly faster ($P<0.05$) than the first 2 groups lapsing into lateral recumbancy in 3.45 ± 1.22 minutes. These sheep stayed down (down time) for 52.40 ± 6.43 minutes which was significantly ($P< 0.05$) lo longer than when Xylazine was used alone but not significantly ($P> 0.05$) longer when there was a 10 minute interval between injections.

The induction time agrees with the results obtained by Keller and Bauman (1978) in goats (3-10 minutes) but the down time was found to be about half that the authors reported. The results were found also to be similar to those reported by Kumar et al. (1976) in goats. This is perhaps a difference between sheep and goats.

The combination of drugs also caused complete loss of pain sensation at all 3 areas tested. The onset of loss of pain at the horn base was significantly ($P< 0.05$) shorter for this group than for the first 2 groups and though there was no significant difference ($P> 0.05$) in the regaining of

pain sensation. A significant difference ($P < 0.05$) in the duration of loss was seen between the 3rd group and the first two. Recovery was also noticed to be more rapid in this group than in the first two. Cullen and Jones (1971) reported rapid recovery in cats.

No significant difference ($P > 0.05$) was found in the times for pain at the flank. At the coronet the times were also very close to those of group 2.

Muscle relaxation obtained in the group was adjudged fair and similar to that obtained by group 2, unlike Nowrouzian et al. (1981) who observed complete muscle relaxation in all sheep treated with the Xylazine/Ketamine combination. Hall and Taylor (1981) reported that muscle relaxation was incomplete with Xylazine/Ketamine anaesthesia in horses.

The onset, cessation and duration of salivation in all the first 3 groups showed no significant differences ($P > 0.05$).

GROUP 4

The weak time for the animals given Ketamine alone intramuscularly was found to be significantly shorter ($P < 0.05$) than that found for the first 2 groups but was not significantly different ($P > 0.05$) from when Ketamine and Xylazine were used in the same syringe. The sheep went

into lateral recumbancy within 2.53 ± 1.77 minutes and were standing at 19.40 ± 7.89 minutes. The down time was significantly shorter ($P< 0.05$) than for any of the other groups. This must be due to there being no Xylazine. The times found were basically in agreement with those obtained by Humphrey (1971), Keller and Bayman (1978) and Nowrouzian et al. (1981).

Ketamine alone did not produce analgesia at the coronet of the foot. However, analgesia was attained at the horn base and flank starting at 2.50 ± 3.45 minutes at the horn base and 1.00 ± 3.16 minutes at the flank and lasting 6.00 ± 6.99 minutes at the horn base and 1.00 ± 6.32 minutes at the flank. This would mean that the surgeon would be hard pressed for time when using Ketamine alone intramuscularly. These times were significantly shorter ($P< 0.05$) than those obtained when the combinations were used.

Ketamine alone did not cause any significant salivation and this want to show that the salivation produced in the first 3 groups was due to Xylazine. This was consistent with the findings of Fuentes and Tellez (1972) and Taylor et al. (1972). Nowrouzian et al. (1981) however found 40% of their sheep had mild salivation. Salivation has been reported in pigs not pretreated with Atropine (Thurmon et al., 1972).

Muscle relaxation was found to be extremely poor or absent when Ketamine was used alone intramuscularly and

muscle rigidity was found to be more pronounced in the animals injected intramuscularly with Ketamine alone. In most cases the sheep were lying with their limbs outstretched and their necks in opisthotonus. These findings were in agreement with those of Cullen and Jone (1977), Muir et al. (1977) and Nowrouzian et al. (1981). Humphrey (1981) observed relatively normal skeletal muscle tone when Ketamine was used alone in dogs.

INTRAVENOUS ROUTE

In general the anaesthetic time were shorter when the intravenous route was used than when the intramuscular route was used.

ANAESTHETIC TIMES

GROUP 5

Weak time was found in this group to be only 0.53 ± 0.18 minutes with the animals progressint to lateral recumbancy in 3.60 ± 3.89 minutes and staying down for 24.36 ± 14.57 minutes. This weak time was significantly shorter ($P< 0.05$) than when Xylazine was used alone intramuscularly but the down time was not significantly different ($P> 0.05$) between the routes.

Pain sensation at the horn base was lost within 5 minutes of the intravenous injection and remained absent for 22.22 ± 8.70 minutes. This duration of the loss of pain was not significantly ($P< 0.05$) different from the intramuscular

injection. At the flank pain sensation was lost in 4.44 ± 3.01 minutes but gained at 15.55 ± 11.02 minutes. The duration of this loss was 11.11 ± 9.28 minutes and none of these time were significantly different ($P < 0.05$) from when the intramuscular route was used. Pain sensation at the coronet was not lost as was the case with the intramuscular route.

Salivation was found to begin at 10.00 ± 2.04 minutes and lasted 16.67 ± 11.18 minutes this aspect also not differing significantly ($P > 0.05$) from the intramuscular route. Muscle relaxation was fair.

One death was recorded in this group, the sheep dying 18 minutes after the injection. On postmortem examination the liver, spleen and kidneys showed a fair degree of congestion while the lungs were acutely inflamed particularly the apical lobes. Several scattered petechial haemorhages were observed on various organs but particularly on the epicardium. The pathological diagnosis reached was acute pneumonia, death being brought about by the combination of the acute pneumonia and the Xylazine injection. Clarke and Hall (1969) when reporting the death of a 2 year old Thoroughbred horse stated that Xylazine may have contributed to the death but thought it was unlikely.

GROUP 6

Weak time, down to sternal time and down to lateral time did not differ significantly ($P > 0.05$) from Group 5 which was expected since no Ketamine had been injected until at 10 minutes. The sheep were standing in 48.25 ± 14.64 minutes having been down for 45.06 ± 13.68 minutes, none of these times being significantly different ($P < 0.05$) from the intramuscular times. Standing and down time were, however, significantly longer ($P < 0.05$) than when Xylazine was used alone intravenously.

Pain at the horn base was lost by 5 minutes this time being significantly shorter ($P < 0.05$) than when the same combination was used intramuscularly but not significantly ($P > 0.05$) different from when Xylazine was used alone intravenously. The loss of pain lasted for 42.22 ± 13.25 minutes. This was significantly longer ($P < 0.05$) than where Xylazine was used alone intravenously but not significantly different ($P > 0.05$) from when the same combination was used intramuscularly.

Pain sensation at the flank was lost within 12.22 ± 4.41 minutes and was absent for 25.56 ± 12.36 minutes. These time were not significantly different ($P > 0.05$) from when the same combination was used intramuscularly. There was a significant difference ($P < 0.05$) in the time for loss of pain at the flank, Group 6 taking longer than Group 5. However, there was no significant difference ($P > 0.05$) when it came to the duration of the loss of pain sensation in that area.

Pain sensation at the coronet was lost but this only lasted 0.55 ± 1.67 minutes which did not differ significantly ($P > 0.05$) from when the combination was used intramuscularly.

The onset and duration of salivation was not significantly different ($P > 0.05$) from when Xylazine was used alone intravenously nor from when the combination was used intramuscularly However the cessation of salivation was significantly longer ($P < 0.05$) when the combination was used than when Xylazine was used alone intravenously.

One of the animals in this group died early in the anaesthesia. Unfortunately a postmortem was not performed due to decomposition of the carcass brought about by the failure of the postmortem room refrigerator.

GROUP 7

In this group the reaction to the combination of Xylazine and Ketamine in the same syringe intravenoulsy was very rapid. The sheep would rear their heads, fall to sternal and then immediately go into lateral recumbancy with rigid limbs and often shaking the whole body. A few also moved their heads around but all settled down quietly soon to give good muscle relaxation. Non-purposeful movements have also been reported by Muir et al. (1977).

Weak time, down to sternal and down to lateral were all 0.28 ± 0.08 minutes and were significantly ($P < 0.05$) shorter than the respective times when the same combination was used

intramuscularly. The time were also significantly ($P < 0.05$) shorter than those of groups 5 and 6. No significant difference ($P > 0.05$) was found in the standing (48.56 ± 17.02 minutes) and the down time (48.28 ± 17.00 minutes) between this route and the times for the intramuscular route. These time were significantly ($P < 0.05$) longer than those for Xylazine alone intramuscular but not significantly different ($P > 0.05$) from the time when Ketamine was injected 10 minutes after Xylazine.

The pain at the horn base was lost at 5 minutes which was longer than when the same combination was given intramuscularly. This however may not show the true image since these animals in group 7 were undergoing non-purposeful movements at the time and as such pain sensation could not accurately be gauged. The duration of the pain loss was 39.44 ± 15.70 minutes which was significantly different ($P < 0.05$) from the times obtained for the intramuscular route. The time washowever, significantly ($P < 0.05$) longer than when Xylazine was used alone though not significantly different ($P > 0.05$) from the time for group 6.

The pain sensation of the flank was lost by 5 minutes and gained at 31.67 ± 7.90 minutes. The duration of the pain loss was 26.67 ± 7.90 minutes which was not significantly ($P > 0.05$) different from when the same combination was given intramuscularly or when Ketamine was given 10 minutes after Xylazine intravenous. The duration was significantly ($P < 0.05$) longer than when Xylazine was used alone intravenously.

At the coronet, although pain sensation was rapdily lost (0.562 ± 1.67 minutes) this loss of pain was very short-lived (1.11 ± 3.39 minutes) being shorter than via the intramuscular route (16.00 ± 9.07 minutes). Furthermore not all the animals showed loss of pain sensation in this area which made a t-test unreliable.

The onset,cessation and duration of salivation was very similar to that obtained with the same combination of drugs intramuscularly though significantly ($P < 0.05$) longer than when Ketamine was given 10 minutes after Xylazine intravenously.

Muscle relaxation in this case was good with Xylazine helping Ketamine to attain it (Kumar et al., 1976; Cullen and Jone, 1977; Mulder and Mulder, 1979; Nowrouzian et al., 1981).

One death was also recorded in this group. On postmortem examination Stilesia hepatica worms were found in the major bile ducts of the liver and the Thymus was greatly enlarged. Microscopically, there were cytoplasmic vacuoles in the hepatocytes and marked hemorrhages in the Thymus. Death in this case was attributed to the Ketamine anaesthetic (anaesthetic death).

GROUP 8

In this group where Ketamine was used alone intravenously the sheep rapidly went into lateral recumbacy and also showed similar behavioural pattern as described for group 7. This

behavioral pattern was then attributed to Ketamine as Xylazine alone intravenously did not give the pattern.

The standing time for Ketamine alone intravenous (17.10 ± 5.98 minutes) was significantly ($P < 0.05$) shorter than when Ketamine was used alone intramuscularly though actual down time showed no significant difference ($P > 0.05$). These results show a shorter time than that recorded by Nowrouzian et al. (1981). Waterman and Livingstone (1978) found that an increase in dosage produced an increase in anaesthetic times.

No loss of paid sensation was recorded for this group at any site and muscle relaxation was poor. Salivation did not occur in this group and no death were recorded in the group.

NYSTAGMUS

Nystagmus was observed in all the animals that progressed tc lateral recumancy. The eyeball rolled downwards and was lowest at the maximal anaesthesia becoming central again as the anaesthetic wore off. When animals did not progress to recumbancy the eyeball remained central. Nystagmus was least obvious when Xylazine was used alone either intramuscularly or intravenously.

REGURGITATION

No significant regurgitation was observed in any of the experimental animals though a trickle or two were found in a few

animals. Regurgitation has however been reported by Thurmon et al. (1978) and Cullen and Jones (1977). Fuentez and Tellez (1972) observed no regurgitation in cows.

TEMPERATURE VARIATIONS

When Xylazine, Ketamine and the various combinations were administered intramuscularly, there was an initial mild increase in temperature followed by a progressive decline. The lowest mean temperature obtained was 37.8^{o}C but it was only in the Group 1 animals where the decline was significant ($P< 0.05$) the others remaining within normal limits.

During intravenous injection Group 5-7 showed a gradual declines in body temperature all of which were significant ($P< 0.05$). Group 8, contrary to most literature showed a significant ($P< 0.05$) rise in body temperature. The rise in this group could possibly be attributed to their excessive muscular activity especially within the first few minutes of anaesthesia. However, Group 7 did not follow the same trend though they too had tremors and non-purposeful movements albeit to a lesser degree than the Group 8. Furthermore Kumar et al. (1976) reported that the muscle relaxant effect of Xylazine was not overiden by the Central stimulation effect of Ketamine. Cullen and Jones (1977), Mulder and Mulder (1979) and Nowrouzian et al. (1981) were also of a similar view. This upward variation in temperature was therefore not only due to the muscular tremors and non-purposeful movements but possibly due also to individual and group variation.

The significant falls in body temperature are contrary to the findings of Kumar et al. (1976) who, though reporting a fall in temperature, reported this fall to be mild and within normal limits. Muir et al. (1977) found no change in the rectal temperature and Nowrouzian et al. (1981) recorded no considerable change.

HEART RATE

A significant ($P< 0.05$) fall was found in all the groups except when Ketamine was used alone intravenously. The falls were consistent with those found by several other authors both for Xylazine (Clarke and Hall, 1969; Rickard et al., 1974; Kosuch, 1975; Aziz and Carlyle, 1979; Aziz and Martin 1978; Campbell et al., 1979; Kumar and Singh, 1979) and for Ketamine (Kumar et al., 1976) though not all are agreed that the falls were significant.

On the other hand Humphrey (1971) observed a mild cardiac stimulation and Waterman and Livingstone (1978) reported an initial rise in the heart rate but with a quick return to normal. Nowrouzian et al. (1981) observed tachycardia at maximal anaesthesia.

Campbell et al. (1979) attributed the fall in heart rate to a probable depression of the myocardium while Aziz and Carlyle (1979) and Aziz and Martin (1979) regarded the fall to be possibly due to the local anaesthetic effect of Xylazine Aziz and Carlyle (1979) also reported a second degree heart block which was short lived.

In explaining the respiratory stimulation Waterman and Livingstone (1978) thought that these was probably due either to direct intoxication of the Medulling respiratory center or to indirect stimulation via peripheral chemoreceptors, or secondary to activation of higher centres.

RESPIRATORY RATE

Apnoea was observed especially in groups 7 and 8 occuring from the time of injection and lasting for 0.5-2.5 minutes. Whether apnoea occured or not, respiration then went on to rise significantly ($P< 0.05$) in all 8 groups. These findings are similar to those reported by Aziz and Carlyle (1979) who found apnoea to last for 3-5 minutes. These authors attributed some of these respiratory effects to the local anaesthetic properties of Xylazine. Other authors have also reported respiratory stimulation especially as regards Ketamine (Humphrey, 1971; Waterman and Livingstone, 1978).

Kosuch (1975) observed a dose-dependant fall in respiratory rate when Xylazine was used as did Presidente et al. (1973), Rickard et al. (1974), Muir et al. (1977) and Kumar and Singh (1979). With Ketamine, Nowrouzian et al. (1981) reported a slight fall in the respiratory rate while Thurmon et al. (1972) and Pezzoli and M. del Bue (1976) recorded only slight variations.

EFFECTS ON BLOOD

The observed trends in the blood picture have also been reported by several authors (De Moor and Desmet, 1971; Seal et al., 1972; Presidente et al., 1973; Drevemo and Karstad 1974, Nowrouzian et al., 1981). All workers found a return to preanaesthetic values within 24 hours, some found the return to take shorter.

Nowrouzian et al. (1981) also reported increases in percentages in neutrophils and lymphocytes. The effect observed were very similar or almost identical when Xylazine and Ketamine were used alone or in the various combinations by either route.

The most used and probably most acceptable explanation for the falls in the blood cellular elements would be hemodilution. Drevemo and Karstad (1974) attributed this hemodilution to an influx of intestinal fluids due in part to the decreased heart rate and to the low blood pressure. Presidente et al. (1973) were of identical views. The hemodilution theory is further supported by the fact that the decrease in blood cellular elements was basically uniform for the various elements.

Kumar et al. (1974) put forward the possibility of pooling or daming of erythrocytes in the spleen to explain the falls in RBC, PCV, and Hb as seeen with other anaesthetics. This however would not explain the falls in the White cells, although admittedly, this could play a part.

De Moor and Desmet (1971) suggested that the fall in PCV and RBC would be due to the lytic effects of Xylazine. However, no discoloration of serum in centrifuged blood was observed. This however did not rule out some hemolysis taking place.

Kumar et al. (1974) thought the fall in the leucocyte count to be probably due to Adrenocortical stimulation and the subsequent effect of glucocorticoids on circulating neutrophils and lymphocytes. The actual effect is a disappearance of lymphocytes from the peripheral blood and the depression of lymphocytic tissue caused by the increased Adrenocortical activity (Schalm, 1970).

CONCLUSIONS

ANAESTHESIA AND ANALGESIA

Xylazine and Ketamine are safe anaesthetics for use in sheep and this is in support of Thurmon et al. (1973) and Nowrouzian et al. (1981).

These experiments revealed only a 3.75% (3 out of 80) deaths only one of which could be attributed directly to anaesthetic death.

The best results for anaesthesia and analgesia were obtained with the combinations of the drugs particularly when Xylazine and Ketamine were used together in the same syringe and injected intramuscularly. In this case pain sensation of the coronet was lost for 16.00 ± 9.07 minutes, at the flank for 32.70 ± 8.98 minutes and at the horn-base for 46.80 ± 7.53 minutes. The sheep were down for 52.40 ± 6.43 minutes which on average was longer than for any of the other groups. The muscle relaxation however was only fair, the best being attained in Groups 6 and 7 where the combinations were injected intravenously.

However, when Xylazine was injected 10 minutes before Ketamine intramuscularly, the anaesthetic times, though shorter, were not significantly ($P > 0.05$) different from the above times.

Ketamine when used alone intravenously did not cause any relief from pain at the coronet and when used intramuscularly

pain sensation at the coronet was retained and at the horn-base only short-lived relief was attained. It is therefore suggested that Ketamine be used together with Xylazine in any of the two combinations.

BLOOD PICTURE

In the majority of the sheep, blood constituent values had returned to pre-anaesthetic values at 24 hours and so the effects of the anaesthetic were temporary. Although the blood constituents in many cases fell significantly ($P< 0.05$) in value at 15 minutes after the injection of the first drug and at 30 minutes after standing this effect was not considered overly dangerous. None-the-less care should be taken in anemic animals and in those severely debilitated as any disease increases anaesthetic risk.

Because the serum was not discoloured when PCV was being determined and because MCV and MCHC remained virtually unchanged, it is concluded that the fall in PCV and RBC was due to hemodilution, most probably by intestinal fluids, rather than due to hemolysis as put forward by Kumar et al. (1974). This supports the prostulations of Presidente et al. (1973) and Drevemo and Karstad (1974).

TEMPERATURE, HEART RATE AND RESPIRATORY RATE

All these factors were found to be significantly lowered (at 5%) during anaesthesia except the temperatures for Group 8 which had a rise. The rise in Group 8 was probably due to the excessive muscular activity during anaesthesia.

These falls, however, though statistically significant, were not considered to be too dangerous and would not likely cause death at the dosage rates used.

The apnoea that occured at the beginning of anaesthesia especially in some of the intravenous injection was short-lived and not fatal.

From the above summaries it can be finally concluded that Xylazine and Ketamine are safe for use as general anaesthetics in sheep at the dosage rate of 0.22 mg/kg Xylazine and 11 mg/kg Ketamine. They can be used effectively for short-term operations requiring laparotomy but not in operations of the distal limbs because there the analgesia is short-lived and not entirely reliable.

The effects of these drugs, at the given dosages on temperature, heart rate and respiratory rate, though statistically significant, should not cause undue worry but they are worth noting. It is further suggested that routine hematology be carried out prior to anaesthesia to determine especially the PCV since anemia would increase the anaesthetic risk.

The excessive salivation, seen whenever Xylazine was used, did not reach alarming proportions.

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A P P E N D I C E S

TABLES A(1) to A(8): INDIVIDUAL RESULTS FOR TIMES OBTAINED VIA THE INTRAMUSCULAR AND INTRAVENOUS ROUTES.

TABLE A(1): (GROUP I - ROMPUN ALONE (IM)

	1 (F)	2 (M)	3 (M)	4 (M)	5 (F)	6 (M)	7 (F)	8 (F)	9 (M)	10 (F)	MEAN	LEAST	MOST	SD	MEAN + SD
Weak time	7	6	14	8	4	3	7	6	4	3	6.2	3	14	3.26	6.2±3.26
Down to sternal	15	14	-	12	8	6	26	16	10	29	13.6	-	29	8.75	13.6±8.75
Down to lateral	-	-	-	-	14	7	-	-	-	-	2.1	-	14	4.72	2.1±6.72
Upto sternal	-	-	-	-	15	61	-	-	-	-	7.6	-	61	19.34	7.6±6.12
Attempt to rise from injection	24	19	--	35	15.5	63	44	47	18	48	31.35	-	63	19.19	31.35±19.19
Attempt to rise (from sternal time)	9	5	-	23	7.5	56	18	31	8	16	17.35	-	56	16.4	17.35±16.4
Down time	10	6	-	26	8	57	18	32	8	16	18.1	-	57	16.72	18.1±16.72
Standing	25	20	-	38	16	63	44	48	18	45	31.7	-	63	18.9	31.7±18.9
Pain at horn base lost	20	20	-	25	5	5	15	15	5	10	12	-	25	8.23	12 ± 8.23
Pain at horn base gained	25	25	-	35	35	65	40	50	20	45	34	-	65	17.9	34 ± 17.9
Duration of loss	5	5	-	10	30	60	25	35	15	25	22	-	60	18.58	22 ± 18.58
Pain at flank lost	5	-	-	-	5	20	25	45	10	10	12	-	45	14.37	12 ±14.37
Pain at flank gained	10	-	-	-	35	35	45	50	20	15	21	-	50	19.11	21 ±19.11
Duration of loss	5	-	-	-	30	15	20	5	10	5	9	-	30	9.94	9 ±9.94
Pain at coronet lost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pain at coronet gained	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duration of loss	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Onset of salivation	5	5	5	10	10	20	10	35	10	5	11.5	5	35	9.94	11.5 9.44
Cessation of salivation	30	25	30	40	25	65	45	50	20	45	37.5	20	65	13.99	37.5±13.99
Duration of salivation	25	20	25	30	15	45	35	15	10	40	26	10	45	11.49	26 ±11.49
Muscle relaxation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE A(2): (GROUP 2 - ROMPUM THE KETAMINE 10 MINUTES LATER (IM)

	1 (F)	2 (F)	3 (M)	4 (M)	5 (F)	6 (F)	7 (M)	8 (M)	9 (M)	10 (F)	MEAN	LEAST	MOST	SD	MEAN ± SD
Weak time	4	5	6	3	3	3	4	4	3	5	4	3	6	1.05	4 ±1.05
Down to sternal	7	14	13	7	15	7	10	6	6	11	9.6	6	15	3.47	9.6±3.47
Down to lateral	-	14.5	15	8	16	11	-	-	13	12	8.95	-	16	6.57	8.9±6.57
Up to sternal	-	35	53	54	47	40	-	-	45	93	36.7	-	93	29.75	36.7±29.75
Attempt to rise (from injection)	47	35.5	53.5	51	47.5	41	63	77	46	96	55.75	35.5	96	18.3	55.7±18.3
Attempt to rise (from sternal time)	40	21.5	40.5	44	32.5	34	53	71	40	85	46.15	21.5	85	18.9	46.1±18.9
Down time	41	22	40	47	32	38	55	74	41	86	47.6	22	86	19.3	47.6±19.3
Standing	48	36	53	54	47	45	65	80	47	97	57.2	36	97	18.5	57.2±18.5
Pain at horn base lost	5	5	15	10	10	10	15	5	10	10	9.5	5	15	3.69	9.5±3.69
Pain at horn base gained	40	35	55	55	45	25	50	80	40	95	52	25	95	21.1	52 ±21.1
Duration of loss	35	30	40	45	35	15	35	75	30	85	42.5	15	85	21.4	42.5±21.4
Pain at flank lost	15	15	15	10	15	15	20	15	15	15	15	10	20	2.36	15 ±2.36
Pain at flank gained	40	20	55	50	40	25	40	40	40	90	44	20	90	19.1	44 ±19.1
Duration of loss	25	5	40	40	25	10	20	25	25	75	29	5	75	19.55	29 ±19.55
Pain at coronet lost	15	-	-	-	-	-	-	15	-	20	5	-	20	8.16	5 ±8.16
Pain at coronet gained	40	-	-	-	-	-	-	35	-	40	11.5	-	40	18.57	11.5±18.57
Duration of loss	25	-	-	-	-	-	-	20	-	20	6.5	-	25	10.55	6.5±10.55
Onset of salivation	15	10	15	10	15	5	10	10	15	20	12.5	10	20	4.25	12.5±4.25
Cessation of salivation	45	30	50	40	35	35	60	70	45	55	46.5	30	70	12.5	46.5±12.5
Duration of salivation	30	20	35	30	20	30	50	60	30	30	33.5	20	60	12.5	33.5±12.5
Muscle relation	-	++	+++	+++	+	++	-	-	++	++	++	-	+++	-	-

TABLE A(3): (GROUP 3 - ROMPUN PLUS KETAMINE IN SAME SYRINGE (IM)

	1 (F)	2 (F)	3 (F)	4(F)	5 (M)	6 (F)	7 (M)	8 (M)	9 (M)	10 (M)	MEAN	LEAST	MOST	SD	MEAN SD
Weak time	2	2	1	1.5	1	1.5	1.5	1.5	1.5	1.5	1.5	1	2	0.3	1.5±0.33
Down to sternal	2	5	2.5	1.75	2	2	2	3	2.5	2	2.48	1.75	5	0.3	2.48±0.16
Down to lateral	5	6	2.75	2	3	3	2.5	3.5	3	4	3.48	2	6	1.2	3.48±1.72
Up to sternal	47	57	59	55	51	41	45	57	42	49	50.3	41	59	6.5	50.3±6.53
Attempt to rise (from injection)	47.5	61	60	55.5	53	42	45.5	58	44	55	52.5	42	60	7.3	52.5±7.33
Attempt to rise (from sternal time)	45.5	59	57.5	53.75	51	40	43.5	55	41.5	53	50.0	40	59	6.8	50.0±6.86
Down time	46	61	58	54.25	53	42	44	57	51.5	57	52.4	42	61	6.4	52.4±6.42
Standing	48	66	60.5	56	55	43	46	60	54	59	54.8	43	66	7.2	54.8±7.21
Pain at horn base lost	3	5	5	2	3	3	2.5	3.5	3	2	3.2	2	5	1.0	3.2±1.05
Pain at horn base gained	40	65	60	55	45	45	40	50	50	50	50	40	60	8.1	50.0±8.16
Duration of loss	37	60	55	53	42	42	37.5	46.5	47	48	46.8	37	60	7.5	46.8±7.53
Pain at flank lost	3	10	10	5	5	5	5	10	5	5	6.3	3	10	2.63	6.3±2.63
Pain at flank gained	40	25	45	35	45	40	40	30	40	50	39	25	50	7.31	39±7.31
Duration of loss	37	15	35	30	40	35	35	20	35	45	32.7	15	45	8.53	32.7±8.53
Pain at Coronet lost	-	-	5	5	5	10	5	10	5	10	5.5	-	10	3.69	5.5±3.69
Pain at coronet gained	-	-	25	30	25	35	20	25	25	30	21.5	-	35	12.03	21.5±12.03
Duration of loss	-	-	20	25	20	25	15	15	20	20	16	-	25	5.97	16±5.97
Onset of salivation	15	15	15	15	10	20	5	20	20	15	15	10	20	4.71	15±4.71
Cessation of salivation	40	60	60	50	50	40	20	55	50	55	48	20	60	12.05	48±12.05
Duration of salivation	25	45	45	35	40	20	15	35	30	40	33	15	45	10.32	33±10.32
Muscle relaxation	+++	+++	++	+	+	+	++	+	+	++	++	+	+++		

TABLE A(5): (GROUP 5 ROMPUN ALONE (I/V)

	1 (F)	2 (F)	3 (M)	4 (M)	5 (M)	6 (M)	7 (F)	8 (F)	9 (F)	10 (M)	MEAN	LEAST	MOST	SD	MEAN± SD
Weak time	0.5	0.5	0.5	0.5	0.5	0.5	0.25	0.5	0.5	1	0.525	0.25	1	0.1[illegible]	[illegible]
Down to sternal	1.5	4	1.5	1	1	1	4	1	0.75	2	1.78	1	4	1.23	1.78±1.23
Down to lateral	5	4.5	2	1.5	1.5	1.5	14	2	1	3	3.60	1	5	3.89	3.60±3.89
Up to sternal	14.5	22	26		53	27	15	20	29.5	14	24.55	14.5	53	12.11	24.55±12.11
Attempt to rise (from injection)	15	22.5	27		57	27.5	15	20.5	31	15	25.61	15	57	13.20	25.61± 13.20
Attempt to rise (from sternal time)	13.5	18.5	25.5		56	26.5	11	19.5	30.25	13	23.75	11	56	13.79	23.75 ±13.79
Down time	14	19	26		59	27	11.5	19.5	30.25	13	24.36	11.5	59	14.57	24.36± 14.57
Standing	15.5	23	27.5		60	28	15.5	20.5	31	15	26.22	15	60	13.99	[illegible]
Pain at horn base lost	5	5	5		5	5	5	5	5	5	5	5	5	0	5 ± 0
Pain at horn base gained	30	30	25		45	30	20	20	30	15	27.22	15	45	8.70	27.22±8.70
Duration of loss	25	25	20		40	25	15	15	25	10	22.22	10	40	8.70	22.22±8.70
Pain at flank lost	5	5	5		-	5	5	-	10	5	4.44	-	10	3.01	4.44±3.01
Pain at flank gained	30	15	15		-	30	20	-	20	10	15.55	-	30	11.02	15.55±11.02
Duration of loss	25	10	10		-	25	15	-	10	5	11.11	-	25	9.28	11.11±9.28
Pain at Coronet lost	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Pain at coronet gained	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Duration of loss	-	-	-		-	-	-	-	-	-	-	-	-	-	-
Onset of salivation	15	10	20		5	10	-	10	15	5	10	-	20	6.12	10± 6.12
Cessation of salivation	30	30	35		45	35	-	20	25	20	26.67	-	45	12.75	26.67±12.75
Duration of salivation	15	20	15		40	25	-	10	10	15	16.67	-	40	11.18	16.67±11.18
Muscle relaxation	+++	++	+		+	++	-	++	++	++	++	-	+++		

TABLE A(6): (GROUP 6 - ROMPUN I/V THEN KETAMIN I/V 10 MINUTES LATER)

	1 (M)	2(F)	3 (F)	4 (M)	5 (M)	6 (F)	7 (F)	8 (M)	9 (F)	10 (M)	MEAN	LEAST	MOST	SD	MEAN ±SD
Weak time	0.5	0.25	0.5	0.25	0.25	0.25	0.5	0.5	0.25	0.5	0.38	0.25	0.5	0.13	0.38 ± 0.13
Down to sternal	1	0.75	1	3.5	0.75	1	1	1.5	8	2	2.05	0.75	8	2.25	2.05±2.25
Down to lateral	1.5	1	1.5	4	1.5	1	1	2	9	8	3.05	1	9	3.01	3.05±3.01
Up to sternal	40	34	43	45	43		44	36	43	79	45.22	34	79	13.20	45.22±13.20
Attempt to rise (from injection)	41	34.5	45	46	43.5		44.5	36	45	80	46.17	34.5	80	13.34	46.17±13.34
Attempt to rise (from sternal time)	40	33.75	44	42.5	42.75		43.5	34.5	37	78	44	33.75	78	13.32	44 ± 13.32
Down time	42	34.25	49	45.5	43.25		44.5	35	35	77	45.06	34.25	77	13.08	45.06±13.08
Standing	43	35	50	49	44		45.5	37	46	85	48.28	35	85	14.64	48.28±14.64
Pain at horn base lost	5	5	5	5	5		5	5	5	5	5	5		0	5 ± 0
Pain at horn base gained	45	35	50	45	45		45	35	45	80	47.22	35	80	13.25	47.22±13.25
Duration of loss	40	30	45	40	40		40	30	40	75	42.22	30	75	13.25	42.22±13.25
Pain at flank lost	15	15	5	15	15		15	5	15	10	12.22	5	15	4.41	12.22±4.41
Pain at flank gained	30	30	30	40	30		45	30	40	65	37.78	30	65	11.79	37.78±11.79
Duration of loss	15	15	25	25	15		30	25	25	55	25.56	15	55	12.36	25.56±12.36
Pain at coronet lost	-	-	15	-	-		-	-	-	-	1.67	-	15	5	1.67 ±5
Pain at coronet gained	-	-	20	-	-		-	-	-	-	2.22	-	20	6.67	2.22 ±6.67
Duration of loss	-	-	5	-	-		-	-	-	-	0.55	-	5	1.67	0.55 ±1.67
Onset of salivation	10	20	-	15	10		20	10	15	10	12.22	-	20	6.15	12.22±6.15
Cessation of salivation	45	35	-	45	45		50	40	40	65	40.55	-	65	17.40	40.55±17.40
Duration of salivation	35	15	-	30	35		30	30	25	55	28.33	-	55	15.06	28.33±15.06
Muscle relaxation	+++	+++	+++	+++	++		+++	+++	++	+++	+++	++	+++		

TABLE A(7): (GROUP 7 - ROMPUN PLUS KETAMINE IN THE SAME SYRINGE I/V)

	1 (F)	2 (F)	3 (F)	4 (F)	5 (M)	6 (M)	7 (M)	8 (M)	9 (M)	10 (F)	MEAN	LEAST	MOST	SD	SE± SD
Walk time	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.275	0.25	0.5	0.08	0.275 ± 0.03
Down to sternal	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.275	0.25	0.5	0.08	0.275 ± 0.03
Down to lateral	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.275	0.25	0.5	0.08	0.275 ± 0.03
Up to sternal	55	68		19	60	45	50	23	26	37	42.56	19	68	17.36	42.56 ± 17.36
Attempt to rise (from injection)	57	68.5		24	72	46	51	24	26	42	45.61	24	68.5	16.41	45.61 ± 16.41
Attempt to rise (from sternal time)	56.5	68.25		23.75	71.75	46.75	50.75	23.75	25.75	41.75	45.33	23.75	68.75	16.29	45.33 ± 16.3
Down time	57.5	68.75		27.75	74.75	46.75	53.75	27.75	33.75	43.75	48.28	27.75	74.75	17.09	48.28 ± 17.0
Standing	58	69		28 28	75	47	54	28	34	44	48.56	28	75	17.02	48.56 ± 17.0
Pain at horn base lost	5	5		5	5	5	5	5	5	5	5	5	5	0	5 ± 0
Pain at horn base gained	60	70		30	60	45	40	25	30	40	44.44	25	70	15.70	44.44 ± 15.7
Duration of loss	55	65		25	55	40	35	20	25	35	39.44	25	65	15.70	39.44 ± 15.7
Pain at flank lost	5	5		5	5	5	5	5	5	5	5	5	5	0	5 ± 0
Pain at flank gained	40	40		25	35	40	25	20	25	35	31.67	20	40	7.90	31.67 ± 7.90
Duration of loss	35	35		20	30	35	20	15	20	30	26.67	15	35	7.90	26.67 ± 7.90
Pain at coronet lost	-	5		-	-	-	-	-	-	-	0.56	-	5	1.67	0.56 ± 1.67
Pain at coronet gained	-	15		-	-	-	-	-	-	-	1.67	-	15	1.67	1.67 ± 1.67
Duration of loss	-	10		-	-	-	-	-	-	-	1.11	-	10	3.39	1.11 ± 3.39
Onset of salivation	10	15		10	10	10	15	10	15	10	11.67	10	15	2.50	11.67 ± 2.50
Cessation of salivation	55	45		30	70	45	45	30	30	40	43.33	30	70	13.23	43.33 ± 13.23
Duration of salivation	45	30		20	60	35	30	20	15	30	31.67	15	60	13.92	31.67 ± 13.92
Muscle relaxation	+++	+++		++	+++	++	+++	++	+	++	++	+	+++		

TABLE A(8): GROUP 8 KETAMINE ALONE I/V

	1 (F)	2 (F)	3 (M)	4 (F)	5 (M)	6 (M)	7 (F)	8 (F)	9 (M)	10 (M)	MEAN	LEAST	MOST	SD	MEAN ± SD
Weak time	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0.25 ± 0
Down to sternal	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0.25 ± 0
Down to lateral	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0.25 ± 0
Up to sternal	7	10	10	13	17	9	7	13	20	10	11.60	7	20	4.22	11.6 ± 4.22
Attempt to rise (from injection)	10	12	12	14	28	12	10	13.5	22	11	14.45	11	28	5.88	14.45 ± 5.8
Attempt to rise (from sternal time)	9.75	11.75	11.75	13.75	27.75	11.75	9.75	13.25	21.75	10.75	14.20	9.75	27.75	5.55	14.2 ± 5.55
Down time	13.75	13.75	14.25	16.75	29.75	13.75	14.75	14.25	24.75	10.75	16.85	10.75	24.75	5.93	16.85 ± 5.93
Standing	14	14	14.5	19	30	14	15	14.5	25	11	17.10	11	25	5.93	17.10 ± 5.93
Pain at horn base lost	)														
Pain at horn base gained	)														
Duration of loss	)														
Pain at flank lost	)														
Pain at flank gained	)														
Duration of loss	)														
Pain at coronet lost	)														
Pain at coronet gained	)														
Duration of loss	)														

)))) - All remained sensitive to pain

Onset of salivation	}														
Cessation of salivation	))) Salivation was negligible if at all.														
Duration of salivation	}														
Muscle relation	)))))))))---- Fits and starts on induction and also half way through														

TABLES A(9) TO A(22): - INDIVIDUAL RESULTS FOR BLOOD CONSTITUENTS VIA THE INTRAMUSCULAR ROUTE

a = Blood sample taken 15 minutes prior to administration of any drug

b = Blood sample taken 15 minutes after the first injection

c = Blood sample taken 30 minutes after the animal stood up

d = Blood sample taken 24 hours after the experiment

(TABLE A(9):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
51a	29	6.6	10.6	11.40	14,200	25	37.8	18	0	81	0	1	0
51b	24	5.6	7.8	8.60	10,800	28	32.4	11	0	88	0	1	0
51 c	B l o o d				c l o t t e d								
51 d	30	6.6	10.2	11.80	14,400	25	34	15	0	85	0	0	0
52 a	38	6.3	13.0	12.95	13,400	29	34.2	36	0	64	0	0	0
52 b	28	5.4	9.7	9.80	11,000	28	34.6	24	0	76	0	0	0
52 c	33	5.6	11.1	11.15	11,900	30	33.7	25	0	73	0	2	0
52 d	38	5.8	13.2	14.12	10,900	27	34.7	29	0	70	0	1	0
53 a	30	6.8	10.1	10.50	23,300	29	33.7	26	0	74	0	0	0
53 b	25	6.4	8.4	8.60	20,100	29	33.6	17	0	83	0	0	0
53 c	23	6.0	8.3	9.10	18,100	25	36.1	19	0	80	0	1	0
53 d	30	6.7	10.1	10.50	25,400	29	33.7	25	0	74	0	1	0

TABLE A(10):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
54 a	30	5.8	10.2	9.60	19,500	31	34.0	15	0	85	0	0	0
54 b	23	5.0	7.6	8.35	11,600	28	33.0	18	0	82	0	0	0
54 c	23	5.3	7.7	8.95	9,100	26	33.4	11	0	88	0	1	0
54 d	31	5.8	9.8	10.20	13,000	30	31.8	17	0	83	0	0	0
55 a	31	5.8	9.8	9.35	14,000	33	31.8	15	0	85	0	0	0
55 b		B	l	o	o	d		c	l	o	t	t	e	d
55 c	25	5.0	7.4	7.90	10,600	32	29.6	21	0	79	0	0	0
55 d	31	6.8	9.1	10.50	13,400	30	29.4	12	0	88	0	0	0
56 a	27	5.4	9.6	9.50	11,600	28	35.5	18	0	81	0	1	0
56 b	27	5.6	9.0	9.80	10,800	28	33.3	17	0	82	0	1	0
56 c	24	5.6	8.6	9.25	9,600	26	35.8	24	0	74	0	2	0
56 d	31	7.2	11.1	12.50	11,400	25	35.6	15	0	85	0	0	0

TABLE A(11):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
57 a	28	6.6	9.5	10.90	14,000	26	33.9	13	0	87	0	0	0
57 b	21	6.0	7.5	9.10	9,600	23	35.7	15	0	85	0	0	0
57 c	24	6.0	8.2	9.00	9,900	27	34.2	17	0	83	0	0	0
57 d	29	6.6	9.8	10.75	13,100	27	33.8	38	0	62	0	0	0
58 a	34	7.4	11.9	13.75	12,000	25	35.0	48	0	50	0	2	0
58 b	26	6.0	9.8	10.70	9,800	24	37.7	42	0	58	0	0	0
58 c	28	5.6	9.5	10.95	9,200	25	33.9	47	0	51	0	2	0
58 d	36	5.6	12.4	14.75	11,600	24	34.5	36	0	62	0	2	0
59 a	28	6.4	9.8	12.25	15,000	23	35.0	17	0	83	0	0	0
59 b	25	6.0	8.3	9.60	11,200	26	33.2	13	0	85	0	2	0
59 c	23	6.2	8.0	9.30	10,800	25	34.8	29	0	70	0	1	0
59 d	31	5.8	10.2	14.45	15,400	22	32.9	25	0	74	0	1	0
60 a	33	6.4	12.0	12.85	12,300	26	36.4	20	0	80	0	0	0
60 b	27	5.2	9.3	10.55	9,600	25	34.4	22	0	78	0	0	0
60 c	27	5.4	9.5	10.25	9,000	26	35.2	22	0	76	0	2	0
60 d	34	6.7	12.5	14.35	13,400	24	36.8	36	0	64	0	0	0

TABLE A(12):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
61 a	33	6.7	11.6	13.40	11,300	25	35.2	32	0	68	0	0	0
61 b	23	5.5	7.6	10.20	11,500	23	33.0	31	0	69	0	0	0
61 c	26	6.2	8.8	10.90	14,000	24	33.9	31	0	69	0	0	0
61 d	32	6.4	11.1	13.60	11,500	24	34.7	21	0	79	0	0	0
62 a	38	6.2	13.3	15.20	18,100	25	35.0	21	0	76	0	3	0
62 b	29	5.1	10.5	12.65	14,600	23	36.2	22	0	76	0	2	0
62 c	29	5.6	10.3	11.80	15,200	25	35.6	10	0	90	0	0	0
62 d	38	6.4	13.1	14.90	17,000	26	34.5	20	0	78	0	2	0

TABLE A(13):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
63 a	33	7.0	12.0	12.80	18,800	26	36.4	16	0	84	0	0	0
63 b	26	5.4	9.0	9.35	13,900	28	34.6	19	0	80	0	1	0
63 c	29	5.4	11.5	14.25	16,800	20	39.7	11	0	89	0	0	0
63 d	32	5.8	11.8	14.35	20,000	22	36.9	18	0	82	0	0	0
64 a	34	6.0	11.7	15.00	17,800	23	34.4	18	0	80	0	2	0
64 b	31	6.4	11.3	13.65	12,900	23	36.5	14	0	86	0	0	0
64 c	28	5.8	10.6	13.10	13,600	21	37.9	16	0	84	0	0	0
64 d	35	6.2	12.2	15.25	17,600	23	34.9	25	0	74	0	1	0
65 a	31	6.6	12.1	14.60	24,000	21	39.1	14	0	86	0	0	0
65 b	27	5.8	9.6	11.70	12,500	23	35.5	23	0	76	0	1	0
65 c	27	6.0	10.0	12.80	15,600	21	37.1	21	0	79	0	0	0
65 d	32	5.6	10.9	13.50	20,900	24	34.3	21	0	79	0	0	0

TABLE A(14):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
66 a	36	6.4	12.3	14.20	17,800	27	34.1	16	0	84	0	0	0
66 b	27	6.4	9.7	11.50	13,700	23	35.8	14	0	86	0	0	0
66 c	29	5.6	10.7	11.25	13,200	26	37.2	9	0	91	0	0	0
66 d	36	6.2	12.2	13.62	16,200	26	34.0	18	0	82	0	0	0
67 a	27	5.8	9.6	12.60	13,100	21	35.5	32	0	68	0	0	0
67 b	22	5.2	7.9	10.30	9,200	21	35.8	20	0	80	0	0	0
67 c	21	5.0	7.5	9.65	8,400	22	35.7	18	0	82	0	0	0
57 d	28	5.6	9.6	12.20	11,600	23	34.3	33	0	67	0	1	0

TABLE A(15):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
68 a	27	6.2	9.5	10.35	21,000	26	35.2	18	0	82	0	0	0
68 b	25	5.4	8.6	9.50	14,400	26	34.5	27	0	73	0	0	0
68 c	24	4.8	8.8	9.95	19,200	24	36.7	20	0	80	0	0	0
68 d	27	5.6	9.2	10.50	19,800	26	34.1	21	0	79	0	0	0
69 a	25	7.2	9.2	9.65	54,000	26	36.9	27	0	73	0	0	0
69 b	22	6.2	8.1	8.40	30,500	26	26.8	13	0	87	0	0	0
69 c	21	6.2	8.2	8.50	41,800	25	39.1	18	0	82	0	0	0
69 d	25	6.4	10.0	10.30	30,100	24	40.0	22	0	78	0	0	0
70 a	29	6.2	10.0	10.10	29,000	29	34.5	49	0	51	0	0	0
70 b	24	6.2	10.0	9.20	18,000	26	41.7	52	0	48	0	0	0
70 c	22	5.8	9.4	8.75	25,000	25	42.6	48	0	50	0	2	0
70 d	31	6.3	9.9	11.50	32,000	27	32.0	66	0	34	0	0	0

TABLE A(16):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
71a	32	7.3	11.3	10.00	12,800	32	35.4	15	0	84	0	1	0
71 b	24	7.0	9.1	9.55	10,900	27	37.9	13	0	87	0	0	0
71 c	26	5.4	8.9	8.45	10,700	31	34.2	31	0	69	0	0	0
71 d	29	6.0	10.5	9.45	24,400	32	36.2	35	0	63	0	2	0
72 a	30	7.0	10.2	10.95	13,300	27	34.1	36	0	64	0	0	0
72 b	25	5.8	8.9	9.25	10,800	27	35.6	35	0	65	0	1	0
72 c	21	7.2	7.7	7.66	10,500	28	36.6	26	0	73	0	1	0
72 d	26	7.4	9.6	8.55	25,300	30	37.0	29	0	71	0	0	0

TABLE A(17):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
73 a	28	6.8	9.7	11.35	40,700	25	34.8	23	0	77	0	1	0
73 b	26	5.8	10.0	10.10	28,700	26	38.5	37	0	63	0	0	0
73 c	25	6.2	10.5	10.25	24,400	24	42.0	31	0	58	0	1	0
73 d	29	6.3	10.9	11.65	26,700	25	37.6	49	0	51	0	0	0
74 a	27	5.6	9.3	9.77	13,400	27	34.4	35	0	65	0	0	0
74 b	22	5.9	8.0	7.92	11,400	28	36.4	23	0	77	0	0	0
74 c	23	6.0	8.8	8.41	15,100	27	38.3	20	0	79	0	0	0
74 d	32	6.2	10.7	10.65	19,900	30	33.5	51	0	49	0	0	0
75 a	30	6.2	11.2	11.00	28,600	27	37.4	21	0	77	0	2	0
75 b	27	6.0	9.9	9.93	19,900	27	36.7	32	0	68	0	0	0
75 c	29	6.5	10.8	10.45	20,700	28	37.3	29	0	71	0	0	0
75 d	34	6.4	11.4	15.50	22,600	30	33.6	36	0	64	0	0	0

TABLE A(18):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST.	L	M	E	B
76 a	34	6.0	12.6	14.05	15,400	27	37.1	29	0	71	0	0	0
76 b	28	5.9	9.7	11.95	14,200	23	34.7	40	0	60	0	0	0
76 c	B l o o d					C l o t t e d							
76 d	35	5.6	12.4	14.55	13,600	24	35.5	46	0	54	0	0	0
77 a	32	7.2	11.8	14.15	12,600	23	36.9	25	0	75	0	0	0
77 b	26	6.1	9.4	10.50	9,500	25	36.2	42	0	58	0	0	0
77 c	24	5.6	9.1	9.80	10,500	28	38.0	41	0	59	0	0	0
77 d	34	6.2	12.1	14.75	17,500	23	35.6	59	0	41	0	0	0

TABLE A(19):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
78 a	37	6.4	10.8	13.00	15,000	28	34.2	34	0	66	0	0	0
78 b	24	6.4	8.9	10.46	12,600	23	37.1	26	0	73	0	1	0
78 c	24	5.0	8.3	10.40	12,400	23	34.6	37	0	62	0	1	0
78 d	30	6.5	11.0	15.12	20,600	20	36.7	32	0	67	0	1	0
79 a	28	6.5	10.4	12.20	17,800	23	37.2	25	0	74	0	1	0
79 b	24	7.2	8.4	9.25	14,200	26	35.00	22	0	78	0	0	0
79 c	22	6.0	9.6	12.25	15,500	20	43.5	38	0	60	0	2	0
79 d	30	8.0	11.7	11.55	22,600	26	39.1	44	0	56	0	0	0
80 a	30	6.8	10.9	12.10	13,200	25	36.4	49	0	50	0	1	0
80 b	26	5.6	9.3	9.70	9,500	27	35.7	49	0	51	0	0	0
80 c	25	5.2	8.9	9.75	10,600	26	35.6	33	0	67	0	0	0
80 d	31	6.8	11.0	10.25	14,700	30	35.5	14	0	86	0	0	0

TABLE A(20):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
31 a	28	6.0	9.4	10.35	13,700	27	33.6	25	0	75	0	0	0
31 b	26	6.2	9.1	10.20	13,100	25	35.0	22	0	77	0	1	0
31 c	26	6.2	9.0	11.55	15,000	23	34.6	20	0	79	0	1	0
31 d	28	6.2	10.0	10.25	14,400	28	35.8	34	0	66	0	0	0
32 a	34	6.0	11.6	14.65	11,200	23	34.2	16	0	83	0	1	0
32 b	29	6.0	10.6	12.00	9,200	24	36.5	35	0	65	0	0	0
32 c	32	6.6	11.6	14.65	11,200	22	36.3	42	0	57	0	1	0
32 d	34	6.2	12.2	13.35	13,300	25	35.9	31	0	68	0	1	0
33 a	28	6.8	9.5	12.10	28,100	23	33.9	32	0	68	0	0	0
33 b	26	6.4	9.2	11.55	24,900	23	35.4	20	0	80	0	0	0
33 c	25	6.2	9.0	12.00	24,400	21	36.0	29	0	71	0	0	0
33 d	29	6.4	10.1	11.60	28,300	25	34.7	24	0	76	0	0	0

TABLE A(21):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
34 a	27	6.4	9.5	11.40	15,700	24	35.3	21	0	79	0	0	0
34 b	26	6.0	8.9	11.15	14,700	23	34.3	16	0	84	0	0	C
34 c	25	7.0	9.1	11.65	16,900	22	36.4	18	0	82	0	0	0
34 d	28	6.4	10.1	10.10	12,900	28	36.1	32	0	68	0	0	0
35 a	29	6.3	9.10	10.10	13,300	29	31.2	34	0	66	0	0	0
35 b	24	5.4	7.7	7.75	13,300	31	32.1	23	0	77	0	0	0
35 c	25	5.6	8.1	8.25	12,500	30	32.4	30	0	70	0	0	0
35 d	28	5.6	8.6	9.75	18,100	29	30.6	35	0	65	0	0	0
36 a	30	6.4	11.0	11.35	9,500	26	36.7	15	0	85	0	0	0
36 b	30	6.1	10.8	11.25	9.700	27	36.0	14	0	86	0	0	0
36 c	26	6.2	9.7	10.50	9,400	25	37.2	18	0	82	0	0	0
36 d	32	6.4	11.8	13.90	14,000	27	36.9	26	0	74	0	0	0

TABLE A(22):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV
37 a	29	6.4	10.5	11.60	18,600	25
37 b	27	5.6	10.0	10.35	16,000	27
37 c	27	6.2	9.8	10.35	17,300	27
37 d	29	6.4	10.2	12.95	19,100	23
38 a	34	5.4	12.1	15.00	16,000	23
38 b	33	5.6	11.8	14.45	16,000	24
38 c	31	5.6	11.4	12.80	15,300	24
38 d	33	5.8	12.1	14.65	13,400	26
39 a	29	6.3	9.8	11.35	16.600	23
39 b	26	6.3	9.3	11.20	16,400	23
39 c	25	5.6	8.8	10.85	16,500	22
39 d	32	6.0	10.1	14.65	20,200	23
40 a	29	5.8	10.2	12.45	14,200	25
40 b	27	5.4	10.5	10.60	14,100	24
40 c	27	5.5	10.6	12.00	16,100	23
40 d	29	5.6	10.8	12.95	14,200	22

MCHC	TN	ST	L	M	E	B
36.2	21	0	79	0	0	0
37.1	23	0	76	0	1	0
36.3	22	0	78	0	0	0
35.3	24	0	76	0	0	0
35.7	45	0	51	0	4	0
36.8	54	0	39	0	6	0
36.8	63	0	35	0	2	0
36.7	49	0	48	0	3	0
33.8	18	0	81	0	1	0
35.8	41	0	58	0	1	0
35.3	22	0	76	0	2	0
31.5	45	0	55	0	0	0
35.2	33	0	67	0	0	0
38.9	55	0	45	0	0	0
39.3	61	0	33	0	0	0
37.3	23	0	77	0	0	0

TABLES A(23) TO A(35): - INDIVIDUAL RESULTS FOR BLOOD CONSTITUENTS VIA THE INTRAVENOUS ROUTE

a = Blood sample taken 15 minutes prior to administration of any drug

b = Blood sample taken 15 minutes after the first injection

c = Blood sample taken 30 minutes after the animal stood up

d = Blood sample taken 24 hours after the experiment

TABLE A(23):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
51 a	25	7.00	9.60	7.65	7200	31	38	34	0	59	4	3	0
51 b	24	6.40	8.60	6.40	6700	27	36	28	0	62	5	5	0
51 c	22	6.20	8.00	6.25	7000	28	36	28	0	59	9	4	0
51 d	28	6.60	9.70	7.20	8200	39	35	42	0	53	0	5	0
52 a	32	7.20	12.80	9.10	5300	28	40	49	0	42	1	8	0
52 b	30	7.20	11.00	8.75	4700	29	37	55	0	36	6	3	0
52 c	27	6.80	10.00	7.10	4700	26	27	64	0	34	1	1	0
52 d	30	6.80	11.30	8.95	5800	34	38	21	0	69	0	10	0
53 a	27	7.80	9.80	8.50	11200	32	33	16	0	78	3	2	1
53 b	20	6.80	7.70	5.65	7700	28	38	15	0	78	2	5	0
53 c	19	6.80	7.30	5.85	7000	31	38	23	0	75	0	2	0
53 d	28	6.80	9.80	7.30	9900	38	35	28	0	68	0	4	0

TABLE A(24):

I.D. No:	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
54 a	29	7.00	10.40	7.75	11800	27	36	35	0	53	1	11	0
54 b	32	7.60	12.50	10.20	11800	32	39	47	0	52	1	0	0
54 c		Blood		clotted									
54 d													
55 a	35	5.80	12.80	8.30	9200	42	37	42	0	53	1	4	0
55 b	33	5.20	12.00	9.15	7800	36	36	45	0	54	0	1	0
55 c	30	5.20	11.00	7.90	9800	38	37	56	0	42	0	2	0
55 d	32	5.80	12.80	9.10	12500	29	40	50	0	46	0	4	0
56 a	28	6.80	11.20	7.80	9800	28	36	14	0	85	1	0	0
56 b	25	6.40	9.00	6.70	7600	27	36	19	0	78	2	1	0
56 c	27	7.00	10.90	7.55	9500	28	41	10	0	80	0	10	0
56 d	31	7.40	11.90	7.49	21400	48	34	71	0	29	0	0	0

TABLE A(25):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	P
57 a	28	7.00	10.70	8.25	7500	29	38	24	0	76	0	0	0
57 b	22	6.20	9.00	7.15	5800	32	40	23	0	75	0	2	0
57 c	23	6.00	8.40	6.90	8600	30	37	44	0	55	0	1	0
57 d	31	7.20	10.80	8.40	12900	37	27	47	0	51	1	1	0
58 a	34	6.60	13.60	10.45	21700	31	40	23	0	70	1	6	0
58 b	27	5.80	9.40	7.20	10700	27	35	37	0	56	0	7	0
58 c	28	6.00	10.70	8.20	11400	29	38	37	0	54	4	5	0
58 d	32	6.80	12.70	5.88	13900	44	40	29	0	70	0	1	0
59 a	37	7.00	14.60	10.50	15000	28	39	41	0	40	6	3	0
59 b	31	7.00	11.60	8.30	9800	27	37	46	1	52	0	2	0
59 c	28	6.40	10.50	7.55	9800	27	28	53	1	44	0	3	0
59 d	33	7.10	12.40	6.77	17300	50	38	58	1	35	0	7	0
60 a	30	6.80	12.40	9.90	11800	33	41	34	0	65	0	1	0
60 b	27	6.80	10.50	8.35	10300	31	39	28	0	71	1	0	0
60 c	27	6.50	9.90	7.60	9400	28	37	42	0	55	3	0	0
60 d	32	6.90	11.20	1.52	14300	55	36	37	0	63	0	0	0

TABLE A(26):

I.D. No.	PCV	TP	HB	RB RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
61 a	27	6.80	10.60	8.45	18800	32	39	21	0	77	0	2	0
61 b	24	6.80	9.40	7.55	14000	31	39	47	0	53	0	0	0
61 c	23	5.60	8.50	6.70	11800	29	37	16	0	80	0	4	0
61 d	32	7.60	10.60	7.85	21700	42	25	37	0	63	0	0	0
62 a	30	6.80	11.50	8.50	15100	29	38	56	0	40	0	4	0
62 b	28	5.80	10.50	8.50	12400	30	35	48	0	52	0	0	0
62 c	26	5.60	9.90	8.10	11700	31	38	42	0	53	0	5	0
62 d	36	5.80	12.90	9.95	18500	36	28	58	0	41	0	1	0

TABLE A(27)

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
63 a	33	6.00	11.30	8.10	8300	25	34	54	0	45	0	1	0
63 b	28	5.20	10.40	7.70	8400	27	37	42	0	58	0	0	0
63 c	25	5.20	8.50	5.65	6600	23	34	54	0	46	0	0	0
63 d	35	6.00	11.40	9.30	10900	38	27	31	0	68	0	1	0
64 a	38	5.80	12.60	8.90	17300	43	36	63	0	36	0	1	0
64 b	31	5.60	10.80	8.10	11800	38	26	62	0	38	0	0	0
64 c	30	5.60	10.20	7.35	11700	41	25	70	0	30	0	0	0
64 d	32	7.00	13.00	12.30	24200	26	40	64	0	36	0	0	0
65 a	37	6.20	12.60	9.85	8200	38	27	36	0	58	0	6	0
65 b	39	6.20	12.90	10.50	7000	37	27	45	0	54	0	1	0
65 c	32	5.40	10.30	7.90	9000	41	25	58	1	41	0	0	0
65 d	34	6.10	12.60	10.10	18000	35	37	59	0	41	0	0	0

TABLE A(28):

ID. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
66 a	30	5.40	10.80	8.65	9100	35	29	35	0	60	0	5	0
66 b	D i e d												
66 c													
66 d													
67 a	37	6.60	13.60	9.90	9600	37	27	39	0	58	0	3	0
67 b	C l o t t e d							30	0	70	0	0	0
67 c	29	5.90	10.30	7.35	7400	39	25	35	0	65	0	0	0
67 d	35	6.50	13.00	9.90	14000	35	37	54	0	45	0	1	0
68 a	29	4.80	12.40	9.20	16000	31	43	45	0	54	0	1	0
68 b	25	6.30	10.70	8.30	11800	30	43	34	0	66	0	0	0
68 c	27	5.00	10.40	7.65	12400	24	39	56	0	43	0	1	0
68 d	33	6.20	11.00	8.60	20500	38	33	47	0	53	0	0	0

TABLE A(29):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
69 a	30	6.10	11.10	9.60	14100	32	37	33	0	60	0	7	0
69 b	26	6.00	10.10	8.75	15100	30	28	30	0	68	0	2	0
69 c	24	5.60	9.20	7.70	13600	31	38	36	0	61	0	3	0
69 d	29	7.40	10.50	8.35	29900	35	36	44	0	53	0	3	0
70 a	33	6.00	11.20	8.80	15000	38	34	40	0	59	0	1	0
70 b	29	5.20	8.30	8.15	14600	35	29	60	0	40	0	0	0
70 c	23	5.10	12.80	6.45	9500	35	51	65	0	33	0	2	0
70 d	29	5.50	10.80	8.25	24800	33	37	68	0	32	0	0	0

TABLE A(30):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
71 a	30	6.00	11.50	8.50	11900	35	38	14	0	86	0	0	0
71 b	32	6.00	12.00	8.85	10800	27	33	19	0	81	0	0	0
71 c	21	7.20	9.00	6.85	10500	31	43	30	0	69	0	1	0
71 d	28	8.20	11.20	8.35	30400	33	42	48	0	47	4	1	0
72 a	30	5.60	12.00	8.50	7400	35	40	47	0	53	0	0	0
72 b	28	5.40	11.30	8.50	8400	33	40	55	0	45	0	0	0
72 c	25	5.40	10.20	7.20	7600	35	41	58	0	41	0	1	0
72 d	30	5.60	11.20	8.35	14900	27	37	56	0	44	0	0	0
73 a	32	6.00	12.50	9.70	13400	33	39	35	0	65	0	0	0
73 b	D	i	e	d									
73 c													
73 d													

TABLE A(31):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
74 a	36	5.80	14.20	10.70	8900	34	39	30	0	70	0	0	0
74 b	31	5.80	12.50	8.45	6700	37	40	29	0	70	0	1	0
74 c	29	5.60	12.00	8.90	7200	33	42	39	0	59	0	2	0
74 d	36	5.80	14.30	10.90	20600	33	40	64	0	33	1	2	0
75 a	35	5.00	12.70	9.30	9400	38	36	39	0	60	0	1	0
75 b	32	5.00	12.00	9.25	8000	35	38	43	0	57	0	0	0
75 c	26	4.20	9.50	6.95	7000	37	37	48	0	52	0	0	0
75 d	30	5.60	12.80	8.80	36300	34	43	63	0	35	0	2	0
76 a	33	6.60	13.00	10.45	32300	31	39	47	0	52	0	1	0
76 b	34	6.00	12.60	9.80	34200	35	37	46	0	52	2	0	0
76 c	29	5.00	10.50	7.85	18400	37	36	62	0	34	3	1	0
76 d	34	6.00	13.00	9.75	11300	35	38	42	0	57	0	1	0

TABLE A(32):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
77 a	36	6.60	12.50	11.20	9200	29	35	37	0	63	0	0	0
77 b	27	5.60	8.40	7.60	6000	36	31	27	0	72	0	0	0
77 c	20	6.00	8.70	7.65	6400	23	43	52	0	46	0	2	0
77 d	35	6.60	12.90	13.80	9400	25	37	33	0	62	0	0	0
78 a	30	5.80	11.40	7.25	21000	42	38	66	0	31	0	3	0
78 b	25	5.60	9.50	7.20	14000	35	38	61	0	39	0	0	0
78 c	26	5.30	9.70	7.40	17800	35	37	65	0	34	0	1	0
78 d	30	6.20	11.50	9.00	17500	30	38	66	0	34	0	0	0
79 a	30	5.80	9.00	8.65	18000	35	30	45	0	46	8	1	0
79 b	33	6.20	11.20	8.90	24400	37	34	42	0	57	1	0	0
79 c	28	5.40	8.90	6.80	9300	41	32	62	0	33	4	1	0
79 d	28	5.80	10.00	8.75	8600	34	35	45	0	55	0	0	0
80 a	35	5.60	12.70	9.05	10300	39	36	46	0	51	3	0	0
80 b	30	5.60	11.50	7.90	9000	38	38	49	0	49	2	0	0
80 c	28	5.60	11.00	7.80	8500	36	39	43	0	52	2	3	0
80 d	32	6.00	11.00	9.50	10900	34	34	64	0	36	0	0	0

TABLE A(33):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
81 a	29	5.60	11.20	8.50	8600	34	39	46	0	52	0	2	0
81 b	26	6.00	C l o t t e d					46	0	54	0	0	0
81 c	28	5.00	10.40	7.70	7800	36	37	59	0	40	0	1	0
81 d	27	6.00	9.20	8.05	6300	34	34	46	0	52	0	2	0
82 a	35	5.40	12.40	10.50	7200	33	35	31	0	69	0	0	0
82 b	31	6.00	10.80	9.25	6700	29	35	30	0	69	0	1	0
82 c	29	5.10	11.20	9.15	7800	32	39	36	0	64	0	0	0
82 d	30	5.8	11.00	9.95	10000	30	37	47	0	52	0	1	0
83 a	35	6.60	12.40	9.20	15000	38	35	46	0	52	0	2	0
83 b	28	6.00	10.00	8.35	9800	34	36	40	0	60	0	0	0
83 c	28	5.90	10.00	7.90	9900	35	36	42	0	58	0	0	0
83 d	31	7.00	10.00	8.55	11800	36	32	45	0	53	0	2	0

TABLE A(34)

I.D. No.	PCV	TP	HB	RBC	WBC	MCV	MCHC	TN	ST	L	M	E	B
84 a	29	5.60	11.00	7.90	18300	36	38	48	0	52	0	0	0
84 b	28	6.00	10.00	7.35	30300	38	36	36	0	62	0	2	0
84 c	27	5.90	11.00	10.05	14900	27	41	41	0	56	0	3	0
84 d	29	6.00	10.00	8.25	18200	32	35	47	0	53	0	0	0
85 a	32	5.80	11.00	10.25	12100	31	34	55	0	44	0	0	1
85 b	37	5.60	13.40	10.25	15300	36	36	46	0	54	0	0	0
85 c	32	5.60	12.30	9.50	11500	34	38	48	0	51	0	1	0
85 d	34	6.00	13.00	10.50	14400	33	38	66	0	32	0	2	0
86 a	31	6.80	11.00	8.90	10300	35	37	40	0	58	0	2	0
86 b	29	6.60	10.00	8.00	8500	36	29	35	0	65	0	0	0
86 c	28	6.40	10.00	8.35	11100	34	28	42	0	58	0	0	0
86 d	30	6.50	11.20	8.60	12100	35	37	45	0	55	0	0	0

TABLE A(35):

I.D. No.	PCV	TP	HB	RBC	WBC	MCV
87 a	29	6.00	10.60	9.80	8000	30
87 b	27	6.80	9.60	7.35	6200	23
87 c	31	5.60	10.80	8.90	8500	35
87d	33	6.60	11.80	12.20	5880	27
88 a	34	6.00	12.40	9.90	13800	27
88 b	34	5.90	12.30	10.35	10800	32
88 c	33	5.80	11.40	9.55	12400	39
88 d	39	6.10	13.90	14.30	13100	27
89 a	35	5.80	12.00	10.10	9600	35
89 b	30	5.50	10.50	10.10	7800	30
89 c	30	5.40	10.60	8.65	9700	35
89 d	34	6.60	12.20	11.75	11200	29
90 a	35	6.40	11.80	8.90	11800	39
90 b	33	6.00	11.00	9.50	12600	35
90 c	30	5.80	10.00	9.05	10600	33
90 d	34	6.20	11.80	10.35	11000	33

MCHC	TN	ST	L	M	E	B
37	38	0	61	0	1	0
36	42	0	57	0	1	0
35	56	0	42	0	2	0
36	33	0	66	0	1	0
37	36	0	64	0	0	0
36	40	0	60	0	0	0
35	57	0	43	0	0	0
36	39	0	61	0	0	0
34	52	0	48	0	0	0
35	56	0	44	0	0	0
35	37	0	63	0	0	0
36	40	0	60	0	0	0
34	53	0	47	0	0	0
33	45	0	55	0	0	0
33	44	0	56	0	0	0
35	42	0	58	0	0	0

TABLE A(36) TO A(37): - INDIVIDUAL RESULTS FOR TEMPERATURES AT 5 MINUTE INTERVALS FOR THE INTRAMUSCULAR (A 36) AND INTRAVENOUS (A 37) ROUTES.

TABLE A(36): INDIVIDUAL E TEMPERATURE RESULTS (°C) FOR THE INTRAMUSCULAR ROUTE

Minutes	Group 1										Group 2									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
- 15	41	40.4	39.9	40	39.4	39.8	40	40.2	40	39.9	40	39.2	39.6	40	39.8	39.4	40	40.6	39.6	40
15	41	40.2	40.1	40.4	39.5	39.8	40.4	40.5	40.2	40.4	40.5	40.3	40.4	39.9	40.2	40.2	40.6	40.5	39.7	40.5
30	41	40	40.1	39.5	39.5	39.2	39.8	40.5		39.8	40.3	39.8	39.7	39.4	39.7	39.7	40.4	39.8	39.6	39.8
45				39.1		39.1	39.4	40.4		39.2	40.2		39.3	38.8	39.7	39	39.8	39.4	39.3	39.5
60						38.9									39.3		39.0	39.5		38.8
75																	39.3	39.1		38.5
90																				37.8

Minutes	Group 3										Group 4									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
- 15	39.6	39.5	39.8	39.7	39.3	39.7	39.9	40	39.8	40.1	40.4	40	39.8	40.2	40.1	40.4	40.4	40.6	40	40.1
15	39.8	40	39.8	39.9	39.9	39.8	40.5	40.4	39.8	40.3	40.9	40.8	40.5	40.5	40.3	40.5	40.3	40.8	40.2	40.2
30	39	39.5	39.2	39.5	39.3	39.5	39.9	40	39.4	39.8	40.6				40.5	40.4		40.3	40.1	40.4
45	39.5	39	38.8	38.8	39	38.6	39.1	39.3	39.1	39.2					40.5				39.8	
60		38.8	38.4	38.5	39			38.6	38.1	39										
75																				
90																				

TABLE A(37): INDIVIDUAL TEMPERATURE RESULTS (°C) AFOR THE INTRAVENOUS ROUTE

Minutes	Group 5										Group 2									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
- 15	39.8	40.5	39.8	39.6	39.1	39.5	40	39.6	39.2	39.9	39.1	40.2	39.5	39.7	39.5	39.7	39.9	40.3	39.1	40.3
15	40.1	40.8	39.6	39.6	38.9	39	39.7	39.5	39.3	39.6	39.2	39.4	39.4	39.4	39.2	Died	39.5	40.1	39.2	40.5
30	40.1	41.1	39.4	Died	38.5	38		38.5	38.5		38.6	39.5	39.5	38.6	38.6		39.4	39.3	38.5	40.2
45					38.2						38.6	38.8	39.5	38	38.5	Died	39.	40	38	39.4
60				Died	38															39
75																				38.
90				Died																

	Group 7										Group									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
- 15	38.8	39.4	39.8	40	40.2	40.1	39.8	39.4	39.2	39.8	39.1	40.4	39.9	39.8	40.2	39.8	39.2	40	40	39.6
15	39	39	Died	40.3	39.4	40	39.7	40.1	39	39.4	39.5	39.7	39.7	39.8	40.1	39.6	38.7	39.8	40	40.2
30	38.5	38.4		40.5	38.8	39.1	39.2	39.7	38.4	38.3					40.3					
45	38	37.7	Died		38.3	38.6	39			38.8										
60	37.8	37.6	Died		38.3		39													
75		37.4	Died		38.3															
90																				

TABLES A(38) TO A(41) - INDIVIDUAL RESULTS FOR HEART RATE FOR THE INTRAMUSCULAR AND INTRAVENOUS ROUTES

TABLE A(38) INDIVIDUAL HEART RATES GROUPS 1 AND 2 INTRAMUSCULAR ROUTE

Animals		Time in Minutes																			
		-15	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
Group 1	1	66	74	100	80	80	80	80													
	2	160	60	88	80	88	88														
	3	96	100	92	84	80	88	84													
	4	100	104	104	92	84	86	80	80	80											
	5	108	92	92	96	120	100	92	92												
	6	92	100	92	92	100	92	92	92	92	92	96	92	92	92						
	7	160	120	124	112	120	112	108	104	108	104										
	8	160	126	108	108	96	104	100	100	100	96	104									
	9	132	92	80	80	84															
	10	136	120	108	112	112	112	112	112	108	104										
Group 2	1	120	108	92	104	100	108	96	96	84	88										
	2	92	126	92	84	92	100	88	95												
	3	108	128	100	100	104	104	100	96	100	100	96	104								
	4	108	96	80	108	124	104	96	104	104	100	96	88								
	5	88	108	120	92	100	100	96	92	92	88	96									
	6	124	84	72	80	88	88	84	80	84	84										
	7	112	116	116	144	112	120	120	112	104	100	120	108	104	104						
	8	160	80	64	96	96	104	104	100	96	88	92	92	88	88	88	84	80			
	9	140	112	92	112	120	110	104	112	100	100										
	10	160	120	120	120	108	120	124	108	120	108	96	92	84	84	84	84	80	80	140	72

TABLE A(39): INDIVIDUAL HEART RATES GROUPS 3 AND 4 INTRAMUSCULAR ROUTE

		Time in minutes													
	Animal	-15	5	10	15	20	25	30	35	40	45	50	55	60	65
Group 3	1	120	88	88	96	104	104	104	96	96	88	92			
	2	180	100	100	104	104	100	100	100	88	96	80	80	76	80
	3	160	120	112	112	180	116	108	112	120	120	96	96	96	
	4	136	108	112	112	108	112	108	108	104	104	104	104		
	5	112	96	92	84	92	92	88	92	92	80	80	80		
	6	152	104	96	92	80	88	80	84	84	96				
	7	152	120	104	112	120	112	112	108	112	96				
	8	128	100	100	100	96	88	96	96	96	88	80	80	76	
	9	108	100	96	96	100	104	100	96	92	92	92	88		
	10	160	116	112	112	112	120	104	104	108	104	96	96	92	
Group 4	1	144	136	136	140	120	152								
	2	112	156	128	136	136									
	3	120	128	112	120	100									
	4	148	136	128	128	144									
	5	128	112	88	88	80	84								
	6	104	144	88	108	120	160								
	7	128	140	144	144	128									
	8	160	160	176	176	156									
	9	120	120	120	120	104	104	116							
	10	160	160	168	164										

TABLE A(40): INDIVIDUAL HEART RATES GROUPS 5 AND 6 INTRAVENOUS ROUTE

		Time in minutes																	
	Animals	- 15	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Group 5	1	120	72	88	86	88	88	88											
	2	96	88	112	96	88	112	96											
	3	112	120	108	100	100	88	96											
	4	104	112	96	96	D	I	E	D										
	5	112	184	140	128	160	80	96	112	120	120	120	104	100					
	6	104	88	96	76	60	68	64											
	7	120	80	96	100	104													
	8	128	80	80	88	104													
	9	96	80	96	96	108	100	120											
	10	160	96	96	92														
Group 5	1	88	64	68	80	76	80	84	80	80	96								
	2	120	76	88	96	104	104	100	96	88									
	3	120	56	48	120	112	96	96	88	80	80	76							
	4	96	104	88	104	96	96	84	84	84	88								
	5	120	88	96	136	120	112	112	112	112	128								
	6	112	80	96	D	i	e	d											
	7	120	96	84	132	128	108	104	108	108	120								
	8	120	84	84	100	72	68	80	72	72									
	9	96	120	80	88	80	80	80	76	88	76								
	10	120	120	120	160	88	88	104	120	96	100	104	112	112	112	108	104	112	108

TABLE A(41): INDIVIDUAL HEART RATES GROUPS 7 AND 8 INTRAVENOUS ROUTE

		Time in Min								
	Animals	-15	5	10	15	20	25	30	35	40	45
Group 7	1	132	120	104	104	104	112	112	108	100	96
	2	108	88	88	92	84	84	92	80	68	64
	3	84	D	i		e	d				
	4	72	148	140	144	96	112	104			
	5	160	148	140	136	116	112	112	104	120	120
	6	88	120	124	120	120	116	88	96	88	80
	7	120	136	128	128	112	104	80	80	80	84
	8	136	128	136	120	120	128	128			
	9	100	88	100	88	80	84	80	80		
	10	84	104	96	84	72	76	72	72	64	64
Group 8	1	88	56	84	120						
	2	160	112	120	136						
	3	120	112	120	104						
	4	80	72	88	88	72					
	5	96	104	112	116	104	88	96			
	6	112	88	120	112						
	7	128	180	80	88						
	8	128	96	96	112						
	9	112	96	88	96	96	100				
	10	128	96	88	96						

u t e s					
50	55	60	65	70	75
92	84	80			
64	68	60	60	68	
112	124	124	128	112	116
80	64				

TABLES A(42) TO A(45) - INDIVIDUAL RESULTS FOR RESPIRATORY RATE FOR THE INTRAMUSCULAR AND INTRAVENOUS ROUTES

TABLE A(42): INDIVIDUAL RESPIRATORY RATES GROUPS 1

	Animals	-10	5	10	25	20	25	Time 30	35	40
Group 5	1	32	44	48	40	40	40	40		
	2	40	48	48	60	44	48			
	3	48	48	48	48	52	48	48		
	4	44	44	48	60	52	52	60	60	60
	5	40	80	100	88	88	102	86	88	
	6	80	96	84	88	88	84	72	64	68
	7	40	52	72	76	80	72	72	68	64
	8	60	68	64	88	92	92	80	72	60
	9	60	64	28	28	28				
	10	48	60	96	80	84	64	64	64	60
Group 6	1	40	68	64	124	120	100	96	76	60
	2	60	96	72	112	44	64	64	68	
	3	32	48	60	46	52	44	44	40	36
	4	72	60	32	92	76	72	64	48	52
	5	40	72	80	48	60	40	72	68	72
	6	60	48	64	48	68	44	56	56	44
	7	44	60	60	76	88	80	68	60	56
	8	40	32	36	80	80	96	80	100	76
	9	36	56	80	104	112	112	80	84	64
	10	44	84	112	104	120	104	104	100	100

AND 2 INTRAMUSCULAR ROUTE

n	m	i	n	u	t	e	s			
45	50	55	60	65	70	75	80	85	90	95
56	56	52	48	48						
56										
50	56									
60										
60										
36	28	40								
56	52	44								
52	56									
56										
56	60	48	48	48						
76	72	60	72	64	60	40				
60										
96	100	96	80	80	80	80	68	68	56	48

TABLE A(43): INDIVIDUAL RESPIRATORY RATES GROUPS 3 AND 4 INTRAMUSCULAR ROUTE

	Animals	Time in minutes														
		- 15	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Group 3	1	32	32	28	36	24	16	24	24	28	24	36				
	2	52	72	60	60	68	60	72	60	60	68	60	60	64	52	
	3	48	92	80	60	68	72	64	60	60	60	60	60	56		
	4	60	72	160	140	136	144	120	104	96	88	88	84			
	5	72	140	144	128	120	120	108	108	92	84	84	60			
	6	40	96	72	96	92	80	80	80	60	56					
	7	60	72	72	56	72	80	72	72	64	48					
	8	36	52	48	44	32	96	88	84	84	76	64	56	72		
	9	48	60	60	60	48	56	56	60	76	80	88	72			
	10	60	144	136	128	128	124	108	84	80	84	72	64	64		
Group 4	1	60	100	108	90	72	64									
	2	40	48	52	60	56										
	3	44	64	60	100	84										
	4	48	92	88	92	96										
	5	88	76	100	120	72	60									
	6	48	72	72	60	80	64									
	7	64	52	100	92	80										
	8	72	100	96	100	112										
	9	48	96	80	88	72	84	52								
	10	76	80	80	56											

TABLE A(44): INDIVIDUAL RESPIRATORY RATES GROUPS 5 and 6 INTRAVENOUS ROUTE

		Time in minutes																	
	Animals	-15	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Group 5	1	52	60	92	96	120	128	112											
	2	40	60	80	72	72	60	60											
	3	96	112	60	96	96	48	36											
	4	96	56	56	60	Died													
	5	40	80	88	56	48	48	46	32	32	24	24	32	40					
	6	32	60	80	80	72	60	56											
	7	64	60	64	80	88													
	8	48	60	80	72	72													
	9	44	120	112	96	88	80	60											
	10	60	84	80	72														
Group 6	1	40	96	80	96	96	80	60	98	48	60								
	2	60	104	96	120	44	68	64	56	60									
	3	48	80	36	12	60	52	28	56	56	48	40							
	4	48	100	104	112	102	96	96	80	60	64								
	5	56	72	60	56	108	68	72	60	60	64								
	6	40	40	88	Died														
	7	60	80	88	48	104	104	88	64	96	88								
	8	60	100	96	84	88	72	60	60	60									
	9	40	104	96	136	112	96	64	60	48	60								
	10	52	88	112	80	78	60	64	96	80	72	80	72	72	64	64	60	72	76

TABLE A(45): INDIVIDUAL RESPIRATORY RATES GROUPS 7 AND 8 INTRAVENOUS ROUTE

	Animals	Time in minutes -15	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
Group 7	1	60	80	12	64	48	48	40	48	40	40	36	40	40			
	2	48	64	40	48	48	44	52	48	48	48	44	44	40	48	56	
	3	48	D	i	e	d											
	4	56	104	80	72	64	60	64									
	5	52	80	112	112	96	80	88	88	80	68	64	72	64	64	64	68
	6	88	120	124	120	120	116	88	96	88	80						
	7	48	104	88	88	72	60	60	48	40	40	48	44				
	8	48	80	60	56	44	52	48									
	9	60	52	56	68	72	68	64	68								
	10	48	96	88	80	80	64	60	52	56	48						
Group 8	1	64	96	112	72												
	2	60	80	96	60												
	3	60	96	96	60												
	4	60	56	72	60	76											
	5	64	60	60	88	80	84	64									
	6	48	96	56	64												
	7	60	48	64	40												
	8	48	96	96	112												
	9	96	60	60	56	60	64										
	10	56	80	72	88												