



Inhalation Anesthesia in the Chinchilla

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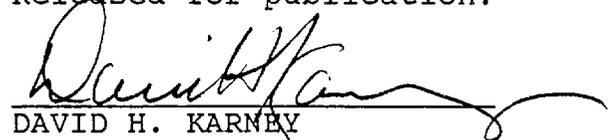


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Table of contents

Introduction.....	3
Methods and procedures.....	3
Results and discussion.....	6
Conclusions.....	8
References.....	10
Appendix A.....	11

List of tables

1. Time to loss of righting reflex in seconds.....	6
2. Time to loss of toepinch reflex in seconds.....	7
3. Time from machine off to return of toepinch reflex in minutes.....	7
4. Time from return to toepinch to standing unaided in minutes.....	8

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Introduction

Halothane (halothane U.S.P.) has been used successfully to induce surgical anesthesia in the chinchilla (Chinchilla villidera). The Acoustical Sciences Branch, Sensory Research Division, U.S. Army Aeromedical Research Laboratory (USAARL), has used halothane as one of its methods of surgical anesthesia for monauralizations of the chinchillas in auditory research (Hargett et al., 1988).

For monauralization surgery in chinchillas, inhalation anesthesia has a number of advantages. Chief among these is the agents are eliminated mostly through the lungs, so recovery from anesthesia does not rely on redistribution within the body and detoxification mechanisms (Lumb and Jones, 1973). Inhalation anesthesia requires specialized equipment, but it is the only technique that allows for control of anesthetic depth and surgical anesthesia duration.

The rapid induction of and rapid recovery from halothane anesthesia, when compared to injectables used for surgical anesthesia in chinchillas, has been clearly established (Hargett et al., 1988). Experience at USAARL has shown that 20 to 25 minutes of surgical anesthesia is sufficient for most procedures. For this reason, we have used a mixture of halothane and nitrous oxide in the past to anesthetize our chinchillas for surgery. Halothane is a halogenated hydrocarbon that produces a potent nonexplosive anesthesia agent (Deutsch, 1971).

Isoflurane (Forane^R), a nonflammable liquid, is a new inhalation general anesthetic. Induction of and recovery from isoflurane anesthesia are rapid. The level of anesthesia may be changed rapidly with isoflurane. Nitrous oxide reduces the inspiratory concentration of isoflurane required to reach a desired level of anesthesia and may reduce the arterial hypotension seen with isoflurane alone. In contrast to halothane, isoflurane does not sensitize the myocardium to exogenously administered epinephrine in the dog. Surgical levels of anesthesia may be sustained with a 1.0 - 2.5 percent concentration when nitrous oxide is used concomitantly. An additional 0.5 - 1.0 percent may be required when isoflurane is given using oxygen alone (Anaquest, 1987).

The present study was undertaken to compare halothane in a semi-closed system, halothane in a nonrebreathing system and isoflurane in a nonrebreathing system in the chinchilla.

Methods and procedures

This study used 26 healthy adult chinchillas of both sexes from the USAARL issue colony. Data from an additional 10 chinchillas were obtained from a previous study (Hargett et al., 1988).

Individual stainless steel laboratory cages (483 mm x 607 mm x 203 mm) were used as housing for the subjects. They were provided with a commercial chinchilla ration* and water ad libitum. Weights ranged from 459 grams to 790 grams with a mean weight of 584 grams and a median weight of 570 grams. Ages ranged from 13 to 22 months. The chinchillas were not deprived of food or water prior to the experiment and were returned to their cages upon being able to stand unaided.

Animals were assigned randomly to each group. Each subject was anesthetized to surgical depth by the method of anesthesia for its assigned group. Surgical depth is defined as the loss of righting reflex followed by the loss of toepinch reflex and is corroborated by subjectively evaluating the chinchilla's overall appearance and vital signs. The following data were collected on each subject: respiration rates, time to loss of righting reflex, time to loss of toepinch reflex, time from removing the anesthetic to return of toepinch reflex, and time from removing the anesthetic to standing unaided. The time at surgical depth was limited to 20 minutes. This is neither a minimum nor maximum for the techniques tested, but merely a convenient benchmark.

The methods used to induce surgical anesthesia were:

Group I: Halothane and nitrous oxide administered by face mask in a semiclosed system.

Group II: Halothane and nitrous oxide administered by face mask in a nonrebreathing system.

Group III: Isoflurane and nitrous oxide administered by face mask in a nonrebreathing system.

Flow rates for Group I were the traditional settings using the semiclosed delivery system. This was determined to be more total gas flow than necessary for the nonrebreathing delivery system. The ratio of nitrous oxide to oxygen for Groups II and III remained the same as Group I with the flow rates scaled down to minimize waste when using the nonrebreathing system.

All times were taken with a stopwatch and recorded to the nearest minute and second.

Group I

Ten chinchillas with a mean weight of 522.6 grams were anesthetized with a semiclosed system of inhalation anesthesia. These subjects actually were run as part of an earlier study reported by

* See Appendix A.

Hargett et al., (1988). The chinchillas were placed on the surface of the anesthesia machine and their heads inserted into the mask. They were held with their heads in the mask until loss of righting reflex occurred. A 4 percent setting of halothane, with a flow rate of 4 liters per minute of nitrous oxide and 2 liters per minute of oxygen, was used for induction. When the toe-pinch reflex was no longer present, the chinchilla was removed from the mask, eyes were lubricated with Optivet^R to prevent corneal drying, and subject was returned to the mask. The loss of toepinch reflex was taken to be the beginning of surgical anesthesia. The chinchilla was maintained at surgical depth using a 2.5 percent halothane setting, with a flow rate of 2 liters per minute of nitrous oxide and 2 liters per minute of oxygen.

At the end of 20 minutes, the halothane and nitrous oxide were turned off (no flow) and the oxygen flow was maintained at 2 liters per minute. This enabled the chinchilla to return to consciousness rapidly, without complications induced by nitrous oxide (Soma, 1971).

Group II

Ten chinchillas were anesthetized using a nonrebreathing system employing a face mask. The chinchillas were placed on a padded surface, and their heads were inserted into the mask. They were restrained physically until they lost their righting reflex. A setting of 4 percent halothane, with a flow rate of 2 liters per minute of nitrous oxide and 1 liter per minute of oxygen, was employed for induction.

Upon the loss of toepinch reflex, each chinchilla was removed from the mask and a small amount of Lubrifair^R was placed in each eye to prevent corneal drying. The subject then was returned to the mask and maintained at surgical depth for 20 minutes using a setting of 2.5 percent halothane at a flow rate of 1.5 liter per minute of both nitrous oxide and oxygen.

At the end of the 20 minutes at surgical depth, the halothane and nitrous oxide were turned off and the oxygen flow maintained at 3 liters per minute. When the subject was able to stand unaided, it was returned to its cage.

Group III

Sixteen chinchillas were anesthetized using a nonrebreathing system employing a face mask. Each chinchilla was placed on a padded surface, and its head was inserted into the mask. Each subject was restrained physically until loss of righting reflex was

observed. A setting of 5 percent isoflurane, with a flow rate of 2 liters per minute of nitrous oxide and 1 liter per minute of oxygen, was employed for induction.

Upon the loss of toepinch reflex, each subject was removed from the mask and a small amount of Lubrifair^R was placed in each eye to prevent corneal drying. The subject then was returned to the mask and maintained at surgical depth for 20 minutes. A total of 3 animals were tested using 2 percent isoflurane, 10 were tested using 1.5 percent isoflurane, 2 were tested using 1.0 percent isoflurane, and 1 was tested using 0.5 percent isoflurane. In each instance, the flow rate was 1.5 liters per minute of nitrous oxide and 1.5 liters per minute of oxygen. Based on the initial trials at the various settings, we concluded 1.5 percent isoflurane would provide satisfactory anesthesia at an economical cost. Thus, this setting was selected for the primary focus of our isoflurane work. Although data were taken at the other percentages as indicated, these findings are not discussed in this report.

At the end of the 20 minutes at surgical anesthesia, these subjects were handled the same as those in Group II.

Results and Discussion

The times to loss of righting reflex are shown in Table 1. These data (time in seconds) for the nonbreathing system with either inhalation anesthetic agent are shorter than the semiclosed system. The analysis of variance revealed significant differences ($\alpha = .05$) between groups. The a posteriori analysis revealed significant differences in mean time to loss of righting reflex between the isoflurane and halothane groups delivered with the nonbreathing system and showed a significant difference between those groups and the group using halothane delivered with the semiclosed system.

Table 1.
Time to loss of righting reflex in seconds

	<u>Group I</u>	<u>Group II</u>	<u>Group III</u>
Median	128.5	63.5	42.5
Range	46-170	50-105	30-50
Mean	124.1	67.8	41.0
S.D.	34.3	16.9	9.1
Group I	= Halothane, semiclosed system, mask		
Group II	= Halothane, nonbreathing system, mask		
Group III	= Isoflurane, nonbreathing system, mask		

The times to loss of toepinch reflex are shown in Table 2. Loss of toepinch reflex in the group receiving isoflurane delivered through a nonbreathing system averaged over 110 seconds faster

than the group receiving halothane delivered through a nonrebreathing system and over 250 seconds faster than the group receiving halothane delivered through a semiclosed system. The analysis of variance revealed significant differences ($\alpha = .05$) between groups.

Table 2.
Time to loss of toepinch reflex in seconds

	<u>Group I</u>	<u>Group II</u>	<u>Group III</u>
Median	332.5	167.5	60.0
Range	150-402	130-220	45-90
Mean	308.2	168.9	58.0
S.D.	72.7	29.0	13.6

Group I = Halothane, semiclosed system, mask
 Group II = Halothane, nonrebreathing system, mask
 Group III = Isoflurane, nonrebreathing system, mask

The times from turning the anesthesia machine off until the return of the toepinch reflex are shown in Table 3. The end of surgical anesthesia was determined by the return of the toepinch after delivery of the anesthetic agent was terminated. The analysis of variance revealed significant differences ($\alpha = .05$) between groups. The a posteriori analysis revealed a significant difference between the isoflurane group and the semiclosed group, with the halothane delivered with a nonrebreathing system having no honestly significant difference from either of the other two groups.

Table 3.
Time from machine off to return of toepinch reflex in minutes

	<u>Group I</u>	<u>Group II</u>	<u>Group III</u>
Median	4.5	4.3	3.4
Range	4.0-6.0	3.0-7.0	1.5-5.5
Mean	4.6	4.5	3.4
S.D.	0.7	1.3	1.2

Group I = Halothane, semiclosed system, mask
 Group II = Halothane, nonrebreathing system, mask
 Group III = Isoflurane, nonrebreathing system, mask

The time in minutes to standing unaided is a major consideration for choosing an anesthetic agent and a delivery system. Data in Table 4 shows this measure averaged 3.2 minutes faster with the isoflurane delivered with the nonrebreathing system than the halothane delivered with the nonrebreathing system and 6.6 minutes faster than the halothane delivered with the semiclosed system.

The analysis of variance revealed significant differences ($\alpha = .05$) between groups.

Table 4.
Time from return of toe pinch to standing unaided in minutes

	<u>Group I</u>	<u>Group II</u>	<u>Group III</u>
Median	7.3	3.3	1.4
Range	4.2-16.0	1.3-13.2	0.8-2.9
Mean	8.2	4.8	1.6
S.D.	3.2	3.8	0.7

Group I = Halothane, semiclosed system, mask
 Group II = Halothane, nonrebreathing system, mask
 Group III = Isoflurane, nonrebreathing system, mask

Conclusions

Although each of the anesthetic techniques employed will successfully anesthetize the chinchilla, there are advantages and disadvantages to each technique.

Halothane using a semiclosed delivery system is unacceptable because the design of the system does not allow for proper air exchange. Because of the small tidal volume of the chinchilla, it is forced to rebreathe the unfiltered air it exhales into the hose system. Induction and recovery times are prolonged, and the animal is rebreathing toxic halothane metabolites.

Halothane using a nonrebreathing system is an acceptable choice for anesthetizing the chinchilla. The delivery system is appropriate for the size animal involved, and halothane is a potent inhalation anesthetic. Induction and recovery times were cut by approximately 40 percent by using the nonrebreathing apparatus. In addition, the equipment required readily is available in the laboratory, and the cost compared to isoflurane is low.

Isoflurane using a nonrebreathing system also is an acceptable choice. The delivery system is appropriate for the chinchilla, and isoflurane is a safe, potent anesthetic agent. Induction time was cut by approximately 40 percent, and recovery time was cut by approximately 65 percent by using isoflurane as the anesthetic agent. This agent is safer than halothane for both the animal and the operating room personnel. It is neither a carcinogen nor a hepatotoxin as is halothane. In addition, the depth of anesthesia can be changed more rapidly with isoflurane than with halothane.

The one disadvantage of isoflurane is cost: the agent is expensive, and new vaporizers would be required for its use.

We conclude the best choice for inhalation anesthesia for the chinchilla is isoflurane using a nonrebreathing delivery system. This system provides more rapid induction and recovery than halothane, and is safer for the animal and the personnel involved.

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Appendix A

List of manufacturers

Halocarbon Laboratories, Incorporated
82 Berlews Court
Hackensack, NJ 07601
(Halothane U.S.P.)

BOC Health Care
Anaquest
Madison, WI 53713
(Forane)

Ralston Purina Company
Checkerboard Square
St. Louis, MO 63164
(Purina Chin Chow)

Burns-Biotec Laboratories, Incorporated
8536 K Street
Omaha, NE 68127
(Optivet)

Pharmafair, Incorporated
110 Kennedy Drive
Hauppauge, NY 11788
(Lubrifaair)