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ANESTHESIA OR IMMOBILIZATION OF DOMESTIC AND MINIATURE SWINE--METHODS AND SOME PROBLEMS

By

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Anesthetic procedures, care, and handling of both miniature swine and domestic swine have been outlined. Practical techniques to overcome some of the former difficulties associated with endotracheal intubation are described. Atropine and halothane were considered the best agents.

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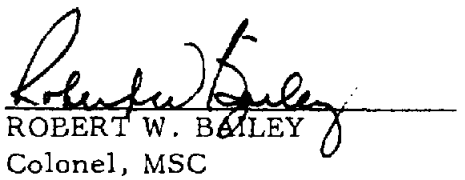
SUMMARY

Anesthetic procedures, care, and handling of both miniature swine and domestic swine have been outlined. Practical techniques to overcome some of the former difficulties associated with endotracheal intubation are described. Atropine and halothane were considered the best agents.

APPROVED: 

ROBERT W. BAILEY
Colonel, MSC
Commanding

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The Vivarium of the United States Army Aeromedical Research Laboratory is fully accredited by the American Association for Accreditation of Laboratory Animal Care.

The animals utilized in this study were procured, maintained, and used in accordance with the Animal Welfare Act of 1970, AR 70-18, and National Research Council guidelines.

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ANESTHESIA OR IMMOBILIZATION OF DOMESTIC AND MINIATURE SWINE--METHODS AND SOME PROBLEMS

INTRODUCTION

Swine have been utilized increasingly as an experimental animal of choice within the last decade[2,5,7,9]. Numerous studies have been conducted in which pigs have been used as surrogate subjects when the experimental procedures precluded the use of human beings[2,9]. During the last several years this laboratory has been involved in a number of experiments where pigs were used.

The purpose of this report is to describe a simplified method of endotracheal intubation and anesthesia regimes for swine. Different experimental requirements necessitated different approaches and varying anesthetic regimes. In one experiment, domestic pigs were instrumented and placed in helicopter hulks. Long-acting, injectable anesthetic combinations were used in this instance. A second test required critical observation and moderate long-term survival before euthanasia and necropsy. Premedication and a gaseous anesthesia administered through a nose cone were employed for this investigation. The third research endeavor called for the animals to be given a large body surface area burn and subsequent treatment. Initially, a series of baseline studies and preparatory work had to be accomplished with subsequent multiple and frequent immobilization over a four-day period. Gaseous anesthesia and tracheal intubation were used in combination with intravenous administration of an immobilizing agent as indicated. The fourth experiment also dictated use of intubation and a gaseous agent. The third and fourth experiments differed only in that miniature swine were used in the third, and domestic swine were utilized in the fourth experiment. In most cases, animals were immobilized and/or anesthetized more than one time.

Current anesthetic practice demands that gaseous anesthetic agents be employed for surgical and related procedures whenever possible. Moldable rubber cones designed for large breeds of dogs are easily adapted for pigs weighing 30-55 Kg but require constant attendance to maintain their position and waste considerable amounts of the anesthetic agent. Endotracheal anesthesia satisfies most needs but requires expertise for intubation.

MATERIALS AND METHODS

Procurement, Care, Housing

In all cases, white Minipigs* and white crossbred, domestic pigs were procured from vendors, quarantined for a minimum of 30 days, treated for endoparasites, and verified to be healthy for use in several studies over a three-year period.

All pigs were canine-tooth clipped and ear tagged upon initial entry. Individual health records were started and maintained from this time. Temperatures were taken rectally twice a day using one of two electronic thermometers, and the temperatures were recorded on charts. A Livestock Weather Safety Index (LWSI) was calculated[8] at least twice a day during the last summer of the work reported herein.

Pens (Figure 1) were located outside and consisted of 24 runs (12 runs per side) with sloped concrete floors and four-inch concrete dividers topped with free-standing chain-link fencing panels. All pens were four feet wide by 16 feet long with four feet wide gates opening onto a central corridor that was eight feet wide. Runs were equipped with automatic waterers. Drainage troughs were located outside the fence at the end of the runs. Each run was hosed clean at least twice a day. A commercially-prepared, 16 percent protein pelleted feed was offered once or twice daily for consumption by the one to four pigs housed in each pen.

The entire vivarium was covered. Each set of runs and the center aisleway were under a metal building that had a high pitch roof. Eight large fans were used in conjunction with ordinary garden-type sprinkler hoses to help provide evaporative cooling and air circulation during the last summer. In all cases, feed, but not water, was withheld at least 18 hours prior to anesthetic attempts. Each animal was extensively handled by the caretakers; as a result, a large number of manual manipulations could be done without animal excitement.

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*Miniature swine from Vita Vet Laboratories, Marion, IN 46952

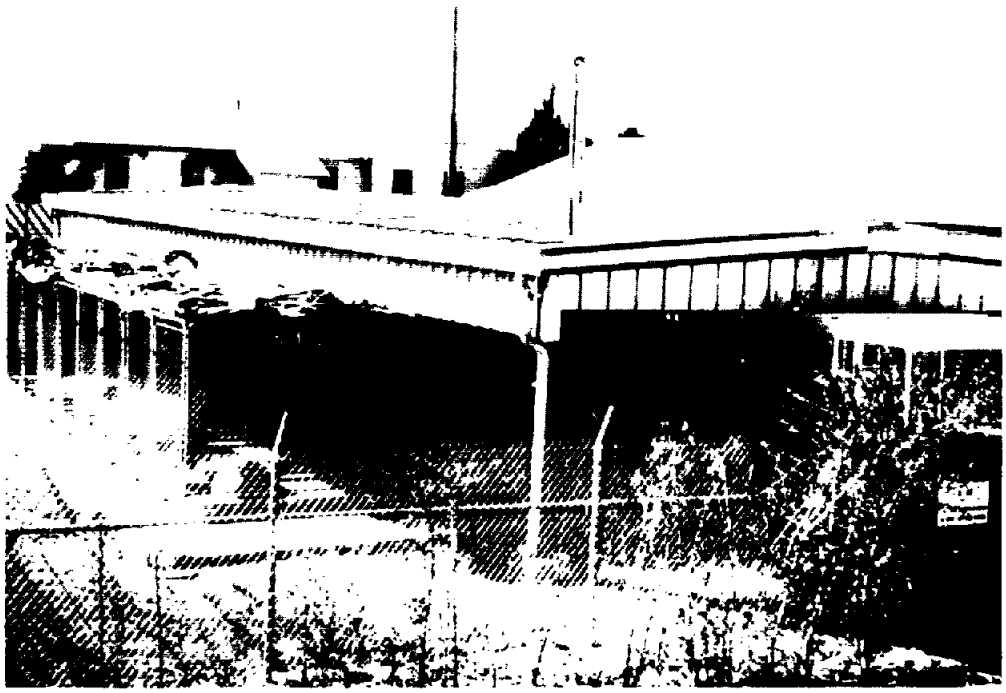

Figure 1. The Vivarium at the United States Army Aeromedical Research Laboratory, Fort Rucker, Alabama.

Major Agents Used*

METHOXYFLURANE, USP, was the first gaseous anesthetic employed with pigs at this laboratory. Most of the original work was accomplished with rubber or metal nose cones. Later work primarily was with the pigs intubated. Oxygen flow in excess of six liters/minute was employed. Breath-holding and laryngospasms occur if the vaporizer is advanced rapidly to its full output. To circumvent these complications, the concentration was increased one increment (0.5%) with each breath until the unit's rated capacity was achieved. When the animal was subdued or could be easily manipulated, the concentration was reduced (to 1-1.5%) and the patient intubated or the procedure initiated using the nose cone.

*See Appendix A.

HALOTHANE, USP, was administered using a moldable rubber nose cone or an endotracheal tube. In all cases oxygen flow was started at not less than six liters/minute with concentration of halothane at the maximum for the vaporizer being used (3.0%). If the subject was to be intubated, the anesthetic agent was used until the patient was deep enough so that the snout could be easily manipulated. The vast majority of pigs that were given halothane had it administered via endotracheal tube at a concentration of 0.5 to 1.5%. One hundred ninety-two (192) separate anesthetics with 92 domestic swine and 85 with 42 miniature swine were accomplished with halothane anesthesia (See Tables 1 & 2).

NITROUS OXIDE was used in combination with either halothane or methoxyflurane. Ultimately, a total combined flow of N_2O with O_2 reached at least six liters/minute with a 70: 30 (N_2O: O_2) ratio.

PHENCYCLIDINE HCl (2 mg/Kg) and THORAZINE (1 mg/Kg) were administered intramuscularly either in combination from the same syringe or independently. It was found that these agents also could be delivered remotely quite easily and with full safety and consistent effectiveness by using CAP-CHUR® delivery projectiles. Thorazine given through intravenous catheters was utilized for one protocol.

KETAMINE HCl was employed at a 1.1-5.5 mg/Kg rate in a fairly large number of miniature swine. All doses were given through previously implanted intravenous catheters (See Table 2).

INNOVAR-VET® at the rate of 1 cc/20 pounds, intramuscularly, was employed both as an adjunctive anesthesia and as a sole agent for minor manipulations.

CHLORAL HYDRATE (90 mg/Kg) was used in conjunction with PENTOBARBITAL SODIUM (25 mg/Kg) and PHENCYCLIDINE HCl (2 mg/Kg) for prolonged anesthesia for one protocol.

Initial Immobilization and Anesthesia Procedures

The animals were either physically restrained or chemically immobilized with one of a variety of drugs* using either a hand syringe or a projectile

*See Tables

syringe and placed on a metal table. After the animal was controlled, a rubber anesthetic mask was fitted over the snout, and gaseous agents* were introduced until the animal became quiescent. Adult sized breathing tubes and a three-liter rebreathing bag were employed in the circle absorber system. The respiratory rate was spontaneous at approximately 12-15 cycles/minute. As the animal relaxed, a topical ointment was applied to each eye for protection, since hair clipping or other procedures were to be done. Usually, 6-10 minutes were required before intubation could be initiated.

Endotracheal Intubation

With the animal appropriately positioned, as shown in Figure 2, an 8 mm cuffed tube was either wiped with a sterile, water soluble lubricant (KY Jelly®) or sprayed with a slippery topical anesthetic (Cetacaine®). A plastic rod-type stiffener was inserted into the tube, and two persons were positioned as illustrated in Figure 2. The ear of the patient should hang over the front edge of the table and the rump should touch the one side of the table when initially positioned. The back makes about a 30 degree angle to the side of the table. These physical relationships are critical for insuring continued success and reproducibility in the intubating technique.

The animal was placed on his left side on the sturdy metal table (72"x 29"x33" high) while the operator sat on a small (7" high) surgical stool. For simplicity, the assistants will be hereafter referred to as A and B. The tongue was grasped by A using a 4"x4" gauze pad. A made certain to pad the underside of the tongue to prevent the lower teeth from causing trauma to the sublingual area. He pulled it as far forward as he could and then applied pressure ventrally to force open the lower jaw. Simultaneously, B, with his left hand, grasped the upper lip just behind the rostrum and pulled it dorsally and at the same time exerted pressure on the back of the neck with his right hand. This forced the oropharynx, larynx, and trachea into a relatively straight line.

The operator (or inserter) held the laryngoscope in his left hand and allowed the blade to pass through the oral cavity and toward the larynx (Figure 3) until the epiglottis was touched. This blade had been lengthened

*See Tables

Figure 2. Position of the animal on the metal table, the assistants (A-left side of picture and B-right side of picture) and the inserter during the intubation procedure.

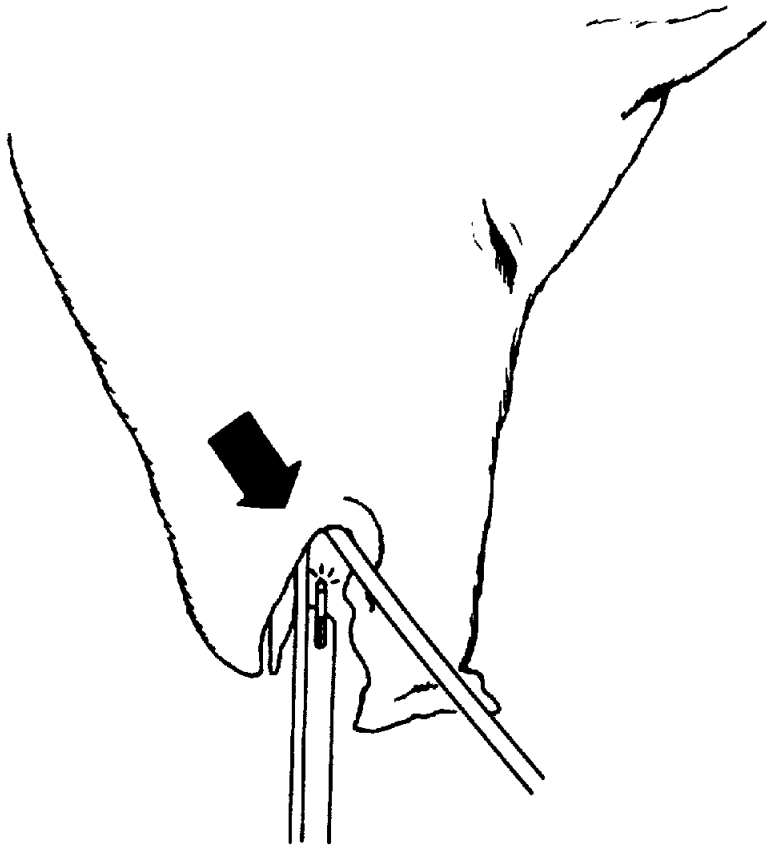

Figure 3. Diagram of insertion of endotracheal tube.

from its usual 195 mm to 325 mm. Usually, the anterio-dorsal tip of the epiglottis was not visible until gentle rearward and ventral sweeping pressure was applied with the end of the blade. (The hyoepiglottic muscle and epiglottic cartilage seem to have a predilection for resting with the epiglottic tip on the soft palate.)

The epiglottial tip usually then was exposed as a spoon-shaped fold. Withdrawal and reinsertion of the blade on top of the epiglottis permitted it to be pushed downward (ventrally), allowing the blade to slide easily over it to expose the very narrow opening into the larynx.

This opening appears like a keyhole (Figure 4) with the dorsal portion being slightly rounded. The corniculate cartilage embraces this hole. Instead of using the circular part of the laryngoscope blade, the tube, with its stiffener, is positioned with its tip approximately at the lamp location of the blade. Then the tube is advanced forward to the rounded part of the opening of the keyhole.

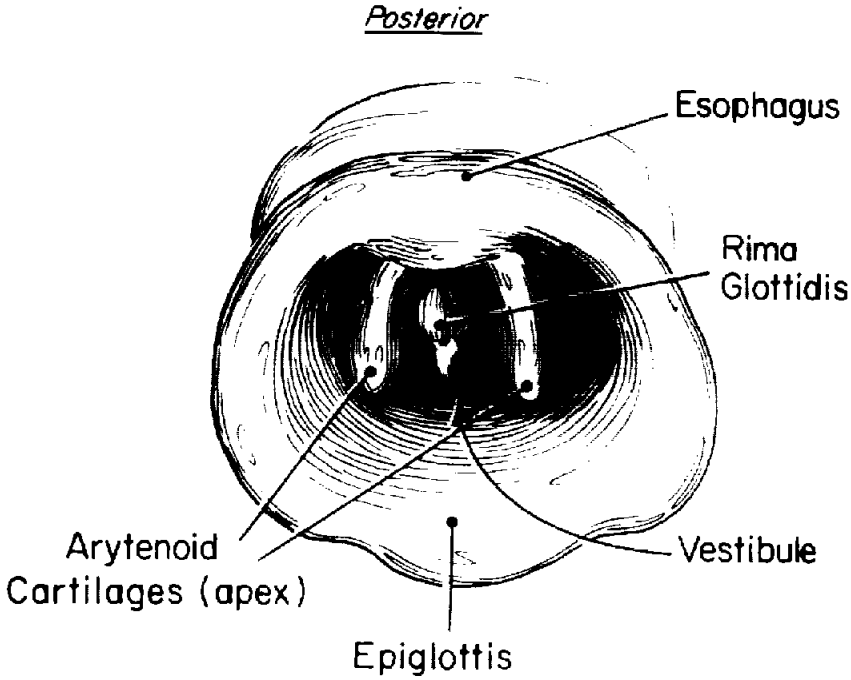

Figure 4. Diagram of the larynx of the pig as it appears during endotracheal intubation (rotate 90° clockwise to afford the view that the inserter would see).

Quite frequently, a topical spray anesthetic, such as Cetacaine, must be used to prevent severe contractions of the larynx. This is sprayed on the cords and the laryngoscope withdrawn for approximately 20-30 seconds. The cone is replaced during this period.

With care in inserting the tube only upon expiration, the folds seem to open a bit which is helpful. Experience has shown the optimum technique

to be to hold the tube firmly to puch it between the folds and then turn it 90° with a clockwise rotation, continuing to push it smoothly into the trachea. If the tube appears to slip to the right side, it tends to slide down the esophagus (although the esophagus actually overlies the trachea); if it slips laterally or ventrally, there are diverticuli that capture it (Figure 5). If it seems to be slipping from the desired area, the tube should be withdrawn about two centimeters and reinserted. One must be careful not to insert the tube more than just past the immediate area of the vocal fold because the bronchus to the right lung (apical lobe) arises separately from the trachea cephaloid to the carina.

Figure 5. Cadaveric larynx of the pig showing the point of the endotracheal tube lodging in the vestibule.

With the tube in place, the cuff is inflated only enough to prevent large movement back and forth. Excess cuff pressure would tend to cut off vascular flow and, if left in place an extended period of time, could cause eventual necrosis of the area.

To secure the tube we have used tape around the tube and then around the upper jaw, taking care not to compress the lips over the teeth. Another technique used roller gauze (bandage) firmly tied around the tube and then around the upper jaw. Sometimes both jaws then were taped or tied together and the tube protruded from the right side of the mouth. In either case, the mosquito forceps (with polypropylene tubing over their tips) used to close off the inflatable cuff were incorporated into the securing material. The gas anesthesia equipment was set to yield the desired depth of anesthesia.

Malignant hyperthermia (MH) occurred in 15 animals. The first sign noted was limb rigidity, usually within 2-3 minutes after application of the nose cone. Tachycardia was detected but undoubtedly the increased heart rate preceded the muscle stiffness. Hyperventilation occurred quite rapidly. A physiological monitor (EKG) was followed visually. Ventricular extrasystoles and ventricular fibrillation were noted most often. A veterinary surgical thermometer was rapidly inserted rectally for a distance of about six inches. Within ten minutes of initial administration of the Halothane the temperature could rise to >109° F. All pigs were white and "blotchy cyanosis" was a prominent feature that occurred with great rapidity. Purple static congestion of multiple areas (similar to the appearance of a partial burn thickness) was noted in all animals involved. Our methods of treatment consisted primarily of intraperitoneal administration of chilled fluids and ventilation with oxygen provided via a pressure respirator.

DISCUSSION

Anesthesia or immobilization of swine have been described[1,3,7,9], and the difficulties, particularly with intubation, are reported[3,7] and frequently heard at many professional meetings. When we first started working with pigs, we diligently searched the literature and found that intubation apparently was not routinely practiced or at least not reported. Additional reports

provided methods that other operators delineated, but difficulties were encountered by our group in putting them into practice. Consequently, we adopted what we considered the better parts of these reports. After consultation with other investigators and extensive experimentation, we came up with the procedure described herein. Perhaps more significantly, we can readily teach our method and have totally inexperienced people apply them after a minimum of instruction. For these reasons we have gone into precise detail as to our equipment, the animal's position, and handling. When we vary our attitudes or procedures we again encounter difficulty.

The first question presented by endotracheal intubation was the optimum tube size. Initially, attempts were made to closely match endotracheal tube size with the trachea size[3]. However, it was quickly discovered that the extra manipulation required with the close fit often caused the vocal folds area to swell, thereby negating our insertion attempts. The optimum tube was determined to be an 8 mm (ID) cuffed tube for all procedures where the pig weighed between 25 Kg and 60 Kg. By varying the oxygen flow rate we achieved adequate oxygenation and gaseous exchange with this diameter tube.

Plastic endotracheal tube stiffeners have been most advantageous in our hands, but stiffeners made from fairly rigid metal coat hangers also work well. Insertion of the endotracheal tube created some problems if the keyhole-like aperture was entered from the ventral aspect. In that case it seemed as though the tube, instead of slipping through easily as would be expected, caused the folds to protrude and close the orifice. Entrance through the dorsal portion of the "keyhole" was the preferred method. Laryngospasm due to repeated attempts at introducing the endotracheal tube has been noted[7]. The pharyngeal recess located dorsal to the esophagus was entered only infrequently even by the most inept or inexperienced operator. Extensive bleeding, without what we considered rational cause, was encountered three times. Two of the animals were rapidly intubated, and the other animal's anesthetic was continued using a nose cone. No sequelae were noted at the postmortem examination at 14 hours except hyperemia in the laryngeal area.

Insufficient nitrous oxide was employed in our initial attempts. When oxygen monitors became available, great success was found in using

combinations of that gas with oxygen alone, halothane, or methoxyflurane. The use of such a monitor provided quantitative controls and instilled confidence in the operators.

The ear veins in our pigs seemed particularly fragile, and, despite extensive handling by the caretakers, the swine resented our efforts when their ears were touched. Piermattei also noted difficulties with this method[7]. Positioning the animals on their backs tended to decrease their anxiety and permitted superior vena cava injections to be accomplished quite handily. The blood collecting "roll-over" rack devised by Dr. Baker[1], when constructed on a smaller scale by our craftsman, provided us with a suitable device in which to immobilize the pigs without chemical restraint.

Although excessive salivation is reportedly not a problem with pigs, our experience has been to the contrary. However, excessive secretions were adequately inhibited with atropine (0.02 mg/lb) administered intramuscularly or subcutaneously 20 minutes prior to the experiment. To circumvent an associated problem, atropine was, at one time, discontinued temporarily. It was felt that the problems of excessive secretion could be avoided by adjusting the position of the animal. However, this proved to be insufficient, and atropine was routinely used in the remaining experiments.

Malignant hyperthermia (MH) was experienced with halothane anesthesia[4,6] administered without benefit of an adjunctive muscle relaxant being employed. The rate and time of onset of temperature rise are at considerable variance with that reported by Jones, et al[4]. The more complex anesthetic schemes shown in our charts are the ones used, after recovery from the initial MH, so that the animals still could be employed in the required experiment. Using these simple treatment regimes, all animals (15) except one were fully utilized.

When chemical immobilization was necessary there was no substitute that could do the job as well as a remotely delivered syringe via the CAP-CHUR Gun®. By careful manipulation of the external power "clicks" of the hand projector it was quite easy to set the proper charge (of CO_2) with no resultant damage to the animal. All injections were targeted for the right hip. Necropsy examination of the area revealed no residual trauma within the muscular area.

Frequent mention is made by researchers of the difficulty in handling miniature swine. Our experience has been to the contrary. Their smaller size and ease of maintenance commend them, and yet their organs approximate the standard man. With frequent handling by understanding and appreciative caretakers, the creatures respond, in most cases, as though they were pets. It is true that they have extraordinary strength for their size and can be tedious and vocal, especially around feeding time, but without exception, our personnel have enjoyed working with them. However, for short term usage or non-survival experiments, domestic swine admirably fill the bill, but rapidly become out-sized and hard to control.

TABLE 1. SUMMARY OF ANESTHETIC PROCEDURES USING DOMESTIC SWINE

Drug(s)	Dose Rate	Route	Times Used	No. of Pigs	Comments
Atropine Halothane	0.02 mg/lb To Effect	IM Gas	174	92	Usually best method Malignant hyperthermia (MH) found in some pigs (15) Vocalization initially
Halothane	To Effect	Gas	8	6	Excessive salivation Vocalization initially
Atropine Methoxyflurane	0.02 mg/lb To Effect	IM Gas	6	6	Slow response Vocalization initially
Halothane Nitrous Oxide	To Effect See Discussion	Gas	4	3	Much salivation Vocalization initially
Atropine Innovar-Vet® Methoxyflurane Nitrous Oxide Promazine HCl	0.02 mg/lb 1 cc/20 lb To Effect See Discussion 2.2-3.0 mg/Kg	IM IM	3	3	Vocalization minimal
Atropine Halothane Nitrous Oxide	0.02 mg/lb To Effect See Discussion	IM Gas	3	3	Excellent Vocalization initially

TABLE 1 (Continued)

Drug(s)	Dose Rate	Route	Times Used	No. of Pigs	Comments
Atropine	0.02 mg/lb	IM	1	1	Excellent but slow
Innovar-Vet®	1 cc/20 lb	IM			Vocalization but minimal
Halothane	To Effect	Gas			
Chlorpromazine HCl	To Effect	Gas	1	1	Excessive salivation; not rapid
Nitrous Oxide	See Discussion				Vocalization initially
Innovar-Vet®	1 cc/20 lb	IM	3	3	Not for anesthesia
			203	95	
NOTE: All had vocalization					
Chloral Hydrate	90 mg/Kg	IP	8	8	Additional injections of
Pentobarbital Na	25 mg/Kg	IP			Phencyclidine HCl given PRN
Phencyclidine HCl	2 mg/Kg	IM			100 mg at a time
Atropine	0.02 mg/lb		51	18	Very slow
Methoxyflurane	To Effect	Gas			Vocalization initially
Atropine	0.02 mg/lb	IM	17	13	Least vocalization
Phencyclidine HCl	2 mg/Kg	IM) (Same			Combination very potent neces-
Chlorpromazine HCl	1 mg/Kg	IM) (Syringe			sitating very close watch when
Methoxyflurane	To Effect	Gas			using gas

TABLE 1 (Continued)

Drug(s)	Dose Rate	Route	Times Used	No. of Pigs	Comments
Atropine Chlorpromazine HCl Methoxyflurane	0.02 mg/lb 2 mg/Kg To Effect	IM IM Gas	6	3	Questionable value to use Chlorpromazine HCl alone Much vocalization
Atropine Phencyclidine HCl Chlorpromazine HCl Pentobarbital Na	0.02 mg/lb 2 mg/Kg 1 mg/Kg	IM IM) (Same IM) (Syringe) IV	5	5	Tendency toward overdose (i.e., not easy to control) Little vocalization
Phencyclidine HCl Chlorpromazine HCl Pentobarbital Na	2 mg/Kg 1 mg/Kg 2.2 mg/Kg	IM) (Same IM) (Syringe IV	5	5	Questionable value Tendency toward overdose Little vocalization
Promazine HCl Phencyclidine HCl Pentobarbital Na	4 mg/Kg 2 mg/Kg 2.2 mg/Kg	IM IM IV	2	2	Questionable value; Promazine apparently not effective at this dose Tendency toward overdose Vocalization medium
Atropine Promazine HCl Methoxyflurane	0.02 mg/lb 4 mg/Kg To Effect	IM IM Gas	2	2	Promazine apparently not effective at this dose rate Vocalization strong

TABLE 1 (Continued)

Drug(s)	Dose Rate	Route	Times Used	No. of Pigs	Comments
Atropine	0.02 mg/lb	IM	1	1	Fair control
Phencyclidine HCl	2 mg/Kg	IM) (Same			Little vocalization
Chlorpromazine HCl	1 mg/Kg	IM) (Syringe			
Thiopental Na	8-10 mg/Kg	IV			
Phencyclidine HCl	2 mg/Kg	IM) (Same	3	3	Excessive salivation
Chlorpromazine HCl	1 mg/Kg	IM) (Syringe			
			100	60	
			303	155	

NOTE: IV through anterior vena caval "stick"

TABLE 2. SUMMARY OF ANESTHETIC PROCEDURES USING MINIATURE SWINE

Drug(s)	Dose Rate	Route	Times Used	No. of Pigs	Comments
Atropine Innovar-Vet® Halothane	0.02 mg/lb 1 cc/20 lb To Effect	IM IM Gas	55	42	Nose cone used at times while other times intubated Salivation controlled Excellent anesthesia overall, but vocalization present at first
Atropine Halothane	0.02 mg/lb To Effect	IM Gas	26	12	Same as above Best overall
Atropine Phencyclidine HCl Chlorpromazine HCl Methoxyflurane	0.02 mg/lb 2 mg/Kg 1 mg/Kg To Effect	IM IM) (Same IM) (Syringe	22	22	Same as above but slow takedown and recovery CAP-CHUR Gun® sometimes used for mixture
Atropine Innovar-Vet® Methoxyflurane	0.02 mg/lb 1 cc/20 lb To Effect	IM IM Gas	20	20	Adequate but slow Vocalization minimal
Atropine Innovar-Vet®	0.02 mg/lb 1 cc/20 lb	IM IM	13	10	Adequate for minor manipulations only (e.g., physical measurements) Vocalization minimal

TABLE 2 (Continued)

Drug(s)	Dose Rate	Route	Times Used	No. of Pigs	Comments
Phencyclidine HCl Chlorpromazine HCl Methoxyflurane	2 mg/Kg 1 mg/Kg To Effect	IM) (Same IM) (Syringe Gas	6	5	Nose cone only Excessive salivation Vocalization minimal
Ketamine HCl Halothane	1.1-3.3 mg/Kg To Effect	IV Gas	4	3	Nose cone only Excessive salivation Vocalization minimal
Ketamine HCl	1.1-5.5 mg/Kg	IV	43	10	Minor manipulations only Although occasionally could replace intravenous catheter, did not appear to offer much analgesic action: Grinding of teeth, itching nose
Chlorpromazine HCl	1 mg/Kg	IV	12	5	Three severe (excitement) reactions in two different pigs
			201	129	
	Total anesthetics or immobilizations		504		
	Total pigs		284		

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APPENDIX A

Drug List

1. Halothane, USP

2. Methoxyflurane, USP

3. Nitrous Oxide, USP

4. Phencyclidine HCl - Parke-Davis Co.; Detroit, MI 48232

5. Chlorpromazine HCl - Smith, Kline & French Laboratories; Philadelphia, PA 19101

6. Ketamine HCl - Bristol Laboratories; Syracuse, NY 13201

7. Innovar-Vet® containing per cc: .4 mg Fentanyl
   .20 mg Droperidol
   1.8 mg Methylparaben
   .2 mg Propylparaben
   Lactic acid
   McNeil Laboratories; Ft. Washington, PA 19034

8. Chloral Hydrate, USP

9. Atropine Sulfate, USP

10. Pentobarbital Sodium, USP

11. Cetacaine - Haver-Lockhart Laboratories; Kansas City, MO 64126

12. Promazine HCl - The Lannett Company, Inc.; Philadelphia, PA 19136

13. Thiopental Na - Abbott Laboratories; North Chicago, IL 60064

14. KY Jelly® - Johnson & Johnson; New Brunswick, NJ 08903

APPENDIX B

Equipment List

1. Automatic waterers - Lixit Dog Waterers; Atco Mfg. Co.; Napa, CA 94558.

2. Rubber nose cone - North America Drager; Model Nos. 371652, 371653, & 371654; Telford, PA 18969.

3. Endotracheal tubes - Davol Rubber Co.; Providence, RI 02901.

4. Gas machine and attachment - Heidbrook Model 780; Ohio Medical Products; Madison, WS 53701; and Fluotec Mark 2; Cyprane Ltd.; Keighley, England.

5. Laryngoscope - FSN: 6515-346-0480.

6. Physiological monitor - Tektronix Type 410; Tektronix, Inc.; Beaverton, OR 97005.

7. Electronic thermometer - GFA Electronic Thermometer Model Nos. 0071 & 0111; Agricultural Electronics; Montclair, CA 91763.

8. Pressure respirator - Bird Mark 10 Respirator; Bird Space Technology; Palm Springs, CA 92262.

9. CAP-CHUR Gun - CAP-CHUR Power Projector®; Palmer Chemical & Equipment Co., Inc.; Douglasville, GA 30134.