ABSTRACT OF THESIS

CURARE AS AN ADJUVANT TO GENERAL ANESTHETIC IN THE DOG

Submitted by

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In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado

Agricultural and Mechanical College

June, 1948

ABSTRACT

Introduction

Since ether was first used as an anesthetic for a surgical operation over a hundred years ago, there has been a constant demand and search for an anesthetic with safety as a primary objective but the depth and duration of anesthesia, the comfort of the patient, and the convenience of the surgeon also as extremely important objectives. Various anesthetics, and combinations of anesthetics, have been used with varying degrees of success.

Complete relaxation of abdominal muscles is of particular concern to the surgeon in operations such as repair of diaphragmatic hernias and upper abdominal exploratory surgery. According to Cole (14), 1945, to obtain relaxation in anesthesia by the use of one drug requires a higher concentration of the agent in the blood; and, in the case of an inhalent, in the inspired atmosphere. It also imposes on the patient a penalty deeper than is necessary to obtain merely anesthesia. In 1946, Knight (32) made the statement that deep anesthesia is more shock producing than surgical trauma. According to the Squibb Memoranda (37), September 1947,

15 minutes of deep third plane anesthesia is as harmful to the patient as two hours of first plane anesthesia.

The objective of this study is to determine whether or not curare may be successfully used as an adjuvant to general anesthesia in the dog.

The problem

What is the value of curare as an adjuvant to general anesthesia of the dog?

Problem analysis.--1. What dosage of curare may be safely administered to the dog?

2. What are the effects of curare used in conjunction with light plane anesthesia?

3. What are the effects of curare used in conjunction with surgical anesthesia?

4. What, if any, hematological changes does the use of curare produce: a. Leukocytes; b. Erythrocytes; c. Hemaglobin?

5. What is the effect on blood pressure of curare used in therapeutic dosages in surgical anesthesia?

Delimitation of the problem.--This study has been limited to the experimental use of 20 dogs in each of problems 1, 2, 3, and 4, and in problem 5, the study has been limited to the experimental use of five dogs. General anesthetics to be used are to be limited to ether, pentobarbital sodium and Pentothal Sodium.

The curare product used in this investigation was Intocostrin.

Materials and methods

The 35 dogs used in this series of experiments were of various ages, sizes and breeds. Some dogs died during experiments; others were lost from distemper and other causes. Those lost were replaced by other dogs. Each problem, with the exception of those determining changes in blood pressure, was carried out on 20 animals. The animals were identified by large numbers cut in their hair coats.

The curare used in this study is known commercially as Intocostrin. This is a physiologically standardized extract of curare secured from the Amazon forests. It is supplied in sterile ampules, one c.c. of the solution containing 20 units of a standard curare.

The anesthetics tested with curare were chosen because they are those most used by veterinarians. They were ether, Nembutal, which is a trade name for pentobarbital sodium, and Pentothal Sodium.

All injections of curare were made intravenously through the entire series of experiments.

In determining the effects of curare used in conjunction with Nembutal and Pentothal Sodium on blood pressure, only the 3/8 unit of curare per pound of body weight was used. This was the therapeutic dose determined

in previous experiments. For determining the effect on blood pressure with ether anesthesia, 1/8 unit of curare was used.

The following methods of investigation were used:

A. Injection of 20 dogs with varying doses of curare.--The doses used were 1/4, 1/2 and 3/4 units per pound of body weight which were injected into each animal on separate days and the effects noted on the following listed systems:

1. Respiratory system
2. Circulatory system
3. Muscular system

a. The character of the abdominal tension was recorded by the following symbols: 3+, 2+, 1+, 1-, 2- and 3-. 3+ was taken to be that amount of abdominal tension shown in a normal unanesthetized and uncurarized dog when the abdomen was palpated. 1+ was that amount of tension found in an anesthetized or curarized dog in which there was a bare amount of voluntary straining. 2+ was that amount of abdominal tension found between 1+ and 3+. 3- was a complete lack of any abdominal tension. 1- indicated a condition of the abdominal muscles in which there was a somewhat marked tension but no

voluntary straining. 2- was midway between 1- tension and 3- tension.

4. Varying symptoms other than those of the three systems listed above were noted:

a. Micturition

b. Defecation

c. Struggling

d. Crying

e. Discomfort

5. Hemapoietic system

a. Red and white blood cell counts were made following injection of curare.

b. Hemoglobin

Findings

The results concerning the action of curare found in this study were as a whole the same as those found by other investigators. There were, however, some minor differences. The investigation of curare as an adjuvant to general anesthetics obtained both positive and negative results.

The injection of 1/4 unit of curare showed few visible symptoms, but 1/2 unit of curare produced a skeletal muscle paralysis in all of the dogs and respiratory paralysis in one. The respirations of all varied from shallow to diaphragmatic. Since 1/4 unit produced

no visible effects and 1/2 unit produced a respiratory paralysis in one dog, it would appear that a safe and effective therapeutic dosage of curare, as far as respiratory paralysis is concerned, would be somewhere between 1/4 and 1/2 units per pound of body weight. The changes in pulse rate with the 1/4 unit dose were not significant. The 1/2 unit dose of curare caused a marked bradycardia in seven dogs.

The symptoms caused by 3/4 unit of curare were considerably more exaggerated. There was a much more profound paralysis. It is interesting to note that those dogs suffering respiratory paralysis regained the use of their leg muscles before regaining the use of their respiratory muscles. This was evidenced by the fact that they pawed the air in an effort to breathe. This disagreed with the writings of Cole (14), in 1945, who wrote that the first muscles recovering were the diaphragm and the intercostal muscles. The paralysis, however, did seem to occur first in the larger muscles of the head, neck, extremities, the intercostals and diaphragm last. This agreed with the writings of Bennett (5), Cullen (15), Cole (14), but disagreed with Sollmann (41), 1944, who wrote that the abdominal muscles were the last to be paralyzed. It was found that in this study that the abdominal muscles seemed to be the first paralyzed following those of the appendages.

Bennett (5) and Cullen (15) wrote that sensory nerves were not affected and that there was no analgesic action. Gray, Spradling and Fechner (24), 1941, wrote that there was a selective depressive action on motor nerve endings, but that the action on sensory endings were entirely excluded. In these experiments, when an animal was completely paralyzed, it showed definite evidence of pain when tested for pedal reflex. It also showed extreme discomfort while unable to breathe, apparently completely alert mentally.

Cullen (15), 1942, wrote that the action of curare was obtained within one minute following its injection. In this study the results were obtained within 30 seconds to two minutes.

Lenahan (33), 1945, wrote that normal function returns when curare disappears from the circulation. According to him the average time for disappearance is 30 minutes. The return to normal range in this study varied from seven to 30 minutes when curare was given alone.

McIntyre (34), in 1947, observed frequent salivation, retching, vomiting and sometimes defecation. These reactions were observed in these experiments following the injection of curare into unanesthetized dogs. Micturition wqs also observed. McIntyre attributed these phenomena to be of almost certain central origin.

In this study it was found that both slight decreases and increases in temperature occurred following the injection of curare. There were more decreases in temperature than increases. Reichert (39), in 1891, ran an extensive series of experiments concerning the changes in body temperature in dogs. He ascribed the increases of temperature to an increase of heat production and the fall to an increase of heat dissipation. Sollmann (41), 1944, wrote that curare produced a peripheral vasomotor depression. It is possible that the dissipation was due to this peripheral vasomotor depression relaxing vessels and allowing escape of heat. The increase of temperature may have been caused by excitement or alarm. The dogs paralyzed with curare were most certainly excited and alarmed.

Nembutal, 3/4 grain, light plane anesthesia.--It is evident from this series of studies that the action of Nembutal enhances the effects of curare and that the reverse is also true. One-fourth unit per pound of body weight given alone showed little effect, but 1/4 unit of curare used simultaneously with a light plane Nembutal anesthesia produced a rather remarkable effect. The animals which were hung at a 45 degree angle had a 3+ abdominal tension and were struggling and crying. Within a few seconds following the injection of 1/4 unit of curare the struggling and crying ceased. The animals hung there

more completely relaxed than they would have been had they been given a full surgical dose of Nembutal.

During this series of experiments with light plane Nembutal anesthesia there was an almost immediate relaxation of the abdominal muscles. With the 1/4 and 3/8 unit injection there was no apparent respiratory depression or untoward effect on the heart. Since the 1/2 unit caused some undesirable symptoms and the injection of 1/4 unit, although having no apparent undesirable symptoms, did not in all cases give a complete relaxation nor did the relaxation last as long, it seems that the 3/8 unit per pound of body weight would be the therapeutic dose of choice for light plane Nembutal anesthesia.

Dogs suffering severe shock caused by injuries, disease or prolonged labor during parturition, have frequently been known to become anesthetized by a fourth of the usual dose of Nembutal. However, relaxation is usually far from complete in these dogs. The results of these studies seem to imply that 3/8 unit of curare may be indicated in those cases. Cullen (16), in 1945, wrote that he used curare cautiously in the presence of shock but that it was probably advantageous, because it is possible to carry the patient in light anesthesia and prevent adding to the shock by increasing the depth of the anesthesia. The Squibb Memoranda (37), September 1947, wrote that poor risk patients are able to take

prolonged surgery which, without the supplemental use of curare, would be considered impractical and contraindicated.

Nembutal, 1 grain, surgical anesthesia.--None of the dogs receiving one grain of Nembutal per five pounds had complete abdominal relaxation. There was slight struggling and crying by some of the dogs while hung at a 45 degree angle. The susceptibility of dogs to Nembutal varies. An experienced veterinary anesthetist will give Nembutal to desired effect. Animals which have been debilitated by any condition such as shock, disease, age, etc., require less Nembutal than normal animals. Healthy, strong animals sometimes require more Nembutal than the one grain to produce surgical anesthesia. Because one grain per five pounds of body weight is the generally advised dose for surgical anesthesia, that was the amount used in this series of experiments.

This series of experiments with Nembutal seem to indicate the feasibility of using curare as an adjuvant to Nembutal anesthesia. The 1/4 unit dose appears to be inadequate in some cases. The 1/2 unit dose is apparently too dangerous for general use without further study. The 3/8 unit injection seemed to produce the desired results with none of the objectionable symptoms.

Pentothal Sodium, light plane anesthesia.--Pentothal Sodium, surgical anesthesia, was given to effect.

Surgical anesthesia was taken to be that stage of anesthesia in which there was a slight palpebral reflex but no pedal reflex. Repeated injections of Pentothal were occasionally necessary to hold the animal under surgical anesthesia unitl the effects of curare were eliminated.

The symptoms of 1/4, 3/8, and 1/2 unit were similar to those under light plane anesthesia. Even the degree of relaxation and time of action were similar to those under light plane anesthesia. Because of the maximum efficiency and lack of undesirable symptoms, 3/8 unit of curare would seem to be the best therapeutic dose with light plane and surgical Pentothal Sodium anesthesia as well as light plane and surgical Nembutal anesthesia.

Ether anesthesia with curare.--Ether in light plane anesthesia and surgical anesthesia, followed by either 1/8 or 1/4 unit of curare produced marked effects on both respirations and pulse. Respirations rapidly became labored and shallow. In most dogs respirations ceased almost immediately. The pulse became weak and thready. In all dogs it was necessary to remove the ether cone immediately following the injection of curare.

Until further studies are made it would seem that curare is definitely contraindicated following the use of ether. These findings correspond with those of Whitacre and Fisher (49), 1945, who wrote that large doses

of curare in light plane ether anesthesia may precipitate severe circulatory depression and that in the presence of deep ether anesthesia even small doses of curare may cause severe circulatory reactions. Ausherman and Brannen (3), October 1947, wrote that if ether in any amount had been introduced into the system before curare had been given, it is best to reduce the estimated dose of curare.

Effects of curare on blood pressure.--Nembutal and Pentothal Sodium produced short but rather marked effects on the blood pressure. Curare showed no change at all following Pentothal Sodium and only a very short dip in blood pressure occurred in two dogs following the use of Nembutal.

Blood pressure in ether anesthesia following curare showed very marked fluctuations. However, the sharp dips in blood pressure were followed by a rise when artificial respiration was applied. This is a possible indication that the blood pressure could be maintained if the animal were intubated and administered constant artificial respiration while being given ether.

Summary

In this study of curare as an adjuvant to general anesthesia in the dog, dogs of various ages and sizes were used. The effects of curare administered

without anesthesia were investigated. In these experiments 1/4 unit seemed to produce very little effect, and 1/2 unit seemed to produce certain danger symptoms. For that reason, while investigating the effects of curare used in conjunction with light plane and surgical anesthesia, it was decided to use as a first dose 1/4 unit of curare and increase the quanity in each series of experiments by 1/8 unit until a damgerous margin was found. An apparently dangerous margin was found to be 1/2 unit of curare per pound of body weight when used in conjunction with both light plane and surgical anesthesia with both Nembutal and Pentothal Sodium.

Since, in ether anesthesia, 1/4 unit of curare per pound of body weight proved dangerous, the dose was reduced to 1/8 unit, which also proved dangerous. Since, 1/8 unit was dangerous and did not produce a desirable degree of relaxation, no further studies were made concerning curare with ether.

In the limited series of experiments made in this study, 3/8 unit of curare was found to have little effect on the blood pressure during surgical anesthesia produced by Nembutal or Pentothal Sodium. During ether anesthesia, 1/8 unit of curare dropped the blood pressure to dangerous levels.

In determining the effects of curare administered alone and used in conjunction with light and

surgical plane anesthesia, 19 experiments were performed on each of 20 dogs. The results obtained from these experiments seemed to indicate very little use for curare without anesthesia. One-fourth unit of curare per pound of body weight may be of some benefit when used with either Nembutal or Pentothal Sodium in light plane or surgical anesthesia. Three-eighth unit of curare per pound of body weight was indicated by this series of studies as being the most advantageous therapeutic dose with Nembutal or Pentothal Sodium in light plane or surgical anesthesia.

This limited series of studies seems to indicate a possibility that curare may find a wide and useful field in veterinary surgery.

T H E S I S

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Submitted by

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In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado

Agricultural and Mechanical College

Fort Collins, Colorado

June, 1948

COLORADO AGRICULTURAL AND MECHANICAL COLLEGE

June 1948

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY DEETS PICKETT

ENTITLED CURARE AS AN ADJUVANT TO GENERAL ANESTHESIA IN THE DOG

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

MAJORING IN VETERINARY SURGERY

CREDITS 10

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Permission to publish this thesis or any part of it must be obtained from the Dean of the Graduate School.

ACKNOWLEDGMENTS

Sincere appreciation is hereby expressed to Dr. James Farquharson, Head of the Department of Surgery and Clinics, Colorado Agricultural and Mechanical College, for his valuable suggestions and guidance and for his aid in obtaining materials and animals for this study.

The writer wishes to acknowledge assistance given by Dr. Rue Jensen, Associate Professor of Pathology, Colorado Agricultural and Mechanical College, for his constructive criticisms and suggestions in developing the problem.

Appreciation is extended to Dr. Arthur W. Deem, Associate Professor of Bacteriology, Colorado Agricultural and Mechanical College, for his friendly advice in the preparation of this thesis.

Deep appreciation is also expressed to Dr. David H. Morgan, Head of the Department of Psychology and Education and Dean of the Graduate School, Colorado Agricultural and Mechanical College, for his encouragement and assistance in the writing of this thesis.

The writer wishes to express appreciation for the technical assistance and advice received from Dr. A.

Donald Rankin, Associate Professor of the Department of Physiology, Colorado Agricultural and Mechanical College.

To Dr. Harry W. Johnson, Professor of Veterinary Medicine and Acting Head of the Department of Veterinary Medicine, and Dr. Robert Zimdahl, Assistant Professor of the Department of Veterinary Surgery and Clinics, appreciation is expressed for their cooperation in supplying the student help necessary for the completion of this study.

For his helpful assistance with the bibliography, appreciation is extended to Dr. James G. Hodgson, Librarian, Colorado Agricultural and Mechanical College.

Appreciation is expressed to Mrs. Frances Barney, Veterinary Librarian, for her valuable assistance in obtaining reference material from various libraries.

The writer expresses appreciation to Mrs. Azalea Brown, Technician in the Physiology Department, for her technical assistance during the experiments with blood pressure.

Special acknowledgment is expressed to the members of the Junior Class of Veterinary Medicine of 1947-48, Colorado Agricultural and Mechanical College, without whose aid it would have been impossible to have completed this study in the allotted time.

Finally, the writer extends deep appreciation to his wife for the long and tedious hours spent in the

typing of this manuscript and for her helpful criticism.

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Chapter I

INTRODUCTION

Since ether was first used as an anesthetic for a surgical operation over a hundred years ago, there has been a constant demand and search for an anesthetic with safety as a primary objective but the depth and duration of anesthesia, the comfort of the patient, and the convenience of the surgeon also as extremely important objectives. Various anesthetics, and combinations of anesthetics, have been used with varying degrees of success.

Complete relaxation of abdominal muscles is of particular concern to the surgeon in operations such as repair of diaphragmatic hernias and upper abdominal exploratory surgery. Reasonably complete relaxation has been achieved in many cases by pushing the anesthetic to the extreme margin of safety. This extreme margin is so narrow in certain conditions, such as shock or debilities of various kinds, that fatalities have frequently occurred. In recent years a greater degree of relaxation has been achieved by the use of "combined anesthesia," or "balanced anesthesia," wherein the patient is put to sleep after the required relaxation has been accomplished

by regional nerve block, usually spinal anesthesia.

According to Cole (14), 1945, to obtain relaxation in anesthesia by the use of one drug required a higher concentration of the agent in the blood; and, in the case of an inhalant, in the inspired atmosphere. It also imposes on the patient a penalty deeper than is necessary to obtain merely anesthesia. In 1946, Knight (32) made the statement that deep anesthesia is more shock producing than surgical trauma. According to the Squibb Memoranda (37), September 1947, 15 minutes of deep third plane anesthesia is as harmful to the patient as two hours of first plane anesthesia.

It would seem that a drug giving maximum relaxation combined with the safety and lack of secondary irritations and dangers of first plane anesthetia would be almost an ideal adjunct to general anesthetics. In 1942, Johnson and Griffith (26) published a paper concerning the use of curare as an adjuvant to general anesthesia in 25 patients. According to their paper they administered the drug intravenously to patients under general anesthesia and found that it acted quickly producing in less than a minute a dramatic and complete relaxation of skeletal muscles. Since then curare has become a standard drug in the armamentarium of thousands of anesthetists in human hospitals.

The veterinarian in small animal practice

seldom has an expert anesthetist. He must rely ordinarily on a comparatively untrained assistant for the administration of anesthetics. The anesthetics used most by veterinarians are: ether, because of its comparatively large margin of safety; nembutal, because of its ease of administration and the fact that when it is injected anesthesia lasts for some time; and pentothal sodium, because of its ease of administration and its short action. Anesthetists have a difficult time with all of their costly apparatus achieving a good degree of relaxation.

It is even more difficult for a veterinarian with his lack of skilled help and costly apparatus to obtain a desirable degree of relaxation. Too large a dose of ether may result in the loss of the patient. Nembutal provides a rather poor degree of relaxation and the narrow margin of safety prohibits the use of more nembutal than is absolutely required to achieve unconsciousness. The same holds true for the use of pentothal sodium. Every veterinary surgeon toward the end of a long operation has found himself perspiringly working over a patient which has started to breathe heavily with a consequent fluctuating abdomen and intestines protruding through the incision. At such times it would have been a blessing to have had a drug at hand which would give complete relaxation quickly and harmlessly at

these critical moments.

The objective of this study is to determine whether or not curare may be successfully used as an adjuvant to general anesthesia in the dog.

The problem

What is the value of curare as an adjuvant to general anesthesia of the dog?

Problem analysis.--1. What dosage of curare may be safely administered to the dog?

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4. What, if any, hematological changes does the use of curare produce: a. Leukocytes; b. Erythrocytes; c. Hemaglobin?

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Delimitation of the problem.--This study has been limited to the experimental use of 20 dogs in each of problems 1, 2, 3, and 4, and in problem 5, the study has been limited to the experimental use of five dogs. General anesthetics to be used are to be limited to ether, pentobarbital sodium and pentothal sodium.

The curare product used in this investigation was Intocostrin.

Chapter II

REVIEW OF LITERATURE

> Curare, Curari (koo-rah're) (South American) A highly toxic dried extract of various species of Strychnos used originally in South America as an arrow poison and now used in pharmacological research. It paralyzes the motor end plates of nerves. It is used for the reduction of spasm in tetanus, plastic muscular rigidity, spastic paralysis, and similar condition. (20:391)

In the review of literature one finds many variations in the spelling and the pronunciation of the word curare. Squibb Memoranda (43), September 1943, cited Boussingault and Roulin as having used the name curarine. Girard (23), 1878-79, referred to curare as curari or woorari. Edmonds and Roth (21), in 1908-09, wrote about curara. McIntyre (34) wrote that the variants of this word were apparently attempts by Europeans to render it into phonetic equivalents in their respective languages.

McIntyre (34), 1947, cited Barbosa Rodriques, a Brazilian naturalist, as having written that the Indian name for curare is uiraery, which comes from two words, uira, meaning bird, and eor, meaning kill. (34:1) McIntyre also cited Perrot and Vogt as having listed the following variants:

Uirary, ourary, urali, urare, wourari, worari, woraru, wourali, worali, woorara, uvari,

avara, kurari, curara, curari, curarayae, all of which obviously seem to be related. (34:1)

History of curare

From the early part of the 16th century there have been many accounts written of the deadly poison used on arrows by the Indians of South America. It is probably natural and in accord with human nature that these accounts have frequently been embellished by the imagination of these early travelers. A poison producing such a sudden and dramatic death naturally would lend itself to colorful tales.

Sir Walter Raleigh (38), in 1596, wrote that the Aroras, a tribe as black as negros, were very valiant people and had "most strong poison on their arrows."

> There was nothing whereof I was more curious, than to finde out the true remedies of these poisoned arrowes, for besides the mortalitie of the wound they make, the partie shot indureth the most insufferable torment in the world, and abideth a most uglie and lamentable death, sometimes dying starke mad, sometimes their bowels breaking out of their bellies, and are presently discolored, as blacke as pitch, and so unsauery, as no man can endure to cure, or to attend them: And it is more strange to know, that in all this time there was never Spaniard, either by gift or torment that could attaine to the true knowledge of the cure, although they have martyred and put to inuented torture I know not how many of them. But every one of these Indians know it not, no not one among thousands, but their southsaiers and priests, who do conceale it, and onely teach it but from the father to the sonne.
>
> Some of the Spaniards have been cured in ordinary wounds, of the common poisoned arrowes with the juice of garlike: but this is a

> generall rule for all men that shall heerafter trauell the Indies where poisoned arrowes are used, that they must abstaine from drinke, for if they take any licor into their body, as they shall be maruellously prouoked therunto by drought, I say, if theu drink before the wound be dressed, or soone upon it, there is no way with them but present death. (38)

Garcilasso de la Vega (22), in 1609, wrote that there were men and women who gave poison to kill by slow degrees or suddenly and to destroy reason.

Harcourt (27), in 1613, made the following reference to poison arrows:

> The power and ftrength of thefe Countries (being fo thinly peopled,) is not very great to withftand the might of forraine enemies; the vfuall weapons of the Indians, are before defcribed, fauing that their arrowes are oft-times poifoned. (27:89)

Father Cristoval De Acuna (2), in 1639, wrote that some of the South American nations used bows and arrows, a weapon which, among all others, was respected for the force and rapidity with which it inflicted wounds. According to him, the poison used on these arrows was so fatal that it destroyed life the minute it drew blood.

Tschudi (45), in 1849, wrote that the poison for arrows differed with almost every tribe and that very mysterious ceremonies were observed at its preparation. This was the reason, according to him, that the ingredients employed were only partially known to Europeans. Tschudi wrote that the poison was mixed with animal substance such as the poisonous emmet and the

teeth of poisonous serpents. Men and large mammalia, according to him, died within four or five minutes after receiving the wound; smaller mammiferous animals and birds died in two minutes.

Herndon (30), in 1853, described the blow-gun of the Indians. The Indians called the blow-gun pucuna.

> It is made of any long, straight piece of wood, generally of a species of palm called chonta--a heavy, elastic wood, of which bows, clubs, and spears are also made. The pole or staff, about eight feet in length, and two inches in diameter near the mouth end, (tapering down to half an inch at the extremity,) is divided longitudinally. The arrow is made of any light wood, generally the wild cane, or the middle fibre of a species of palm-leaf, which is about a foot in length, and of the thickness of an ordinary lucifer match. . . . and the other end, very sharply pointed, is dipped in a vegetable poison prepared from the juice of the creeper, called bejuco de ambihuasca, mixed with aji, or strong red pepper, barbasco, sarnangom and whatever substances the Indians know to be deleterious. The marksman, when using his pucuna, instead of stretching out the left hand along the body of the tube, places it to his mouth by grasping it, with both hands together, close to the mouth piece, in such a manner that it requires considerable strength in the arms to hold it out at all, much less steadily. If a practised marksman, he will kill a small bird at thirty or forty paces. In an experiment that I saw, the Indian held the pucuna horizontally, and the arrow blown from it stuck in the ground at thirty-eight paces. (30:Vol.1:135)

Bates (4), in 1863, wrote that the blow-pipe, in the hands of an expert adult Indian, could be made to propel arrows which would kill at a distance of 50 or 60 yards.

Girard (23), in 1879, wrote that Sir Walter

Raleigh was the first to take curare poisoned arrows to Europe. According to Girard, the poison was in general use on the Atlantic slope of South America at that time. He said that in 1879 the depths of the forest had to be penetrated to find the remnants of the ancient populations who possessed the recipe for preparing curare. West (48), in 1935, wrote that Sir Walter Raleigh was very desirous of finding an antidote to the poisonous effect of curare. Various later writers, Denhoff and Bradley (19), Griffith (25), and Lenahan (33), have likewise attributed the introduction of curare to Europe to Sir Walter Raleigh.

McIntyre (34), 1947, disagreed with the statements of these other writers about Sir Walter Raleigh's having first taken poisoned arrows to Europe. According to McIntyre, the statement that Raleigh was the first to introduce curare to Europe has been made so frequently that reiteration seems to have established its veracity. He placed the responsibility for this conception upon Munter, who, according to McIntyre, misread Caley's biography. Munter gave as his authority Caley's Life of Raleigh. (1:196; 2:13) According to McIntyre, neither Caley nor other biographers of Raleigh make any mention of Raleigh's taking arrow poison back to Europe with him. McIntyre also wrote that a rather extensive search of Raleigh's own writings failed to disclose any mention

of his carrying the poison home. (34:14)

Squibb Memoranda (43), September 1943, cited Boussingault and Roulin, 1824, as having extracted from crude curare a syrupy substance which they called curarine. It also credited Claude Bernard with having carried out, in 1844, experiments to demonstrate the site of action of the curare. In addition to demonstrating that the site of action was the myoneural junction, he showed that the drug must enter the body in some manner other than the alimentary tract in order to be effective, that the drug did not affect the sensory mechanism, that it produced no irreversible change in the muscle or nerve, and that it did not directly affect the cardiovascular system.

According to the same memoranda, the modern development of curare may be dated from 1934 when Mr. Richard C. Gill, traveling through South America, collected many specimans of curare of known botanical origin. He also learned much of the native methods of preparing the extracts.

Bennett (5), 1941, wrote the following regarding the development of curare:

> Jousset, Demine and Busch in 1867, first attempted to apply the drug to clinical medical therapy. They treated convulsive states, epilepsy, rabies, chorea, strychine poisoning, and various tics. Hoffman (1879), Hock (1894), and Cash (1901), also experimented with curare. Tsocanakis, in 1924, tried curare in spastic paralysis. Bremer, in 1929, proved that the

drug exhibited a selective action in reduction of local tetanus and decerebrate rigidity. West (1931-35) and Cole (1934) reported partial results in the relief of tetanus convulsions, rigidity of Parkinsonism causalgia, and spastic paraplegia. Burman (1938-39) reported extensively upon its relaxing effect in spastic, athetoid, and dystonic states of muscular regidity and tremor. (5:102)

Anesthesia

The following summary of general anesthesia was made by Knight (32) in 1946:

GENERAL ANESTHESIA

The administration of anesthesia is an exacting medical procedure. In no other act are the patient's life and welfare so immediately and exactly controlled and manipulated. No other diagnoses must be more exact than the minute to minute diagnoses during anesthesia. No other drugs are given to such exact physiologic limits as are anesthetics; no other must be given, taken away or antidoted so precisely.

GENERAL CONSIDERATIONS

Analgesia is the absence of the sensation of pain, anesthesia is the absence of all sensation, while general anesthesia is the absence of sensation throughout the entire body accompanied by unconsciousness. Not only are sensation and consciousness abolished, but frequently the efferent paths also are narcotized, suspending the function of glands and muscles. "Anesthesia," then, denotes the induced loss of irritability and conductivity, with insensibility, inhibition or paralysis in any part of the nervous system, afferent, central or efferent./ "Tone or tonicity is," according to Stedman, "a state of normal elastic tension of the tissues by virtue of which the parts are kept in shape and, as it were, alert and ready to function in response to a suitable stimulus." Tone is present as long as the efferent nerve path is normal even though unstimulated. Tone is abolished if the efferent nerve path is entirely

deprived of its irritability and conductivity. Surgical anesthesia is loss of sensation, with mental and muscular relaxation sufficient to permit operative work.

In general anesthesia the agent or agents are brought into contact with the nervous system through the blood stream. Approaches to the blood stream in the order of their rapidity are as follows: intravenously, by inhalation, subcutaneously, by colonic absorption and by stomach. In general, those parts which are newer in evolution and less necessary for the maintenance of life are more easily affected by weaker concentration, while those parts which are older and more necessary for life require stronger concentrations to affect them.

As the concentration of the anesthetic in the blood stream and in the tissues is increased from nothing to the lethal dose, the parts of the nervous system are inhibited and paralyzed in approximately the following order:

1. The higher centers: Inhibitions, orientation, emotions, memory, will, sensation, consciousness.

2. The spinal and cranial nerve reflexes: From the clinical evidence it would seem that these are blocked by anesthetizing one or more neurons on the sensory side of the arc.

   a. The reflexes from the periphery through the brain stem or spinal cord to the voluntary muscles, including the respiratory muscles.

   b. The reflexes from the periphery through the spinal cord to the sympathetic (thoracicolumbar autonomic) system.

3. The efferent or motor neurons to more voluntary muscles.

4. a. The parasympathetic (craniosacral autonomic) system.

   b. The vasomotor center.

   c. The respiratory center.

FIRST STAGE: INDUCTION ANALGESIA

This stage is entered as soon as the administration begins. It is characterized by waning sensation and consciousness. As this stage progresses, the inhibitions, orientation, emotions, memory, will, sensation and consciousness wane and disappear in approximately the order named. Sensation may begin to wane from the very first but may not entirely disappear until just before unconsciousness, thus giving a considerable period of analgesia.

SECOND STAGE: LIGHT ANESTHESIA

This stage is entered when consciousness has completely gone. It is characterized by unconsciousness with remaining activity of the sympathetic reflexes and the voluntary muscle reflexes, including those of the respiratory muscles. As this stage progresses, the sensory or afferent neurons become increasingly anesthetized so that the reflexes diminish. The muscles remain in tone.

THIRD STAGE: SURGICAL ANESTHESIA

This stage is entered when the sympathetic and voluntary muscle reflexes, including the respiratory, have disappeared. It is characterized by unconsciousness and absence of reflexes; that is, stimulation may be applied to any field without causing a sympathetic, muscular or respiratory response. If a motor nerve is directly stimulated, however, the corresponding muscles contract. As this stage progresses, the motor, or efferent, neurons apparently become progressively anesthetized, so that the chest muscles move less and less in respiration until they cease, and the tone of the abdominal and skeletal muscles diminishes, relaxation becoming more and more complete.

FOURTH STAGE: OVERDOSE

This stage is entered when the parasympathetics and the vasomotor and respiratory centers, especially the last, become paralyzed. It is characterized by unconsciousness, absence of reflexes, great

relaxation and failing centers. (32:1438-1446)

Physiology and pharmacology

Curare has been an aid to students of physiology and pharmacology for nearly one hundred years in the study of the action of muscles and nerves. Edmonds and Roth (21), in 1908-09, wrote that for fifty years previous to that time one of the first facts learned by students of physiology and pharmacology was that "curara" caused a paralysis of the endings of the motor nerves. He cited Bernard and Kolliker as having first demonstrated that fact.

Action of curare on muscles.--According to Bennett (5), 1941, in his discussion of the physiologic action of curare, the action is upon the net-like structure of fine nerve fibers at the terminus called the motor end plate. It is here that curare prevents acetylcholine acting on the nerve-muscle junction, thus producing a paresis of the muscle. This peripheral motor flaccid paralysis affected, in general, the nerve endings of all striated or voluntary musculature, but selectively affects first the muscles of high chronaxie, such as the short muscles of the eyes and throat and later, the larger muscles of the head, neck, extremities, intercostals and diaphragm. He said the sensory nerves are not affected. Reflexes may be somewhat diminished, but they are not abolished.

Cullen (15), in 1942, pointed out that curare was selective in its action affecting first those muscles innervated by cranial nerves, then the muscles of the trunk and extremities, followed by the muscles of respiration, the diaphragm being the last to be paralyzed. Smooth muscle is not affected. No analgesic or anesthetic action had been demonstrated. According to him the effect of curare when given intravenously is obtained in one minute and that when given intramuscularly its maximum effect was obtained in from ten to fifteen minutes. He said that it was not effective when administered subcutaneously or perorally.

Sollmann (41), in 1944, said that curare produced a number of side effects, resembling nicotine in depressing autonomic ganglia and strychnine in stimulating the spinal cord. He disagreed with Cullen (15) and Bennett (5) in listing the sequence of muscle paralysis. According to Sollmann, the last muscles to be paralyzed were the abdominal muscles. Bennett and Cullen were of the opinion that the diaphragmatic muscles were the last to be paralyzed. Sollmann wrote that the muscles which are least affected by curare are those containing the largest amount of utilizable oxygen and surviving longest after the death of the animal.

Cole (14), in his article of January 1945, stated that the action of curare is entirely peripheral.

According to him a nerve bathed in curare will still conduct impulses. He said that the neutralization of acetylcholine reaction by curare has been shown to be inhibited by prostigmine. He said that the first muscles affected were those supplied by the cranial nerves, followed by those of the trunk and extremities, and finally those of respiration. Cole, as had Cullen (15) and Bennett (5), listed the diaphragm as being the last muscle to be paralyzed. He wrote that recovery occurred in the reverse order, the diaphragm and intercostal muscles being the first to regain their function.

Lehahan (33), in 1945, agreed with Bennett (5) and Cole (14) in that curare acts at the myoneural junction preventing the acceptance by the muscle of acetylcholine. He said that curare prevented the transmission of impulses between the nerve and muscle and that the reaction is reversible, normal function returning when curare disappears from the circulation. According to him the average time for disappearance is thirty minutes.

Action of curare on cardiovascular system.--Sollmann (41), in 1944, wrote that curare given intravenously causes a temporary fall of blood pressure which returns rapidly to normal with moderate doses. The heart, according to Sollmann, is not affected except with very large doses. The autonomic ganglia, the vagus, the vasomotor, salivary, pupillary, etc., ganglia are depressed

but not usually as strongly as with nicotine. In discussing the effects on circulation, he stated that the first effect of curare on the circulation consists in the fall of blood pressure due to peripheral vasomotor depression. This is accompanied by quickened heart beat from depression of the vagus ganglia. Because the depression does not readily pass into paralysis, stimulation of the vagus or sciatic is still affected.

The Squibb Memoranda (31), September 1944, cited Smith as having observed that the greatest systolic drop in blood pressure, following curare, was 20 millimeters of mercury, with recovery in ten minutes. Where the respiratory depression was greatest there was an increase in systolic pressure of five to 20 millimeters; and that this was accomplished by a slight increase in the pulse rate when the respiratory depression was permitted to persist.

Cullen (16), in 1945, wrote that large amounts of curare given intravenously in a short period of time occasionally produce a momentary fall in blood pressure which may be marked and that long continued administration will also reduce the blood pressure level. He explained that this might be the result of impaired venous return accompanying wide spread peripheral muscle relaxation.

Whitacre and Fisher (49), in 1945, wrote that

large doses of curare in first plane ether anesthesia may precipitate severe circulatory depression and that in the presence of deep ether anesthesia even small doses of curare may cause severe circulatory reactions.

Aushermann and Brannen (3), October 1947, in discussing the effects of curare on circulation stated that if ether in any amount has been introduced into the system before curare has been given, it is best to reduce the estimated dose of curare. They had an experience of two instances in which they believed that curare produced a mild hypotension for a short period.

The Squibb Memoranda (37), of 1947, stated that very little change occurs in blood pressure and cardiac rate following curare.

McIntyre (34), in 1947, wrote that the classical concept of curare causing respiratory failure bacause of peripheral muscular paralysis was far from adequate. The truth, according to McIntyre, was that artificial respiration alone may completely fail to resuscitate, particularly if the drug had been administered too rapidly. He believed that cardiovascular collapse could occur. (34:130)

Perlstein and Weinglass (36), in 1944, made the observation that it appeared that curare had some cardiotoxic action that became evident only after the animal had received curare for a considerable period.

Initial symptoms of curare.--Wooley and Ingalls (52), in 1942, wrote that in their experiences when curare is given without anesthesia the primary causes of trouble usually lie in the weakness of the tongue, neck, and thoracic cage and in the accumulation of mucous in the throat. However, they had been rarely severe enough to cause concern. Another common cause of respiratory distress was stridor, due, apparently, to laryngeal or bronchial spasm.

Cole (14), 1945, described the following symptoms in order of their appearance: weakness of the eyelids, strabismus with diplopia, weakness of throat and jaw muscles with inability to swallow or cough, inability of the patient to raise himself, weakness of the arms and legs, and finally respiratory paralysis. According to him, the only effect observed under anesthesia with a proper dose of curare is the almost immediate relaxation of the abdominal muscles and with a larger dose respiratory depression. He believed the incidence of laryngospasm to be smaller when curare had been given.

Lenahan (33), 1945, wrote that the first symptoms of relaxation induced by curare are haziness of vision followed by drooping of the eyelids and relaxation of the jaws. This is followed by a generalized weakness of neck muscles and the subject is unable to raise his head. The paralysis is developed rapidly, being usually

complete in three to four minutes following injection.

Bennett (5), in 1941, stated that a method of essay is the head drop method in the rabbit developed by Holaday. The curare solution is injected slowly into the ear vein of a rabbit and the dose adjusted so that the neck muscles, after two and one-half to three minutes reach a degree of relaxation which barely prevents the animal from raising the head and keeps the chin down. This end point is clear cut and is the effect seen in a human after injection of a curarizing dose. The amount per kilogram necessary to produce this effect in the rabbit is estimated and the dosage is figured according to the body weight.

Miscellaneous effects and actions.--Bennett (6), 1940-41, wrote that the so-called lethal point of curare is questionable because large doses are tolerated if respiration can be continued. According to him, there is no increased tolerance to repeated doses of curare.

Denhoff and Bradley (19), in 1942, in their article wrote that curare is entirely ineffectual when given by mouth unless absorbed through a wound or extensive ulceration in the gastro-intestinal tract.

Cullen (15), in 1943, wrote that the elimination of curare is accomplished in about two hours by destruction in the liver and excretion through the kidney. The action of the drug lasts from 20 to 30 minutes but

Cullen said that the muscular relaxation produced by curare during inhalation anesthesia lasts longer. Cullen (16), 1945, wrote that there was no evidence that liver or kidney impairment prolongs or intensifies the action of curare. He stated that there is apparently little or no accumulative effect on repetition of the drug after an hour or two and that no temporary or permanent organic damage had been shown to be due to the direct effect of curare. Cole (14), January 1945, disagreed with Cullen in that he considered impaired renal function a relative contraindication for the use of curare believing that it might serve to heighten the effect of an otherwise harmless dose. McIntyre (34), in 1947, wrote that the liver may furnish a minor degree of protection against curare poisoning. (34:154)

Sollmann (41), in 1944, wrote that sensory nerves are not affected by curare. Whitacre and Fisher (49), in 1945, agreed with Sollman, stating that curare gave no analgesic effect. However, they made the statement that large doses could bring about a loss of consciousness without any preceding period of analgesia. They did not believe that it was advisable to administer sufficient curare to produce an unconsciousness.

Whitacre and Fisher (49), in 1945, wrote that reflexes of the pharynx and larynx are less active following the administration of large amounts of curare.

Ausherman and Brannen (3), October 1947, stated that under curare and cyclopropane anesthesia there is a very definite decrease in the intestinal motility and usually some contraction.

Burman (12), in 1939, cited Bremer as having noted an antagonism between curare and epinephrine.

Cummins (18), in 1942, said that prostigmine is a spectacular and perfect drug to be used as an antidote for curare. According to him, it unites with the curare and frees the acetylcholine.

Curare in human medicine

Stewart (42), in January 1942, reported that one cubic centimeter of intocostrin which contains 20 units would curarize about 40 pounds of body weight. Tuohy (46), November 1947, stated that the amount of curare used in individual cases varies.

Griffith and Johnson (26) who were the first to report the use of curare in general anesthesia, in July 1942, cited an example of a man weighing 250 pounds who insisted on general anesthesia for hemorrhoidectomy. Under cyclopropane, relaxation of the anal sphincter was unsatisfactory. Immediately upon the administration of 100 units of curare complete relaxation was obtained, and the operation was easily performed. They further cited several cases of appendectomy in healthy young

adults undergoing operation for an acute infection, and who were particularly resistant to anesthesia. When the surgeon began to close the peritoneum the abdominal muscles became tense. Upon administration of 100 units of curare and within one minute, the abdomen was "soft as dough" and the surgeon was able to finish the operation without difficulty.

Cullen (15), in 1943, used intravenous injections of curare repeated, when necessary, at three to five minutes intervals until the desired effect was manifest. Relaxation then usually persisted for 60 to 120 minutes. After relaxation was established, it was unnecessary to repeat the curare during the course of long operations. However, there were some occasions when curare was repeated for closure of the abdomen if the operative procedure lasted longer than 45 minutes. No thrombosis or phlebitis was noted in veins used for injections, even when relatively frequent injections were made.

As an interesting case, Cullen (15) cited an example of a woman who was difficult to examine bimanually because of marked voluntary abdominal muscular spasm. She was given curare intravenously followed by morphine sulfate and scopolamine intravenously. The relaxation of the recti was improved enough that the bimanual examination was made satisfactorily. A vaginal

hysterectomy was indicated. The patient was then anesthetized with cyclopropane and the operation carried out with only first plane anesthesia. The abdominal muscle relaxation was excellent.

Griffith (25) in his article, of February 1944, stated that he had found curare to be required most frequently in strong, young adults who may be just as resistant to any anesthetic agent as some men are to the effects of whiskey.

Whitacre and Fisher (50), December 1944, wrote that the use of curare has increased the amount of inhalation anesthesia ordinarily required for Cesarean sections, thus decreasing the incidence of severe respiratory depression of the baby. They used curare alone or with local anesthesia in a few cases. Its use was thus effective in improving the relaxation for intra-abdominal operations in babies. According to them curare seems to be well tolerated even by poor risk patients and permits the use of smaller quantities of other agents.

Whitacre and Fisher (49), March 1945, wrote that 20 milligram doses of curare improved the relaxation of first plane ether anesthesia but large doses, 100 milligrams or more, may precipitate severe circulatory depression. They cited an example of one patient in the third plane of ether anesthesia receiving 20 milligrams of curare having complete peripheral circulatory failure.

According to him, if sufficient ether has been given to produce third plane anesthesia and the relaxation is still unsatisfactory, it is probably unwise to use curare. Whitacre and Fisher advised that when respiratory spasms occur it is necessary either to increase the depth of anesthesia or to give additional curare to relax the muscles and permit inflation of the lungs. They said that curare had been used in conjunction with cyclopropane anesthesia for Cesarean sections in 100 cases with satisfactory results.

According to Cole (14), January 1945, the only proper dose of curare is that dose which will give immediate relaxation of the abdominal muscles and not produce respiratory depression. Cole stated that endotracheal intubation may be facilitated by the use of curare and that curare may also be used in the treatment of laryngo-spasm. According to him, two absolute contraindications for the use of curare are myasthenia gravis and the inability of the anesthetist to perform artificial respiration. The youngest patient on which he used curare was three years old; the heaviest weighed 222 pounds. He had no fatalities attributable to curare.

Cullen (16), in February 1945, wrote that it was possible to carry a patient in light second plane inhalation anesthesia, and, with proper doses of curare, obtain as good relaxation and quiet breathing as with

spinal anesthesia. According to him no post-anesthetic complications had been noted which can be either directly or indirectly ascribed to curare. He felt that with curare there was a distinct reduction in morbidity and and mortality, particularly because it allowed the use of gaseous agents instead of ether. He said that the principle disadvantage in the use of curare is the narrow margin between the effective dose and the dose which produces respiratory depression. Cullen used curare cautiously in the presence of shock. He stated that it was probably advantageous, because it is possible to carry the patient in light anesthesia and prevent adding to the shock by increasing the depth of the anesthesia.

Lenahan (33), March 1945, reported that there are several types of operations that lend themselves admirably to curare. He quoted nephrectomies as an example where a maximum amount of relaxation is necessary at certain times. He said that it was much better to produce complete relaxation with one to three cubic centimeters of curare (20 to 60 units) than it would be to deepen the patient to a possibly dangerous level of anesthesia to produce the desired relaxation. With curare the patient is not dangerously depressed. His age range in human patients had been 17 to 70 years. According to him curare may be repeated several times during an operation, however, the dose is usually one-half the

preceding dose.

Knight (32), 1946, cited curare as the most spectacular advance in anesthesia in the last few years. According to him relaxation of any desired degree may be produced by the intravenous injection of 40 to 120 units of curare. Prostigmine is the antedote for curare but Knight had never found its use necessary.

Squibb Memoranda (37), in the article "Prolonged Relaxation Without Deep Anesthesia," September 1947, stated that by permitting the use of light plane anesthesia, curare facilitates difficult surgery. Poor risk patients are able to take prolonged surgery which, without the supplemental use of curare, would be considered impractical and contraindicated. Endotracheal and bronchoscopy are facilitated.

Ausherman and Brannen (3), October 1947, wrote that they used curare in all upper abdominal patients unless the patient was very thin with poor tone to the muscles. Many lower abdominal cases were given curare, especially the husky, muscular type of individual. In all of their patients they made a deliberate effort to maintain a lighter level of anesthesia and obtained relaxation by the use of curare rather than by deep level of anesthesia. In their early experiences with curare they made an effort to give the solution slowly but they found that slow administration was not necessary. In

their abdominal patients when distended intestine pushed into the wound they found that in a matter of 30 seconds to 2 minutes, with the administration of curare, the bowel would contract to a point where it would not protrude into the incision at all. They found no contraindications to the use of curare when the proper dose was given with the exception of the inability to give manually controlled respiration. They agreed with other writers in that patients who have received ether in moderate to large amounts should be given curare very cautiously in small doses.

According to Wiggin (51), November 1947, curare is indicated where a reduction of the general anesthetic agent is necessary to prevent over-concentration in the patient in poor condition or the general anesthetic is not sufficient to control the reflexes of respiration or the abdomen.

Burman (11), in 1938, stated that the use of curare in spastic paralysis and in certain of the hystonic diseases such as dystonia, musculorum deformans, spasmodic torticollis, and the dystonic syndromes is based upon the fact that curare has the specific effect of interrupting the transmission of the nerve impulse to the muscle.

Bennett (10), in 1941, stated that in a series of 295 treatments in convulsive therapy, only one case

suffered severe respiratory depression, He agreed with others that curare prevented much damage in convulsive shock therapy.

Bennett (7), in 1942, concluded that curare produced a marked temporary relaxation of rigidity and abolution of involuntary movements in the use of metrazol shock therapy.

Gray, Spradling and Fechner (24), in 1941, wrote that curare would prevent the intense and violent clonic spasm of the unmodified metrazol convulsion. In its place is a more gentle action. Because of this gentle action, it is possible to treat patients who, because of their age or disease, might not be safely treated otherwise.

Bennett and Cash (8), in their article of 1941, agreed with the findings of Gray, Spradling and Fechner in that curare adequately prevents all traumatic complications in metrazol therapy.

Harris, Pacella and Horwitz (28), 1941, stated that the only untoward symptoms they had observed in the use of curare in the treatment of metrazol shock were depression of respipation and laryngeal stridor; and that only on a few occasions was it found necessary to stop the injection of curare because of these symptoms.

Shelton (40), in 1941, stated that curarization before metrazol injection in no way lessens the

therapeutic value of metrazol while it greatly minimizes or entirely eliminates the complications which frequently occur following metrazol convulsive therapy.

Cummins (18), in 1942, stated that in metrazol shock treatment, curare had reduced the incidence of compressions from 14.8% to 3.4%.

Wooley and Ingalls (52), in 1942, wrote that even when curarization is not achieved previous to convulsive shock treatment, the severity of the convulsion is much modified by the presence of any considerable amount of curare in the circulation.

Bennett and Cash (9), in 1943, wrote that curarization produces all of the manifestations of myasthenia gravis and that myasthenic patients are exceedingly sensitive to the drug. They suggested an injection of 1/10 the usual physiologic dose of standardized curare as a safe diagnostic test for the disease, provided that it be followed by the administration of prostigmine and methylsulfate.

Cummins (17), in 1943, after using curare on approximately 3,000 cases, concluded it to be an excellent drug for preventing complications associated with metrazol therapy. The only difficulties encountered had been a few of respiratory embarrassment. This embarrassment of the respirations was readily controlled by intravenous injections of prostigmine.

Squibb Memoranda (1) in its article "Action of Intocostrin in Poliomyelitis", June 1946, states that the use of curare has been found to be beneficial in treating acute anterior poliomyelitis according to electromyographic studies, the muscles which are involved in the poliomyelitis disease picture, and which show abnormal records, are restored to a normal record state and to an effective voluntary control. The injection of curare relieves pain and permits carrying out an intensive physical therapy program.

Stewart (42), 1942, wrote that the patient may complain of tightness of the throat and huskiness of the voice. Generalized heaviness and weakness of the neck muscles and inability to raise the head are followed by weakness to complete paresis of the spinal muscles, legs and arms.

Cullen (15), 1943, wrote that curare has been used since 1857 in the treatment of convulsive states such as tetany, strychnine poisoning and chorea. He cited Burman as having advocated its use in the treatment of spastic disorders.

McIntyre (34), in 1947, cited Thiercelien as having published a report in 1860 concerning the treatment of two cases of epilepsy with curare. One was a man 23 years of age who had been having seizures since birth, with 15 or 20 grand mal attacks each month.

The other was a girl of 17 who had a history of frequent epileptic attacks from the age of 8. Thiercelien stated that curare reduced the seizures to 5 per month for the man and 8 for the girl. (34:187)

Bennett (5), in 1941, stated that there was a tremendous potential usefulness for a safe drug of curare's nature. He suggested that the drug may be useful in controlling convulsive states such as strychnine poisoning, eclampsia, hydrophobia, and status epilepticus.

McIntyre (34), 1947, cited Drummond as having used curare to treat chorea in 1878 and Tsocankis as having used curare for the treatment of chorea in 1923. McIntyre believed the reports were over-optimistic and that more data must be gathered before an evaluation could be made. (34:187)

McIntyre (34), 1947, believed that a combination of cyclopropane and curare most nearly approaches the ideal in anesthesia, particularly when deep relaxation of the muscles is essential. He said that successful surgery could be accomplished at a plane of anesthesia that would, without curare, be too shallow for adequate surgical manipulation. (34:103)

McIntyre (34), 1947, cited Sister Borromea as having employed curare for vaginal examinations when hypertonicity rendered diagnosis difficult. (34:193)

He also cited Johnson as having used curare in

dysmenorrhea who reported almost instantaneous relief obtained by intravenous injections when the drug was administered early in the period.

McIntyre (34), 1947, advised the use of curare as an aid in the reduction of fractures and dislocations. According to him the number of such cases treated with curare was small but the results had been uniformly good. He wrote that several orthopedic patients had been markedly relieved of muscle and joint discomfort by the administration of curare, sometimes eliminating routine sedation. (34:197)

Curare in animals

West (47), in 1937-38, described the effects of curare on respiration in dogs as follows:

> The injected animal suddenly commences to breathe slowly and with effort, the difficulty appearing to be inspiratory rather than expiratory. The inspiratory phase being represented by a short deep gasp sometimes divided into two stages, due to lack of synchronization of the intercostal muscles with the diaphragm, the former usually contracting first. In dogs, the independence of this respiratory attack from general curarization may be striking. The hitherto normal animal suddenly stands still, braces its forelegs, and breathes stertoriously, slowly, and with inspiratory difficulty. The attack may remit after a few seconds, recur, and finally pass off, or else it may lead to a fatal asphyxia, in which case it is usually accompanied by some degree of general curarization. (47:439-446)

West (47) found in two cases that it was impossible to induce an air current in the trachea when

artificial respiration was attempted by compression of the chest. The difficulty experienced by West in those two cases is probably explained by the assertion of Harris, Pacella and Horwitz (28), 1941, that some of the difficulty in respiration was apparently caused by paralysis of the vocal cords of the dog and spasms of the bronchial musculature.

Bennett (5), 1941, cited McIntyre as having given 50 times the lethal dose of curare to dogs without fatality by keeping up artificial respiration. Cash and Hoekstra (13), in 1943, wrote that in the laboratory deaths in animals only occured from asphyxia as the result of intercostal paralysis. According to their article, 100 times the so-called lethal dose of curare has been given with no animal deaths as long as respiration is maintained. Cullen (15), in 1943, wrote about a few dogs having been given curare. Doses giving abdominal muscle relaxation caused profuse salivation, extreme respiratory depression, and asphyxial convulsive movements. According to Cullen these effects in experiments with dogs deterred the clinical application of curare in humans. Sollmann (41) wrote that warm blooded animals die of paralysis of the respiratory muscles. He stated that if artificial respiration were kept up and the dose had been just large enough to produce paralysis there was a chance for recovery. The recovery of

the respiratory muscles begins first.

Effect of curare on cardiovascular system.-- Perlstein and Weinglass (36), 1944, described some experiments on dogs receiving intocostrin. Their problem was to find out how long an animal, by means of artificial respiration, could be kept continuously curarized. One dog died because of an obstructed air way. The second dog developed cardiac arrhythmia and bradycardia after about three hours of continuous curarization. Tachycardia appeared and the dog died after about 15 hours of curarization. When autopsied the heart was found to be greatly dilated and the viscera was moderately congested. A third dog was kept completely paralyzed by eight hours and 20 minutes of continuous complete curarization. This animal died at the end of this time after having first developed arrhythmia after a period of bradycardia. When autopsied its heart was found to be slightly distended.

Perlstein and Weinglass (36) believed that curare had some cardiotoxic action which became evident only after the animal had been under the influence of curare for a long enough period. In the experiments which followed, it was attempted to allow intermittent periods of freedom from the influence of curare so as to avoid a cumulative effect of the toxic agent. During these periods there was only sufficient paralysis to

keep the animal quiet and some degree of spontaneous respiration was present. It was found that the use of sufficient curare to keep the dog quiet necessitated artificial respiration for at least 50 per cent. Some animals had to be given artificial respiration for the duration of the experiment in order to supply sufficient oxygen. Under those conditions, two dogs survived for 45 hours and 13 minutes and for 27 hours and 15 minutes respectively. A third lived only two hours and 55 minutes. When autopsied, these dogs showed cardiac dilatation and congestion of the viscera.

Perlstein and Weinglass (36) advanced the idea that because of bradycardia being noticed frequently, it could be considered possible that acetylcholine was the cardiotoxic agent. Because of this an attempt was made to keep the next four curarized dogs alive by continuous atropinization. Two dogs lived less than an hour after curare and atropine were injected intravenously. One animal died within five minutes. Autopsies showed no cardiac dilatation to explain these deaths. Another dog given a much smaller dose of atropine after a terminal period of cardiac arrhythmia, five hours and 57 minutes after beginning curarization. The heart of this animal was greatly dilated. The atropinized animals required much less curare to maintain paralysis than those animals not given atropine. Curare was not found

to have affected the blood pressure in those experiments. In two curarized dogs the injection of a physiologic dose of atropine resulted in immediate death.

Perlstein and Weinglass (36) could find no clear indication as to the exact cause of death in prolonged curarization. They did, however, point to the heart as the principal organ affected. Slowing of the pulse and irregularity of the heart was found regularly. They did not know whether the cardiac failure was due to a prolonged direct effect of curare on the heart or to an indirect effect on circulation or on the vasomotor centers.

Tournade and Rocchisani (44), in 1934, wrote that in the curarized and vagotomized dog, strong faradization of the Cyon-Ludwig nerve caused a paradoxical reaction of hypertension. They further wrote that if the animal was later anesthetized and the opposite nerve faradized that it caused normal reflex of hypotension.

Bennett (6), 1940-41, wrote that circulation in animals is relatively unaffected by curare and that sensory nerves are not affected. While reflexes may be somewhat diminished, they are not abolished. Small amounts of the drug injected rapidly are toxic and produce cardiac failure in animals while large amounts may be given slowly without toxic symptoms. Sollmann (41), 1944, disagreed with Bennett by writing that the first

effect of curare on the circulation consists in a fall of blood pressure due to peripheral vasomotor depression. This is soon accompanied by quickened heart beat, from depression of the vagus ganglia.

McIntyre (34), in 1947, wrote that during his investigations he had found that slow intravenous injections of Intocostrin in man and crude curares administered subcutaneously to dogs did not cause any marked change in blood pressure. But large doses rapidly injected intravenously caused a precipitious fall in blood pressure. Intra-carotid injections could be instantly fatal caused by a sudden and fatal cardiovascular collapse. McIntyre had observed rapid death in dogs from such injections when it was difficult to decide whether death was caused by failure of respiration or too sudden cessation of the heart. (34:130)

Miscellaneous effects of curare.--Gray, Spradling and Fechner (24), 1941, wrote that experimental work on the dog has shown the efficiency of curare in modifying muscle contractility over the entire body. The drug produces a paralysis of skeletal motor muscles. There is a selective depressive action on motor endings and altogether excludes sensory endings. Whitacre and Fisher (50), in 1944, stated that when large doses of curare were given dogs, the time required to recover from the stage of complete muscular relaxation was

several hours. He cited this as being a serious objection to the use of curare alone for surgical operations.

Cullen (16), 1945, implied that curare has some effect upon smooth muscle. He wrote that animals upon which he had done studies had complete cessation of peristalsis and loss of tone for varying periods of time. This loss of tone lasted from 15 to 20 minutes. There was then a rather prompt recovery and in a few instances a little compensatory over-activity.

Following rapid intravenous injections of curare into unanesthetized dogs, McIntyre (34), 1947, observed frequent salivation, retching, vomiting, and sometimes defecation. He attributed these phenomena to be of almost certain central origin. McIntyre cited Bert as having found that reflex control of the bladder was unaffected by curare. (34:137)

Girard (23), in January 1879, mixed a lethal dose of curare with food given to dogs and rabbits. The animals suffered no inconvenience. According to him, however, young mammals and birds, while fasting, cannot take curare in the stomach with impunity. McIntyre (34), 1947, wrote that the fatal dose of curare per os is roughly 50 times that by subcutaneous injection.

McIntyre (34), 1947, cited Bernard as having proved that gastric juice does not destroy the poison. Bernard, according to McIntyre, poisoned frogs by the

injection of stomach contents of a dog previously given curare by mouth. (34:153)

Miscellaneous experiments and comments.-- Heriffant (29), 1751-52, did a number of experiments with curare in animals. He wrote that before the animals died they seemed to be seized with a sudden and almost universal palsy and that the muscles of the animals having died with curare were clammy to the touch and were contracted. He further observed that sugar and sea-salt ought not to be regarded as antidotes. According to him the only thing of any benefit in counteracting the poison was the application of a red-hot iron to the wound.

Reichert (39), in 1891, ran a rather extensive series of experiments concerning the changes in body temperature in dogs following the use of curare. He concluded that doses insufficient to cause motor paralysis may increase the temperature, or primarily increase and secondarily diminish it. Doses sufficient to abolish voluntary motion acted differently in different animals. The temperature could be increased or decreased, or primarily increased and secondarily diminished, or primarily diminished and secondarily increased. However, there was generally a notable diminution or a decided increase, the former effect predominating. Repeated doses caused a progressive lowering of the temperature or a progressive rise until death ensued.

Large doses invariably diminished the temperature excepting in those cases where the animal had been under the influence of curare for some time when the temperature exhibits a strong tendency to rise. He ascribed the increase of temperature to an increase of heat production and the fall to an increase of heat dissipation.

McIntyre (34), 1947, stated that in view of the assumption that muscles are responsible for most of the heat normally generated, the decrease in body temperature in curarized animals is less than might be expected. (34:143)

McIntyre (34), 1947, cited Vellard and De Assis as having made a series of experiments in which they checked repeated doses of curare upon tolerance in dogs. Vellard and De Assis observed that such animals manifested serological reactions such as fixation of complement. No increase of tolerance was found. The serological reaction was attributed by them to proteinoids contained in the curare. Vellard was of the belief that these proteinoids were of animal origin. (34:157)

West (48), in 1935, found curare removed the violent muscular spasms found in parathyroidectomized dogs. Dogs treated with curare appeared free of their tetany and with full powers of locomotion.

McIntyre (34), 1947, wrote that explorers are generally agreed that the flesh of animals killed by curare has a better flavor and remains fresh longer than that killed by other methods. (34:153)

Chapter III

MATERIALS AND METHODS

While evaluating curare as an adjuvant to general anesthesia one must remember that the practicing veterinarian is interested in the care of dogs as individuals. A drug producing excellent results in 95 per cent of the cases, with a remaining five per cent mortality, would be valueless to him in his practice. The additional convenience afforded by such a drug could not compensate for the loss of patients and reputation. For that reason, this study has been based on the individual dog. When a certain dose of curare or combination of curare and anesthetic caused danger symptoms, that dose of curare or combination was eliminated as unsatisfactory.

The 35 dogs used in this series of experiments were of various ages, sizes, and breeds. Some dogs died during experiments; others were lost from distemper and other causes. Those lost were replaced by other dogs. Each problem, with the exception of those determining changes in blood pressure, was carried out on 20 animals. The animals were identified by large numbers cut in their hair coats.

The curare used in this study is known

commercially as Intocostrin. This is a physiologically standardized extract of curare secured from the Amazon forests. It is supplied in sterile ampules, one c.c. of the solution containing 20 units of a standard curare.

The drug which was used as an antidote was prostigmine, 1-2000. According to Griffith (25) prostigmine bears the closest resemblance to a true physiological antidote for curare.

The anesthetics tested with curare were chosen because they are those most used by veterinarians. They were ether, Nembutal, which is a trade name for pentobarbital sodium, and Pentothal Sodium.

According to Stewart (42) the recommended dose of curare for human patients is 1/2 unit per pound of body weight. It was decided to start this series of experiments with half that amount and increase the dose of curare in each succeeding experiment by 1/4 unit per pound until the danger limit was reached.

All injections of curare were made intravenously through the entire series of experiments.

When setting up the experimental procedure, it was found that 1/4 unit, when administered without an anesthetic, produced little detectable effect. Complete respiratory paralysis occurred in one dog when 1/2 unit was administered. Great respiratory depression necessitating artificial respiration was produced in several

dogs by 3/4 unit. There was one fatality. Prostigmine was administered to several.

Because undesirable symptoms had been shown with the injection of 1/2 unit in the unanesthetized dog, the simultaneous use of curare and Nembutal was started with 1/4 unit per pound of body weight and then increased only 1/8 unit per pound of body weight until an unsafe margin was discovered. One half unit was found to be that margin.

When anesthesia was induced with ether and 1/4 unit of curare was injected, a marked respiratory paralysis and severe circulatory disturbances occurred. Because 1/4 unit showed dangerous potentialities, the next dose administered was 1/8 unit per pound of body weight. Much the same results occurred with the 1/8 unit. Because 1/8 unit produced danger symptoms without obtaining a satisfactory degree of relaxation in either light plane or surgical anesthesia, it was decided not to pursue further the study of curare in ether anesthesia in this series of experiments.

In determining the effects of curare used in conjunction with Nembutal and Pentothal Sodium on blood pressure, only the 3/8 unit of curare per pound of body weight was used. This was the therapeutic dose determined in previous experiments. For determining the effect on blood pressure with ether anesthesia, 1/8

unit of curare was used.

The Baumanometer was the first instrument used in attempting to find the effects of curare on blood pressure. This instrument is used very satisfactorily in humans, but because of the triangular shape of the dog's hind limb the results obtained with the Baumanometer were unsatisfactory. It was, therefore, decided to cannulate the femoral artery and take kymographic tracings with a Phipps and Bird mercury manometer. Because it was necessary to make three cannulations, the first opening was made at the most distal point at which the femoral pulse could be detected on the medial surface of the thigh. After the tracing was made the artery was ligated and the wound was dusted with granulated sulfanilamide. The cannulation for the second tracing was made in the femoral artery of the opposite leg, and that for the third tracing was made in the femoral artery at a point proximal to the first opening.

To one who has dissected the caudal appendage of the dog, it would seem that ligation of the femoral artery, which is the chief blood supply to that appendage, would cause a gangrenous sloughing. The collateral blood supply described by Miller (35), in 1947, would seem to be too small to establish itself rapidly in the distal portion of the limb. However, such is apparently not the case because of the five dogs in which the

femoral arteries were ligated in both limbs, three dogs developed no apparent lameness and two developed only a minor, temporary lameness.

In the first two or three kymograms taken, some trouble, caused by clotting of the blood, was encountered. The initial anticoagulant used in the manometer system was a five per cent sodium citrate. The clotting was prevented by adding 0.1 cubic centimeters of Heparin, diluted by physiological saline to two cubic centimeters, three minutes after cannulation. Because Heparin is an expensive product, it was not used alone as an anticoagulant. All of the following tracings were very satisfactory.

Methods of investigation

The following methods of investigation were used:

A. Injection of 20 dogs with varying doses of curare.--The doses used were 1/4, 1/2, and 3/4 units per pound of body weight which were injected into each animal on separate days and the effects noted on the following listed systems.

1. Respiratory system

a. The number of respirations per minute were counted at three-minute intervals up to 15 minutes after which counts were taken at five-

minute intervals up to 30 minutes. Respirations were again counted at the end of an hour.

b. Various aberrations in character of the respirations and the time of occurrence were noted.

c. If respiration ceased, time was noted.

d. Records were kept of the length of time artificial respirations were necessary and also the time at which an antidote or stimulants were necessary.

2. Circulatory system

a. Counts were taken of the pulse at three-minute intervals up to 15 minutes after which counts were taken at five-minute intervals up to 30 minutes. Pulse was again taken at the end of an hour.

b. Various aberrations in character of the pulse and the time of occurrence were noted. If stimulants were administered, time was recorded.

c. If circulatory collapse occurred, time was noted.

d. Degree of cyanosis, if present, was noted.

3. Muscular system

a. The character of the abdominal

tension was recorded by the following symbols: 3+, 2+, 1+, 1-, 2-, 3-. 3+ was taken to be that amount of abdominal tension shown in a normal unanesthetized and uncurarized dog when the abdomen was palpated. 1+ was that amount of tension found in an anesthethized or curarized dog in which there was a bare amount of voluntary straining. 2+ was that amount of abdominal tension found between 1+ and 3+. 3- was a complete lack of any abdominal tension. 1- indicated a condition of the abdominal muscles in which there was a somewhat marked tension but no voluntary straining. 2- was midway between 1- tension and 3- tension.

(1) The degree of abdominal tension was checked at three minute intervals and recorded.

(2) The degree of anal relaxation was noted.

(3) Pedal reflexes, if present, were noted.

4. Varying symptoms other than those of the three systems listed above were noted.

a. Micturition

b. Defecation

c. Struggling

d. Crying

e. Discomfort

5. Hemapoietic system

a. Red and white blood cell counts were made following injection of curare.

b. Hemoglobin

All of the above notations were made only so long as the animal was detectably under the influence of curare.

B. Injection of curare in conjunction with Nembutal, Pentothal Sodium, and ether.--The methods described under "A" were also used for ascertaining the effects of the combination of curare with these general anesthetics except for the dosage of curare. The dosage of curare used with Nembutal and Pentothal Sodium 1/ were 1/4, 3/8, and 1/2 units per pound of body weight. 1/4 and 1/8 units of curare per pound were used with ether. Curare was used in the same amounts in both light plane and surgical anesthesia. Light plane anesthesia was produced with Nembutal by the injection intravenously of 3/4 grain of Nembutal per five pounds of body weight. With Pentothal Sodium and ether it was produced by administering to effect. Surgical anesthesia was produced with Nembutal by the injection intravenously of one grain of Nembutal per five pounds of body weight. As in light anesthesia, surgical anesthesia with Pentothal Sodium

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1/ The Nembutal and Pentothal Sodium were furnished by Abbott and Co.

and ether was produced by administering to effect.

C. Determination of blood pressure by continuous kymographic tracings, while using curare in conjunction with the general anesthetics mentioned in "B".--The systemic effects were noted as in "A" in order to correlate them with the changes in blood pressure.

Equipment and materials used in these investigations

A. Equipment

1. Hypodermic syringes and needles
2. Microscope
3. Blood counting chamber (Neubauer)
4. Blood diluting pipettes
5. Hemoglobinometer (Spencer)
6. Kennels for controlling dogs
7. Ether cones
8. Physiology experimental table
9. Clinical thermometers
10. Master sheet for each dog for recording daily findings
11. Note book for supplementary data
12. Phipps and Bird mercury manometer

B. Materials

1. Intocostrin
2. Prostigmine

3. Heparin
4. Sodium citrate
5. Metrazol
6. Amphetesul
7. 70% alcohol

Light plane anesthesia in this study was regarded as that degree of anesthesia in which there was unconsciousness with remaining activity of the voluntary muscle reflexes. Surgical anesthesia was that stage of anesthesia which is characterized by unconsciousness and absence of reflexes.

The abdominal tension was tested empirically by palpation of the abdomen. The various stages of abdominal tension and relaxation were arbitrary as there was no sharp line of demarkation.

Because the dosage of Intocostrin could not be controlled with a solution containing 20 units per cubic centimeter, each cubic centimeter of Intocostrin was diluted with nine cubic centimeters of Physiological saline solution forming a concentration of only two units of Intocostrin per cubic centimeter. This concentration allowed the satisfactory administration of proper dosage.

Heparin is an anticoagulant supplied in 10 c.c. vials.

All of the equipment used was ordinary with

the exception of the master sheets for recording daily findings. These sheets were marked by horizontal and vertical lines. The horizontal lines were begun two inches from the top of the sheet and were continued 5/6 inch apart to the bottom of the sheet. The vertical lines were begun two inches from the left side of the sheet and continued 5/6 inch apart to the right edge. The lines thus drawn formed at the left side of the sheet horizontal spaces for the insertion of dates and at the top of the sheet two-inch vertical spaces for the insertion of data needed. The lines so drawn also left a blank two-inch square at the upper left hand corner. The identifying nummber of the dog was inserted in this square. The 5/6 inch squares were used for recording data collected. At various intervals the vertical lines were made heavy in order to separate the component parts of the various data. The only heavy horizontal line was the first which was drawn two inches from the top of the sheet.

Chapter IV

ANALYSIS OF DATA

McIntyre (34), 1947, cited Cullen as having in 1941, at Iowa University, injected a number of dogs with curare. The respiratory disturbances shown by these dogs, plus the excessive salivation, deterred the earlier use of curare as an adjuvant to general anesthesia. Had he tried administering a barbiturate to these dogs prior to their injection of curare, the chances are there would have been an earlier use of curare as an adjuvant to general anesthesia. In this study, while determining a dosage of curare which may be safely administered to the dog, the results of injection of curare into dogs without previously administering an anesthetic were somewhat similar to his.

Curare.--Following the intravenous injection of 1/4 unit of curare, 15 dogs showed no visable symptoms, two showed some bewilderment, two showed a very slight muscular tremor for two or three minutes following the injection, and one, which had eaten shortly before injection, vomited.

There was no apparent change in abdominal tension, nor were there any significant changes in pulse

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6	9	12	15	20	25	30	1 hour	abdominal reflex after anesthetic before curare	abdominal reflex 3 min. after curare	6	9	12	15	20	25	30	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autoresuscitation	" administration metrazol	" " angiotonin	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	1/4									136		128	128	123	118	122	124	124	126	112	36		38	46	48	38	48	38	30	24	34		3+	3+	3+	3+	3+																102^{8}	102^{8}	102^{8}
4	1/4									100		126	120	114	116	112	118	114	110	120	24		24	22	24	26	22	24	22	22	24		3+	3+	3+	3+	3+																104	103^{8}	103
6	1/4									148		124	100	116	116	120	123	130	132	138	24		26	28	24	24	24	23	25	24	24		3+	3+	3+	3+	3+																103^{4}		102
3	1/4									120		126	100	110	108	120	118	131	134	100	26		28	30	24	26	26	26	24	24	32		3+	3+	3+	3+	3+																102^{6}	102^{6}	102^{4}
9	1/4									120		126	116	112	114	120	122	122	134	120	24		27	24	22	20	24	24	24	26	24		3+	3+	3+	3+	3+																101^{4}	101^{8}	101^{4}
1	1/4									140		128	124	124	118	110	116	124	124	120	28		26	24	24	26	20	20	22	24	28		3+	3+	3+	3+	3+																101^{4}	101^{6}	101^{4}
2	1/4									130		144	140	136	136	134	142	138	130	140	36		40	44	38	40	34	34	32	32	28		3+	3+	3+	3+	3+																101^{6}	101^{3}	101
19	1/4									112		99	86	86	88	98	114	120	120	100	24		20	20	20	20	24	26	24	24	20		3+	3+	3+	3+	3+																101^{9}	101^{9}	102
17	1/4									108		112	108	108	100	114	114	118	118	120	36		40	40	40	44	40	36	36	30	40		3+	3+	3+	3+	3+																102	102	102^{4}
15	1/4									102		104	98	94	88	88	88	92	96	120	36		38	24	24	26	26	26	20	22	28		3+	3+	3+	3+	3+																102	102	102^{6}
10	1/4									128		132	130	126	110	108	118	132	136	124	28		30	32	26	26	26	24	22	22	32		3+	3+	3+	3+	3+																102^{6}	102^{6}	102^{6}
11	1/4									128		112	104	106	108	114	118	114	110	138	44		36	30	30	28	16	36	30	30	40		3+	3+	3+	3+	3+																102	102^{6}	102
14	1/4									120		112	102	108	110	110	124	124	124	120	48		26	34	34	38	40	40	40	36	60		3+	3+	3+	3+	3+																104^{3}	104^{6}	104^{6}
21	1/4									108		120	116	108	108	114	116	132	132	72	16		19	16	16	18	20	24	26	24	24		3+	3+	3+	3+	3+																102	101^{6}	101^{6}
5	1/4									84		128	122	126	110	114	118	120	122	128	30		28	26	34	36	24	26	26	26	30		3+	3+	3+	3+	3+																101^{4}	101^{8}	102
16	1/4									100		104	102	100	96	90	94	102	100	88	30		26	24	24	22	22	26	24	22	16		3+	3+	3+	3+	3+																102	102	102^{4}
7	1/4									88		94	100	103	106	106	104	104	132	88	20		24	24	24	24	22	24	24	22	22		3+	3+	3+	3+	3+																101^{4}		101^{6}
13	1/4									101		106	98	96	90	92	94	92	90	88	24		26	26	24	24	24	22	26	24	25		3+	3+	3+	3+	3+																100^{4}	101	101^{3}
18	1/4									74		92	88	76	78	80	84	86	86	88	40		44	46	36	40	42	34	30	28	24		3+	3+	3+	3+	3+																104	104	101
12	1/4									92		80	78	74	74	76	90	96	100	88	18		26	30	38	26	24	24	28	26	12		3+	3+	3+	3+	3+																100^{8}	100^{8}	101^{4}

Fig. 1; Reaction of 20 dogs to 1/4 unit curare per pound body weight

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6	9	12	15	20	25	30	1 hour	abdominal reflex after anesthetic before curare	abdominal reflex 3 min. after curare	6	9	12	15	20	25	30	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autoresuscitation	" administration metrazol	" " angiotonin	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	1/2				1'30"	2'	6'	8'	11'	120		140	76	80	76	78	87	96	104	132	26		40	62	44	44	36	32	26	24	32		3-	3-	2+	3+	3+												+		1+		102^{8}	103^{9}	103^{2}
4	1/2				1'45"	2'30"	11'	14'	16'	88		136	98	80	76	80	86	90	77	124	20		30	55	52	48	37	33	28	26	24		3-	3-	3-	2+	3+	3+			4'1+									+	1+	8'	103	103	103
6	1/2				45"	1'	11'	13'	23'	120		104	34	36	40	48	84	90	112	108	28		40	24	24	24	22	24	23	24	25		3-	3-	3-	1-	1-	3+	3+	3+	2'1+								+	+	3+	11'	101^{2}	100	101
3	1/2				30"	45"	9'	11'	12'	96		100	48	50	52	48				130	20		28	24	22	22	24				32		3-	3-	3-	3+	3+				2'1+								+	+	1+	10'	102^{6}	102^{6}	102^{4}
9	1/2				20"	40"	9'	13'	15'	88		100	64	50	54	66	74	76	102	124	32		20	22	16	16	18	16	22	26	32		3-	3-	3-	3-	3+																102^{4}	103^{4}	102^{4}
1	1/2				10"	20"	10'	12'	15'	100		138	104	88	76	84	84	96	98	124	24		22	18	18	20	20	24	24	20	20		3-	3-	3-	1+	3+																101^{6}	101	102
2	1/2				15"	45"	5'	7'	8'	110		120	136	124	120	120	124	124	120	120	28		29	28	32	28	28	34	30	28	26		3-	1+	3+	3+	3+																101	101	101^{2}
19	1/2				30"	30"	7'	9'	9'	104		76	80	86	94	100	102	102	100	100	28		36	40	44	36	30	30	30	30	44		3-	3-	3+	3+	3+				1'20"	1'25"	2'20"		5'45"				+	+	3+		101^{3}	101^{4}	102^{4}
17	1/2				30"	45"	9'	10'	15'	100		80	76	60	60	108	112	112	106	108	32		42	54	48	44	46	40	36	36	32		3-	3-	3-	1+	3+	3+													1+		101^{8}	101^{4}	103
15	1/2				1'30"	1'30"	5'	6'	6'	140		144	140	136	136	140				140	40		32	34	36	34	34				16		1-	2+	3+	3+	3+																103^{4}	103	103^{2}
10	1/2				10"	45"	5'	7'	9'	80		80	92	84	86					128	24		28	24	24	24					24		3-	1-	3+	3+															1+		102^{8}	103	103
11	1/2				45"	2'	7'	8'30"	12'	88		140	124	80	78	70	90	98	94	140	24		52	56	44	36	36	38	40	36	28		3-	2-	1+	3+	3+														1+		102^{4}	102^{4}	102^{4}
14	1/2				35"	45"	6'	7'	9'	132		112	66	58	58	76	84	92	112	134	54		48	32	32	28	28	30	34	26	48		3-	3-	3+	3+	3+				4'1+												103^{4}	103	102^{4}
21	1/2				40"	1'30"	9'	10'	15'	120		128	124	112	112	122	108	124	124	120	20		32	26	20	16	16	18	24	23	32		3-	3-	3-	1+	3+															8'	102	102^{4}	104
5	1/2				30"	1'	9'	10'	11'	120		102	82	62	64	86	90	92	88	120	24		36	34	56	54	40	26	26	22	42		3-	3-	3-	3+	3+												+	+			102^{4}	102^{4}	102^{4}
16	1/2				1'	1'30"	6'	7'	9'	100		110	80	100	104	98	96	101	104	84	18		24	26	24	22	26	28	26	30	8		1-	1-	3+	3+	3+														1+		101^{2}	102	102^{3}
7	1/2				45"	1'	7'	5'	9'	104		104	94	70	76	80	88	90	90	92	24		30	22	20	18	18	22	24	26	32		3-	3-	2-	3+																8'	101	102^{4}	102
13	1/2				1'30"	2'	5'	4'	6'	132		160	136	120	120	100	106	112	130	136	24		24	30	26	28	26	24	22	24	24		2-	3+	3+	3+	3+																101^{8}	101	104
18	1/2				1'	2'30"	9'	8'	15'	82		86	64	58	64	74	80	86	86	100	24		30	28	30	26	26	30	24	24	24		3-	3-	3-	1+	3+	3+			2'1+												101^{6}	101^{4}	101^{3}
12	1/2				1'	1'30"	11'	12'	15'	96		100	112	124	124	124	120	112	112	96	16		26	30	28	18	18	18	20	24	20		3-	3-	3-	3+	3+															10'	100^{8}	100^{4}	101

Fig. 2; Reaction of 20 dogs to 1/2 unit curare per pound of body weight

rate or respirations following the injection.

There were very slight decreases in temperature following curare in five of the dogs varying from 0.2 to 0.9 degree at the end of the duration of action. There were eight dogs in which there were no changes following the injection. There were four dogs which had an increase of temperature varying from 0.1 to 0.4 degree, Fig. 1.

The general picture following the injection of 1/2 unit of curare was immediate nervousness, bewilderment, staggering and incoordination before going down, Fig. 2. Following paralysis, all of the dogs were mentally alert. Respirations varied from shallow to diaphragmatic. All dogs showed some mydriasis. The time of relaxation varied from five to 11 minutes. After rising, the animals walked with a staggering action. Recovery was rapid.

The time for head drop varied from 10 seconds to one minute, 45 seconds. The time for full induction varied from 20 seconds to two minutes, 30 seconds. The duration of action on the abdominal muscles varied from five minutes to 11 minutes, Fig. 2.

The 1/2 unit caused the pulse rates of seven dogs to drop below 60. The pulse of one dog dropped as far as 36 and the pulse of six dogs varied between 40 and 50. The respirations varied from shallow to

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to run	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6- "	" 9- "	" 12- "	" 15- "	" 20- "	" 25- "	" 30- "	" 1 hour "	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	6-	9-	12-	13-	20-	25-	30-	1 hour
8	3/4				25"	1'30"	12'	14'	23'	116		146	88	68	64	70	88	94	100	124	32		48	54	0	32	26	28	24	24	48
4	3/4				1'30"	2'	12'	14'	16'	88		104	116	88	80	82	84	94	102	108	24		16	58	64	62	46	34	36	36	32
6	3/4				45"	1'	11'	13'	25'	120		80	36	36	41	50	81	93	110	116	28		40	26	24	24	24	24	24	25	24
3	3/4				1'30"	2'	8'	9'	17'	100		48	40	36	40	48	78			113	24		40	20	18	16	24	26			40
9	3/4				20"	50"	14'	18'	20'	80		86	36	40	46	58	64	86	84	132	24		20	14	12	18	20	20	18	22	32
1	3/4				15"	35"	12'	14'	15'	120		116	104	90	78	86	86	94	106	120	28		38	60	54	46	38	28	30	40	20
2	3/4				20"	1'	8'	18'	26'	104		84	72	64	64	76	80	88	100	128	44		40	32	36	36	28	28	22	20	26
19	3/4				30"	30"	6'	9'	9'	108		68	74	76	84	90	90	100	100	140	28		0	40	36	36	40	32	32	32	28
17	3/4				30"	30"	6'	8'	12'	86		60	68	76	80	92				112	42		0	36	42	34	36				32
15	3/4				40"	1'10"	10'	13'	18'	84		112	116	130	96	96	100	100		90	16		30	32	36	36	34	30	40		24
10	3/4				1'30"	1'30"	5'	7'	7'	140		90	86	90						124	44		0	38	44						18
11	3/4				30"	30"		4'		132		52	64	40	44						25										
14	3/4				40"	40"	20'	23'	25'	88		96	76	76	60	60	80	94	112	84	40		40	40	60	66	0	36	40	40	48
21	3/4				27"	1'	15'	17'	26'	100		106	80	76	72	82	84	84	82	96	16		24	16	12	12	10	16	20	20	24
5	3/4				15"	20"	7'	8'	9'	108		112	82	76	86	92	100			120	26		0	42	36	32	26	28			26
16	3/4				1'30"	2'	7'	8'	9'	96		116	76	105	112	104	108	108	106	108	18		24	28	22	22	24	26	26	24	20
7	3/4				1'	1'	9'	9'	25'	96		120	80	80	85	90	126	126		136	24		6	0	20	20	25	24	24		24
13	3/4				2'	2'30"	16'	18'	26'	96		103	80	47	36	50	81	90	100	68	14		30	26	22	22	20	24	24	30	20
18	3/4				15"	35"	25'	27'	30'	84		80	42	48	56	48	44	56	52	108	16		24	0	0	24	20	18	22	18	24
12	3/4				1'	1'30"	13'	15'	20'	88		110	104	100	84	84	88	82	82	92	24		26	28	24	19	18	22	22	24	20

Dog No.	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	6-	9-	12-	15-	20-	25-	30-	minutes and degree dyspnosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8		3-	3-	3-	3-	1+	1+	3+	3+	3'20	8'	11'		11½'				+		3+	6'	103	103	103
4		3-	3-	3-	3-	3+	3+			5'10								+		1+		103	102	103
6		3-	3-	3-	2-	1-	3+	3+	3+	2'10								+	+	3+	11'	101	100	101
3		3-	3-	2-	3+	3+	3+			2'10								+		1+	9'	103	102	102
9		3-	3-	3-	3-	1+	3+	3+	3+	4'10												101	101	102
1		3-	3-	3-	3-	3+				4'10											4'	101	102	101
2		3-	3-	1+	1+	1+	1+	1+	3+											1+		102	101	102
19		3-	1-	3+	3+	3+				3'20	2'	2'30"		4'30"				+	+	3+	7'	101	101	99
17		3-	1-	3+	3+					3'20	1'30"	3'		4'						3+		102	102	103
15		3-	2-	1-	1+	1+	3+	3+		3'10												102	102	104
10		3-	2+	3+						3'30	2'	2'30"		5'								102	102	103
11		3-	3-	3-	3-	3-					30"	2'			5'		18'	+	+	3+		102		
14		3-	3-	3-	3-	3-	3-	3+	3+	10'20	4'45"	16'		17'				+		3+		103	103	102
21		3-	3-	3-	3-	3-	3+			4'20								+	+	3+	9'	102	102	101
5		3-	[illegible]	3+	3+	3+	3+			2'30	1'45"	3'30"		5'				+	+	3+	7'	102	102	104
16		3-	1-	3+	3+	3+																102	102	102
7		3-	3-	3-	3+	3+				1'20	5'			7'				+	+	3+		103	102	102
13		3-	3-	3-	3-	2-	3+	3+	3+	5'10								+	+	2+	12'	102	100	101
18		3-	3-	3-	3-	3-	3-	1-	3+	7'20	4'30"			10'30"				+	+	3+	11'	105	102	101
12		3-	3-	3-	3-	1+	3+	3+		5'10										3+		101	100	101

Fig. 3; Reaction of 20 dogs to 3/4 unit curare per pound body weight

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to run	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6- "	" 9- "	" 12- "	" 15- "	" 20- "	" 25- "	" 30- "	" 1 hour "	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	6-	9-	12-	13-	20-	25-	30-	1 hour
8	1/4	N	3/4	L		15"	10'		12'	108	112	136	138	156	144	112	112	112	124	124	24	20	24	24	20	12	12	12	12	14	12
4	1/4	N.	3/4	L		45"	9'		15'	100	144	136	104	112	80	100	128			158	16	32	24	28	20	22	18	16			12
6	1/4	N	3/4	L		40"	20'		27'	112	100	120	115	104	90	89	85	80	80	90	24	21	24	20	16	14	12	14	14	16	20
3	1/4	N	3/4	L		45"	8'		9'	112	140	116	92	88	92					158	20	16	44	40	36	28					24
9	1/4	N	3/4	L		30"	9'		15'	100	152	142	122	112	138	136	128			134	24	32	12	12	12	12	12	14			20
1	1/4	N	3/4	L		30"	12'		15'	120	142	126	144	120	120	126				140	28	18	24	18	20	18	18				14
2	1/4	N	3/4	L		1'	12'		15'	140	170	152	146	128	118	118	116	120		130	28	26	30	24	22	22	20	20	16		24
19	1/4	N	3/4	L		1'	15'		20'	94	128	128	128	140	140	140	160	154		100	32	24	24	20	16	20	20	28	24		12
17	1/4	N	3/4	L		30"	12'		20'	100	138	148	132	120	106	106	100	104	92	92	22	50	52	44	40	36	40	40	32	32	32
15	1/4	N	3/4	L		15"	12'		20'	108	112	104	112	100	100	108	112	112		124	44	36	40	40	36	36	32	32	24		12
10	1/4	N	3/4	L		15"	15'		25'	112	152	140	112	128	120	128	142	132		120	32	44	40	40	40	36	30	26	32		32
11-24	1/4	N	3/4	L		40"	9'		15'	100	140	136	106	110	100	104	128			140	16	30	24	26	22	20	18	16			12
14	1/4	N	3/4	L		30"	15'		20'	72	152	176	132	130	112	104	112	112		88	24	36	36	48	36	32	28	32	28		32
21	1/4	N	3/4	L		20"	8'		12'	100	132	160	168	144	136	132	128			136	28	20	20	20	24	24	24	24			24
5	1/4	N	3/4	L		40"	50'		60'	106	136	120	128	112	120	98	96	94	92	110	20	44	24	24	20	22	20	18	18	22	48
16	1/4	N	3/4	L		31"	9'		12'	100	90	100	108	104	100	104	116			96	40	24	20	20	20	20	20	20			20
7	1/4	N	3/4	L		1'	20'		25'	100	120	100	90	90	100	115	130	123		80	20	32	26	26	28	30	30	32	30	25	44
13	1/4	N	3/4	L		30"	15'		20'	140	150	160	84	124	112	100	104	100		102	24	32	20	20	12	24	20	20	20		26
18	1/4	N	3/4	L		30"	15'		25'	80	144	120	112	104	100	112	108	108	104	104	24	28	16	16	16	16	20	16	16	16	16
12	1/4	N	3/4	L		30"	18'		25'	112	144	152	140	140	140	132	128	130		112	16	20	16	16	16	14	14	12	12		24

Dog No.	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	6-	9-	12-	15-	20-	25-	30-	minutes and degree dyspnosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	3+	2-	2-	2-	2+	3+	3+															102	100	98
4	3+	2-	2-	2-	1+	3+	3+															103	100	97
6	3+	1-	1-	1+	1+	1+	2+	3+	3+													101	100	101
3	3+	2-	2-	1+	3+																	101	100	101
9	3+	1-	2-	2-	1+	3+	3+															102	99	98
1	3+	2-	2-	2-	1-	3+																100	99	99
2	3+	1-	1-	1-	1-	3+	3+	3+														100	100	100
19	3+	3-	3-	3-	3-	1-	3+	3+														101	98	98
17	3+	3-	3-	3-	1+	1+	3+															104	101	100
15	3+	3-	3-	3-	2-	1+	3+	3+														102	99	96
10	3+	3-	3-	3-	3-	3-	1+	3+														103	103	98
11-24	3+	3-	2-	2-	2+	3+	3+															102	100	97
14	3+	3-	3-	3-	3-	3-	1-	3+														101	100	100
21	3+	3-	3-	1+	3+	3+	3+															103	101	101
5	3+	3-	3-	3-	3-	3-	3-	3-	3-													101	100	98
16	3+	2-	1-	1-	3+	3+	3+															103	101	101
7	3+	3-	3-	1-	1-	1-	1-	3+												3+		101	100	98
13	3+	3-	3-	3-	2-	2-	3+	3+														102	99	97
18	3+	1-	1-	1-	1-	1-	1+	3+	3+													101	100	99
12	3+	3-	3-	3-	3-	3-	1+	3+														101	101	98

Fig. 4; Reaction of 20 dogs to 1/4 unit per pound of body weight during light plane nembutal anesthesia

diaphragmatic. It was necessary to administer artificial respiration to one dog for one minute, 25 seconds. This animal was administered a dose of prostigmine at two minutes, 30 seconds. Respirations of all dogs had recovered to normal or approximately normal at 30 minutes, Fig. 2.

Seventeen of these dogs developed a 3- abdominal relaxation varying from three to 12 minutes. One dog developed a 2- relaxation lasting three minutes and two developed a 1- relaxation lasting six minutes, Fig. 2.

Involuntary micturition and defecation occurred in four dogs. Involuntary micturition alone occurred in one and involuntary defecation alone occurred in one. Salivation was 3+ in two dogs and 1+ in seven dogs. Six dogs had a cyanosis varying from 1+ to 2+ and lasting from one minute to four minutes. Ten of the dogs injected showed a pedal reflex at the maximum point of action. At the end of the duration there was a decrease in temperature in 12 dogs varying from 0.1 to 0.6 degree, Fig. 2.

The symptoms caused by the injection of 3/4 unit of curare were similar to those caused by the 1/2 unit except that they were decidedly more exaggerated, Fig. 3. One dog vomited. Salivation was profuse in all animals.

The time for head drop varied from 15 seconds

to one minute, 30 seconds, Fig. 3. The time for full induction varied from 30 seconds to two minutes, 30 seconds. The duration of action varied from five minutes to 25 minutes.

Nine minutes after injection of 3/4 unit of curare, four dogs had a pulse rate varying from 40 to 50, Fig. 3. Two of them dropped as low as 36. All had recovered to normal or approximately normal within 30 minutes, except one which had a pulse rate of 52 at that time. At the end of an hour the pulse rate of that dog had increased to 108. The respirations of four dogs ceased at three minutes following the injection of curare. The respirations of all four had started again at six minutes, following artificial respiration. One, which had a respiration of six at three minutes, had a sessation of respiration at six minutes. One, which had had 24 shallow labored respirations at three minutes, had a cessation of respiration at six minutes. Artificial respiration was administered to this dog for a period of six minutes. One dog, which had had very shallow respirarion with a count of 54 at six minutes, had a cessation of respirations at nine minutes. Another, which had had shallow labored respirations numbering 66 at 12 minutes, had a cessation of respirations at 15 minutes. One animal died at 13 minutes regardless of the fact that he had been given artificial respiration

and a therapeutic dose of prostigmine. All dogs with the exception of the one fatality were breathing normally at 30 minutes.

The entire group, following the injection of curare, had a 3- abdominal relaxation which varied from three minutes to 20 minutes. Seventeen animals for two to ten minutes had a cyanosis varying from 1+ to 3+. There were eight dogs in which artificial respiration was necessary. The time of artificial respiration varied from two minutes to six minutes. It was necessary to administer prostigmine to seven dogs. Involuntary micturition occurred in four with no accompanying defecation. Involuntary defecation and micturition occurred in eight. Salivation varying from 1+ to 3+ occurred in 15 dogs, Fig. 3.

A reduction of temperature of 0.1 to one degree occurred in seven dogs. Four had temperature increases of from 0.1 to 0.6 degree. There was no change of temperature in the remaining group. The length of the duration of action seemed to have little correlation with the loss in temperature. There were increases in temperature which could not be correlated with the length of action. Thirteen animals had a pedal reflex at the height of curare action, Fig. 3.

Nembutal, 3/4 grain, light plane anesthesia.-- Although there was very little detectable effect from

1/4 unit of curare when given alone, when given with Nembutal, there were some rather marked effects, Fig. 4. The dogs, following the intravenous injection of Nembutal, were elevated by their hind legs to an angle of 45 degrees to simulate the position in which they are frequently placed for surgery. Although they were unconscious, there was considerable crying and struggling. The crying was high-pitched in sound. Within a few seconds after injection of curare the high-pitched crying changed to a very hoarse, low note and ceased entirely within 15 seconds. The struggling stopped shortly after. When the effect of curare subsided, the animals again cried in a high-pitched voice and struggled. Their voices were hoarse again during the stage of recovery from curare.

Time of full induction varied from 15 seconds to one minute. Duration of action varied from eight minutes to 50 minutes. The 50 minute duration was displayed in one animal. There were no significant changes in the pulse rate of any of the dogs. Respirations varied within the normal range of those found in dogs during Nembutal anesthesia, Fig. 4.

Eighteen dogs had a decrease in temperature of from one to 3.2 degrees. One had a temperature rise of 0.2 degree. One had no temperature change, Fig. 4.

The symptoms following 3/8 unit other than

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time till induction	duration of action	time of attempt to rotate	complete return to normal pulse before anesthesia or curare	pulse after curare before curare	pulse 3 min. after curare: 6	9	12	15	20	25	30	1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare: 6	9	12	15	20	25	30	1 hour	abdominal tension before anesthetic, before curare	abdominal tension 3 min. after curare: 6	9	12	15	20	25	30	minutes and degree of spasms	micturition	defecation	salivation	muscular tremors	temperature before anesthesia or curare	temperature 24 hrs after curare	temperature 48 hrs after curare
8	1/8	N	3/4	L	15"	12'		15'	116	120	120	100	86	104	100	92	110		92	16	48	32	20	12	20	12	14	14		14	3+	3-	3-	3-	3-	2-	3+	3+	3+					100	101	100
4	3/8	N	3/4	L	20"	20'		23'	88	136	144	136	116	108	108	108	120	120	112	120	28	28	20	20	20	28	24	28	24	24	24	3+	3-	3-	3-	3-	3-	3-	2+	3+					102	99	99
6	3/8	N	3/4	L	45"	12'		20'	128	116	140	128	116	88	72	78	80	84	100	22	16	24	24	20	16	12	12	14	16	16	3+	3-	3-	3-	3-	2-	1-	1+	3+	3+					101	97	95
3	3/8	N	3/4	L	12"	12'		13'	108	124	128	112	116	96	100				100	24	16	16	16	12	12	24				24	3+	3	3-	3-	3+	3+						9'	100	101	101
7	3/8	N	3/4	L	15"	20'		25'	84	120	140	86	84	76	80	80	86	100	76	16	32	28	20	20	18	20	20	20	20	16	3+	3-	3-	3-	3-	3-	3-	3-	3+					101	100	99
1	3/8	N	3/4	L	45"	9'		15'	100	152	144	132	128	120	104				104	20	20	24	20	20	20	16				16	3+	3-	3-	3-	1+	3+							101	99	95
2	3/8	N	3/4	L	50"	20'		25'	136	136	152	144	120	116	112	108	112		112	28	24	28	24	20	20	20	24	24	20		20	3+	3-	3-	3-	3-	3-	1-	3+							102	98	94
19	3/8	N	3/4	L	12"	25'		30'	108	116	132	128	116	104	108	104	124	100	96	32	24	16	16	16	16	12	12	12	12	16	3+	3-	3-	3-	3-	3-	3-	1-	3+					101	98	98
17	3/4	N	3/4	L	10"	20'		25'	144	140	136	128	128	136	140	144	144		144	44	46	60	64	64	56	40	40	44		80	3+	3-	3-	3-	3-	3-	3-	3+							104	102	99
15	3/8	N	3/4	L	30"	25'		35'	104	120	96	92	96	92	96	92	96	100	112	16	38	52	44	40	44	40	32	28	28	28	3+	3-	3-	3-	3-	3-	3-	3-	1+					102	99	98
10	3/8	N	3/4	L	25"	15'		25'	140	136	160	140	120	144	128	128	134		132	32	44	56	66	64	48	42	36	36		32	3+	3-	3-	3-	3-	1-	1+	3+					104	99	94
11-34	3/8	N	3/4	L	25"	21'		24'	90	152	136	124	116	108	108	116	136		120	24	28	20	22	22	22	28	28	24		20	3+	3-	3-	3-	3-	3-	3-	2+	3+					102	99	99
14	3/8	N	3/4	L	15"	20'		26'	72	132	132	112	120	112	100	100	120	100	96	44	40	16	12	12	12	10	12	16	10	20	3+	3-	3-	3-	3-	2-	1-	1+	2+					102	100	98
21	3/8	N	3/4	L	12"	12'		15'	92	96	172	168	112	144	132				132	20	20	20	16	20	16	16				16	3+	3-	3-	3-	1-	3+						9'	102	101	101
5	3/8	N	3/4	L	20"	25'		30'	120	148	120	84	72	68	72	72	76	76	86	44	40	16	12	12	16	16	14	16	16	16	3+	3-	3-	3-	3-	3-	3-	3-	3-					102	99	99
16	3/8	N	3/4	L	15"	25'		30'	72	124	124	128	108	104	108	96	92	98	104	18	12	14	14	14	12	14	12	12	12	12	3+	3-	3-	3-	3-	3-	3-	2-	3+					102	99	97
7	3/8	N	3/4	L	15"	25'		30'	108	128	120	112	96	84	80	86	86	90	80	20	16	16	16	12	12	12	12	12	12	16	3+	3-	3-	3-	3	3	3-	3+				3+	101	97	94
13	3/8	N	3/4	L	30	30'		40'	108	104	92	98	76	68	72	80	72	64	72	16	24	22	14	20	24	20	22	20	24	20	3+	3-	3-	3-	3-	3-	3-	2-							101	98	98
12	3/8	N	3/4	L	35"	25'		35'	77	112	120	104	150	124	116	84	112	96	102	24	18	16	12	8	8	8	8	12	12	16	3+	3-	3-	3-	3-	3-	3-	3-	1+					102	100	99
12	3/8	N	3/4	L	30"	20'		30'	120	116	132	128	120	120	140	128	120	134	130	20	14	20	18	20	12	12	12	16	16	16	3+	3-	3-	3-	3-	3	1-	1+	3+					101	99	97

Fig. 5; Reaction of 20 dogs to 3/4 unit curare per pound of body weight during light plane nembutal anesthesia

Dog No.																																																		
1	1/2	N	3/4	L	30"	20'		25'	132	112	100	100	100	108	116	116	118	120	120	18	16	20	16	16	12	14	12	11	14	14	3+	3-	3-	3-	3-	3-	2-	3+	3+					102	101	101
4	1/2	N	3/4	L	30"	20'		24'	88	140	140	136	148	128	120	108	116	108	120	12	10	12	12	12	12	14	12	12	12	24	3+	3-	3-	3-	3-	3-	3-	3+	3+					101	100	99
x	1/2	N	3/4	L	45"	15'		23'	120	68	64	72	68	64	64	58	60	60	70	20	20	16	12	16	12	12	12	12	12	16	3+	3-	3-	3-	1+	1+	2+	3+	3+		+			102	98	99
3	1/2	N	3/4	L	35"	15'		20'	148	148	108	88	76	96	100	124			140	36	12	16	10	8	8	12	12			24	3+	3-	3-	3-	3-	3-	3+					14"	101	101	101
7	1/2	N	3/4	L	20"	25'		40'	92	80	132	108	112	104	120	128	128	140	140	20	16	16	16	16	16	16	18	18	24	3+	3	3	3	3	3	2-	2-	1-					104	101	98
1	1/2	N	3/4	L	45"	13'		18'	115	116	120	131	140	104	106	108			108	24	16	28	24	16	12	20	20			16	3+	3-	3-	3-	3-	1+	3+					10'	101	99	96
2	1/2	N	3/4	L	15"	20'		30'	144	180	164	108	120	160	100	88	100	80	116	20	24	20	12	12	12	12	12	12	20	3+	3-	3-	3-	3-	3-	3-	1+	3+					102	100	101
19	1/2	N	3/4	L	25"	25'		35'	120	100	120	146	150	156	162	150	144	146	132	16	20	20	32	34	36	30	30	32	26	30	3+	3-	3-	3-	3-	3-	3-	3-	1+					100	99	98
17-22	1/2	N	3/4	L	15"	25'		30'	85	108	120	120	128	104	100	100	100	100	96	24	20	20	28	20	20	24	24	24	16	3+	3-	3-	3-	3-	3-	3-	1-	3+					102	100	98
15-28	1/2	N	3/4	L	1'	15'		26'	146	100	96	84	80	72	68	68	60	64	94	24	14	16	12	12	12	14	14	12	16	22	3+	3-	3-	3-	2-	1-	3+	3+	3+					101	99	99
10-23	1/2	N	3/4	L	45"	15'		20'	132	150	120	100	86	90	102	124			124	14	14	18	10	10	8	8	12			16	3+	3-	3-	3-	3-	3-	3+							101	101	101
11-24	1/2	N	3/4	L	30"	20'		23'	90	144	152	134	144	140	136	118	116	112	126	18	12	14	14	10	10	14	16	16	12	20	3+	3-	3-	3-	3-	3-	3-	3+	3+					102	100	99
14	1/2	N	3/4	L	18"	15'		21'	88	144	120	136	132	128	108	104	112	100	84	16	28	20	18	16	16	14	14	12	12	24	3+	3-	3-	3-	3-	3-	3+	3+	3+					102	102	101
21	1/2	N	3/4	L	45"	12'		20'	85	180	200	216	200	200	200	210	156	184	120	24	24	28	28	14	24	24	40	36	28	28	3+	3-	3-	3-	3-	3+	3+	3+	3+					103	102	105
6	1/2	N	3/4	L	48"	20'		30'	108	120	140	140	112	88	100	96	96	96	100	20	40	20	20	16	16	14	15	16	16	20	3+	3-	3-	3-	3-	3-	2-	3+	3+					103	100	100
16	1/2	N	3/4	L	18"	26'		35'	108	160	128	120	120	120	114	96	90	80	160	32	24	12	10	10	10	7	8	8	10	24	3+	3-	3-	3-	3-	3-	3-	2-	1-					101	98	97
7	1/2	N	3/4	L	35"	20'		25'	102	90	132	120	116	100	88	76	70	76	68	16	20	16	12	12	12	12	12	12	12	16	3+	3-	3-	3-	3-	3-	3-	3+							101	100	100
13	1/2	N	3/4	L	45"	15'		18'	152	80	68	72	68	96	56	56	48	52	88	20	12	16	14	14	12	12	14	12	14	20	3+	3-	3-	3-	1-	1-	3+	3+	3+	5	11			101	99	99
18	1/2	N	3/4	L	35"	35'		45'	96	120	108	104	88	68	64	64	64	78	112	18	18	12	12	8	8	6	6	6	10	22	3+	3-	3-	3-	3-	3-	3-	3-	3-					101	99	99
12	1/2	N	3/4	L	1'	25'		30'	80	76	140	128	108	100	84	80	80	120	140	20	14	16	14	14	14	12	12	12	12	18	3+	3-	3-	3-	3-	3-	3-	2-	2+					101	99	99

Fig 6; Reaction of 20 dogs to 1/2 unit curare per pound of body weight during light plane nembutal anesthesia

those recorded on the chart were similar to those of the 1/4 unit dose of curare, Fig. 5. The time of full induction varied from 10 seconds to one minute, 30 seconds. Following the injection of 3/8 unit of curare per pound of body weight, with the exception of a very short increase in pulse rate among some dogs, there was little change. There was no notable change in respiratory action. Two dogs developed rather rapid respirations which quickly returned to normal. All dogs had a drop in temperature which varied from 0.8 to 4 degrees. Pedal reflex occurred under this light anesthesia in 12 dogs even though they had complete abdominal relaxation and showed no movement while hung at a 45 degree angle. The skeletal muscles were relaxed in all dogs.

The symptoms in a majority of the dogs following 1/2 unit of curare were similar to those following 1/4 and 3/8 unit, Fig. 6. Time of full induction varied from 15 seconds to one minute. Duration of action varied from 12 minutes to 35 minutes. Two dogs developed a bradycardia varying from 40 to 50. One dog developed a tachycardia of 200 or over which lasted 18 minutes. The respirations of Dog No. 18 dropped to six. This dog had a 1+ cyanosis for 11 minutes. Dog No. 13 developed slow shallow respirations and had a 1+ cyanosis for five minutes. Seventeen dogs had a decrease of temperature from 0.5 to 3.6 degrees. One dog had a 0.7 degree rise in

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time for induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	" 1 hour " "	respiration before anesthetic before curare	respiration after anesthetic before curare	respiration 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	" 1 hour " "	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	1/4	N	1	S	25"	19'		22'	80	106	100	124	120	110	100	90	80	84	112	20	16	28	24	24	26	20	18	18	18	14	1-	3-	3-	3-	3-	3-	3-	2+	2+	101	101	101
4	1/4	N	1	S	16"	38'		42'	164	188	184	176	146	144	186	156	128	144	150	16	20	16	16	16	16	18	12	14	16	16	1+	3-	3-	3-	3-	3-	3-	3-	3-	102	100	99
6	1/4	N	1	S	23"	15'		19'	100	90	86	90	100	100	104	112	108	100	100	20	16	16	12	12	14	14	16	16	16	16	1+	2-	2-	1-	1-	1+	1+	1+	1+	101	99	97
3	1/4	N	1	S	18"	12'		15'	140	156	88	100	100	100	88	96			128	20	24	16	16	16	18	16	16		16	24	3-	3-	3-	2-	3+	3+				101	100	97
9	1/4	N	1	S	12"	26'		30'	124	132	114	108	100	108	84	76	76	82	76	28	20	16	16	16	16	16	14	14	16	16	1+	3-	3-	3-	3-	3-	2-	1+	1+	102	100	96
1	1/4	N	1	S	15"	18"		20'	108	144	140	136	112	100	100	96			112	12	20	16	16	16	16	14	12		12	1+	3-	3-	3-	3-	2-	3+				100	98	97
2	1/4	N	1	S	20"	20'		25'	120	136	104	140	128	120	120	112	114	114	116	16	24	28	20	18	16	14	14	16	20	14	3-	3-	3-	3-	3-	1-	3+	3+		102	100	99
19	1/4	N	1	S	26"	18"		20'	108	108	144	136	134	134	130	130	136		140	16	20	18	26	28	24	24	24	24		20	1-	3-	3-	3-	3-	1+	2+			101	101	97
17-22	1/4	N	1	S	20"	20'		25'	112	132	128	112	116	112	116	120	124		100	24	24	16	16	16	12	12	12	12	18	14	3-	3-	3-	3-	3-	1-	3+			102	102	97
15-28	1/4	N	1	S	15"	23'		25'	128	140	120	92	70	70	70	72	72	68	66	20	20	10	10	10	12	14	14	14	12	26	1-	3-	3-	3-	3-	2-	3+	3+		101	99	97
10-23	1/4	N	1	S	10"	15'		20'	104	144	144	136	136	136	124	120	120		96	12	24	22	20	16	16	16	14	12		12	3+	3-	3-	3-	3-	1-	2+	3+		102	100	100
11-24	1/4	N	1	S	12"	10'		12'	112	128	92	100	120	132	120	100			100	20	20	12	12	20	20	18	16		24	1+	3-	3-	3-	1+	3+	3+			102	99	97
14	1/4	N	1	S	26"	30'		36'	120	160	140	120	128	120	120	124	118	112	112	16	8	10	10	8	8	6	6	6	8	12	1-	3-	3-	3-	3-	3-	3-	1-		102	102	97
21	1/4	N	1	S	18"	12'		15'	124	144	128	140	128	140	140	120			120	18	28	28	28	24	28	28	32		24	1-	3-	2-	2-	1-	2+	2+			100	99	96
5	1/4	N	1	S	23"	20'		25'	100	88	120	88	84	80	78	78	82	90	82	16	20	16	12	20	16	20	20	20	22	20	1+	3-	3-	3-	3-	3-	1-	3+	3+		102	99	97
16	1/4	N	1	S	18"	19'		20'	80	88	100	110	106	100	102	114	112		120	24	24	20	22	18	18	18	22	24		20	3+	3-	3-	3-	2-	2-	1-	3+		100	99	96
7	1/4	N	1	S	18"	18'		20'	108	136	128	130	104	104	100	100	106		72	18	14	14	12	12	12	18	18	20		24	3+	2-	2-	2-	2-	2-	2-	2+		101	98	96
13	1/4	N	1	S	25"	21'		24'	124	136	112	84	68	68	64	68	60	66	60	20	16	12	12	12	12	14	12	14	16	14	3-	3-	3-	3-	3-	3-	1-	3+	3+	100	99	98
18	1/4	N	1	S	15"	8'		10'	84	84	104	150	140	132	128	128			98	12	16	12	10	8	8	8	8		28	1-	2-	2-	1+	2+	2+	2+			101	100	99
12	1/4	N	1	S	20"	15'		20'	100	120	128	120	112	108	104	112	88	96	100	16	16	18	14	14	14	13	12	12	12	8	1+	2-	2-	2-	2-	2-	3+	3+	3+	101	98	95

Fig. 7. Reaction of 20 dogs to 1/4 unit curare per pound of body weight during surgical nembutal anesthesia.

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time for induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	" 1 hour " "	respiration before anesthetic before curare	respiration after anesthetic before curare	respiration 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	" 1 hour " "	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	3/8	N	1	S	25"	14'		18'	120	100	120	120	112	108	104	100	92	92	112	12	20	14	14	12	14	14	12	12	14	16	1+	3-	3-	3-	3-	1-	2+	2+	3+	100	100	98
4	3/8	N	1	S	20"	35'		40'	84	162	156	148	148	144	144	124	116	116	128	20	30	16	12	12	12	12	16	16	16	2+	3-	3-	3-	3-	3-	3-	3-	3-	102	101	99
6	3/8	N	1	S	25"	18'		20'	92	104	76	80	92	100	100	102	104	104	106	20	20	20	20	20	16	16	18	18	18	22	2+	3-	3-	3-	3-	3-	2+	2+	2+	102	97	96
3	3/8	N	1	S	18"	15'		20'	140	120	156	140	136	140	130	128	116		112	14	16	8	8	12	14	12	12	12		12	1+	3-	3-	3-	3-	3+	3+			101	100	96
9	3/8	N	1	S	7"	40'		55'	80	96	116	96	120	116	72	84	80	78	96	30	16	12	11	12	13	12	12	10	10	24	2-	3-	3-	3-	3-	3-	3-	3-		101	100	97
1	3/8	N	1	S	10"	20'		25'	88	104	104	112	104	100	84	80	84	80	106	12	16	12	12	12	12	12	14	12	12	1-	3-	3-	3-	3-	3-	3-	3+	3+		101	101	97
2	3/8	N	1	S	15"	15'		20'	100	120	148	120	112	120	108	108	100	86	98	28	16	27	18	14	12	14	12	10	12	10	3+	3-	3-	3-	3-	3-	3+	3+	3+	101	99	95
19	3/8	N	1	S	40"	25'		35'	96	100	168	176	174	156	156	146	140	132	108	20	22	28	34	20	24	24	26	26	26	14	1+	3-	3-	3-	3-	3-	3-	3-	1+	101	99	98
17-22	3/8	N	1	S	15"	28"		30'	92	80	100	98	96	96	88	84	88	96	96	20	16	8	8	8	8	10	16	16	20	12	3+	3-	3-	3-	3-	3-	2-	3+		101	99	99
15-28	3/8	N	1	S	20"	16'		20'	104	112	94	94	80	74	74	70	70	82	74	30	24	20	14	10	10	12	12	10	14	26	1+	3-	3-	3-	3-	1-	2+	3+	3+	101	97	97
10-23	3/8	N	1	S	35"	25'		30'	112	102	80	88	100	110	108	96	104	100	88	20	16	20	20	20	18	16	16	16	16	12	1+	3-	3-	3-	3-	3-	3-	3-	2+	100	100	99
11-24	3/8	N	1	S	15"	25'		30'	92	80	100	98	96	96	88	84	88	96	100	20	16	8	8	8	8	10	16	16	20	20	1+	3-	3-	3-	3-	3-	3-	1-	3+	102	100	99
14	3/8	N	1	S	20"	60'		70'	120	120	220	164	160	160	156	136	130	128	120	24	28	24	16	12	12	12	12	12	8	8	1-	3-	3-	3-	3-	3-	3-	3-	3-	102	99	100
21	3/8	N	1	S	15"	18"		25'	120	160	160	160	200	200	200	180	146		140	18	18	14	16	14	20	20	18	18		24	1+	3-	3-	3-	3-	3-	1-	1+		102	102	99
5	3/8	N	1	S	25"	25'		30'	80	110	112	112	120	120	120	118	118	126	112	40	32	20	16	16	16	18	12	16	20	32	1+	3-	3-	3-	3-	3-	3-	3+	3+	102	98	97
16	3/8	N	1	S	15"	49'		60'	80	120	132	124	104	100	102	98	94	90	110	20	16	12	13	12	11	11	10	10	24	1+	3-	3-	3-	3-	3-	3-	3-	3-	102	102	102
7	3/8	N	1	S	15"	25'		30'	104	104	108	96	80	72	78	76	70	88	106	16	8	16	16	12	12	12	12	8	8	12	2+	3-	3-	3-	3-	3-	2-	2+		101	98	97
13	3/8	N	1	S	17"	15'		18'	104	106	100	100	84	72	68	72	80		76	16	20	12	14	12	16	14	16	14		14	2+	3-	3-	3-	3-	2-	3+	3+		102	100	96
18	3/8	N	1	S	20"	20'		30'	72	72	112	120	120	112	110	106	92	92	112	14	8	8	8	8	8	8	8	12	8	18	1-	3-	3-	3-	3-	3-	3-	1+	2+	101	100	98
12	3/8	N	1	S	50"	20'		30'	84	120	128	136	132	108	120	96	100	100	106	12	12	12	12	12	12	8	8	8	12	2-	3-	3-	3-	3-	3-	3-	3+	3+	102	100	97

Fig 8; Reaction of 20 dogs to 3/8 unit curare per pound of body weight during surgical nembutal anesthesia

temperature. Seven dogs showed a pedal reflex during the action of curare.

Nembutal, 1 grain, surgical anesthesia.--The abdomens of most of the dogs, in spite of receiving a full grain of Nembutal per five pounds, were quite tense. There was slight struggling and crying by three of the dogs before curare. This ceased immediately following administration of curare.

Time of full induction following 1/4 unit curare varied from 10 seconds to 45 seconds, Fig. 7. Duration of action varied from eight minutes to 38 minutes. There were no marked changes in pulse rate following the combined use of 1/4 unit of curare with Nembutal. There were also no significant changes in respirations. Eighteen dogs had a decrease in temperature varying from 0.5 to three degrees during the duration of action of the curare.

The symptoms of 3/8 unit of curare with Nembutal surgical anesthesia were, as a whole, the same as those of 1/4 unit, Fig. 8. Time of full induction varied from seven to 45 seconds. Duration of action varied from 14 to 60 minutes. There were no marked variations in pulse rate with the exception of Dog. No. 21 which developed a pulse of 200 lasting nine minutes. The rise from 160 to 200 occurred six minutes following the injection of curare. There were no significant changes

Dog No.	unit curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full relaxation	duration of action	time of attempt to rise	complete return to normal pulse pattern, breathing or temperature	pulse, respiration return to normal	pulse 3 min after curare	pulse 3 min after curare: 6 min	9 min	12 min	15 min	20 min	25 min	30 min	1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare: 6 min	9 min	12 min	15 min	20 min	25 min	30 min	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare: 6 min	9 min	12 min	15 min	20 min	25 min	30 min	1 hour	time, artificial respiration	time, 1st dose prostigmine	" 2nd "	" subcutaneously start	" administration end	" " emphysema	time, death	micturition	defecation	salivation	muscular tremor	temperature at onset of anesthesia or curare	temperature at end of duration	temperature, hour after administration
8	1/2	N	1	S	13"	35'		46'	144	144	134	124	116	108	108	112	112	112	144	24	28	36	16	12	12	10	10	14	12	28	1+	3-	3-	3-	3-	3-	3-	3-	3-													101	100	97
4	1/2	N	1	S	10"	46'		50'	84	120	148	140	124	132	128	116	116	130	180	24	20	12	12	12	12	12	12	12	20	1+	3-	3-	3-	3-	3-	3-	3-	3-													102	99	98
6	1/2	N	1	S	26"	26'		25'	100	108	108	116	120	100	84	76	72	68	68	68	24	20	12	10	10	10	9	10	8	9	10	24	3-	3-	3-	3-	3-	3-	2+	2+													101	98	98
3	1/2	N	1	S	30"	12'		15'	184	164	144	144	148	160	200	216	180	112		12	20	12	10	10	12	16	20	18	12	12	34	3-	3-	3-	3-	3+	3+													6'	102	98	97
9	1/2	N	1	S	28"	25'		35'	120	136	124	104	104	100	88	84	84	84	140	24	24	12	10	10	9	12	12	12	32	1+	3-	3-	3-	3-	3-	3-	2-	2+													101	98	96
1	1/2	N	1	S	20"	15'		20'	100	160	140	120	112	100	116	100	100	92	104	12	20	16	14	16	14	14	11	16	14	12	3-	3-	3-	3-	1-	3+	3+	3+													101	97	96
2	1/2	N	1	S	15"	14'		26'	112	124	120	100	96	100	112	92	100		104	28	20	14	12	14	16	12	12	12	12	24	3-	3-	3-	3-	1+	3+	2+													100	97	96
19	1/2	N	1	S	25"	20'		30'	100	116	144	136	114	104	104	108	108	110	136	20	24	18	18	14	14	16	16	12	12	12	14	3-	3-	3-	3-	3-	3-	1+	3+													101	101	99
17-22	1/2	N	1	S	20"				126	136	32									16	28	0																													102			
15-28	1/2	N	1	S	20"	25'		35'	96	80	90	88	76	70	78	60	60	56	74	18	20	12	12	10	10	10	12	12	14	20	1+	3-	3-	3-	3-	3-	3-	3-	3-											36°	3'				5'35	+					102	100	98	97
10-23	1/2	N	1	S	30"	25'		34'	144	128	92	100	92	100	100	100	100	100	100	20	32	32	24	16	16	14	12	13	16	1+	3-	3-	3-	3-	3-	3-	3-	2+													101	98	97
11-24	1/2	N	1	S	30"	25'		36'	88	160	144	140	128	120	118	96	92	92	140	28	20	32	24	16	16	16	12	12	20	2+	3-	3-	3-	3-	3-	3-	3-	2+													102	99	98
14	1/2	N	1	S	25"	40'		50'	120	148	168	144	140	138	128	126	116	120	148	36	40	32	24	28	20	22	19	16	12	24	1+	3-	3-	3-	3-	3-	3-	3-	3-													102	100	100
21	1/2	N	1	S	25"	25'		35'	136	160	132			72	116	116	120	136		16	32	12	0	0	0	28	28	32	32	32	1-	3-	3-	3-	3-	3-	3-	1+	16'	5'30	6'30	14'	7'	+	14	16'	102	101	99
5	1/2	N	1	S	17"	15'		20'	98	114	108	96	84	90	94	100			114	20	30	20	20	16	16	18	20			30	3+	3-	3-	3-	3-	3-	3+															102	100	100
16	1/2	N	1	S	18"	35'		48'	84	132	138	134	100	96	96	90	88	90	136	20	30	12	10	10	14	9	8	8	12	20	1+	2-	3-	3-	3-	3-	3-	3-													102	102	102
7	1/2	N	1	S	20"	20'		25'	98	88	120	112	92	88	80	72	68	64	120	24	24	14	12	10	10	10	10	10	12	1-	3-	3-	3-	3-	3-	3-	1+	1+													100	100	100
13	1/2	N	1	S	15"	44'		60'	84	62	88	72	60	72	56	48	44	60	62	18	14	10	8	8	8	8	6	8	10	14	3+	3-	3-	2-	3-	3-	3-	2-	3-	5'10											102	97	97
18	1/2	N	1	S	25"	25'		35'	92	124	104	108	108	84	88	88	84	96	104	16	20	12	8	8	7	7	8	8	10	20	1+	3-	3-	2-	3-	3-	3-	1-	1+													101	97	97
12	1/2	N	1	S	16"	8'		14'	120	156	180	152	128	120	124				120	16	24	20	16	16	16	20				12	3+	3-	3-	1-	3+	3+															101	100	101

Fig. 9; Reaction of 20 dogs to 1/2 unit curare per pound body weight during surgical nembutal anesthesia.

Dog No.	unit curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full relaxation	duration of action	time of attempt to rise	complete return to normal pulse pattern, breathing or temperature	pulse, respiration return to normal	pulse 3 min after curare	pulse 3 min after curare: 6 min	9 min	12 min	15 min	20 min	25 min	30 min	1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare: 6 min	9 min	12 min	15 min	20 min	25 min	30 min	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare: 6 min	9 min	12 min	15 min	20 min	25 min	30 min	1 hour	time, artificial respiration	time, 1st dose prostigmine	" 2nd "	" subcutaneously start	" administration end	" " emphysema	time, death	micturition	defecation	salivation	muscular tremor	temperature at onset of anesthesia or curare	temperature at end of duration	temperature, hour after administration
8	1/4	PS		L	26"	9'		11'	132	140	136	136	136	120	108	132			136	20	24	16	12	12	12	12	14		16	3+	2-	2-	2-	2+	3+	3+															101	100	100
4	1/4	PS		L	36"	6'		8'	132	124	167	160	164	132	144				132	24	20	16	18	18	18	22			12	3+	1-	1-	3+	3+	3+															120	120	101
6	1/4	PS		L	2"	21'		26'	144	140	138	136	134	130	126	128	160		112	24	24	24	20	16	20	18	18	20		24	3+	2-	2-	2-	2-	2-	2-	3+													101	99	100
3	1/4	PS		L	36"	9'		18"	144	176	160	156	132	156	156	152			176	20	28	12	12	16	16	16	16			28	3+	3-	3-	2-	1-	3+	3+															102	101	100
9	1/4	PS		L	18"	9'		15'	124	152	140	128	150	134	146	132			146	28	32	32	20	24	24	22	26			20	3+	1-	2-	3-	1+	3+	3+															102	99	97
1	1/4	PS		L	7"	9'		14"	124	124	128	138	140	146	160				128	24	20	20	18	20	20	18			20	3+	2-	2-	2-	1+	3+																	101	101	101
2	1/4	PS		L	10"	11'		14'	104	124	120	120	140	120	128	146			104	40	27	24	20	28	28	28	24			20	3+	3-	3-	3-	1+	3+	3+															102	101	100
19	1/4	PS		L	25"	6'		12"	120	160	116	120	120	126	136				120	24	32	28	20	20	20	22			18	3+	2-	2-	1+	3+	3+																	101	101	99
17-22-25	1/4	PS		L	30"	10'		19'	96	162	150	132	118	118	124	124			130	20	28	12	12	14	14	12	16			20	3+	2-	2-	2-	1+	3+	3+															101	100	100
15-28	1/4	PS		L	30"	6'		11'	108	136	90	80	76	76	84	84			96	18	18	16	16	16	16	18	18	20		24	3+	3-	2-	2-	3+	3+	3+															101	100	98
10-23	1/4	PS		L	10"	9'		12'	160	164	164	156	132	146					148	16	20	20	16	20	26				20	3+	3-	2-	1-	3+																	102	101	97
11-24	1/4	PS		L	26"	9'		12'	72	80	112	112	120	132					80	32	20	28	32	20	24				20	3+	2-	2-	2-	3+																	102	102	101
14	1/4	PS		L	12"	6'		9'	116	172	184	144	138	132					120	28	40	30	24	24	24				30	1+	2-	2-	3+	3+																	102	101	101
21	1/4	PS		L	18"	6'		9'	124	160	160	152	200	180	164	146			124	40	28	26	40	36	36	30	24			28	3+	3-	3-	2+	3+	3+	3+															102	104	104
5	1/4	PS		L	7"	9'		11'	128	112	110	98	88	88	94				120	20	24	24	24	18	18	20			30	3+	1-	1-	1-	3+	3+																	102	101	101
16	1/4	PS		L	16"	9'		21'	86	132	120	94	96	112	92				118	16	24	20	16	M*	16	16				30	2+	2-	2-	1-	3+	3+																	102	102	101
7	1/4	PS		L	1'	7'		12'	124	120	128	104	100	96	96				128	18	28	18	18	16	16	16				18	3+	2-	2-	1+	3+	3+																	101	100	99
13	1/4	PS		L	30"	7'30		18'	104	128	92	76	80	76	80	90			92	22	32	18	20	16	16	18	18			18	3+	2-	2-	3+	3+	3+	3+															100	100	99
18	1/4	PS		L	28"	9'		12'	92	156	144	128	120	108	120				124	20	26	12	12	10	12	16				20	3+	2-	1-	1-	2+	3+																	102	100	100
12	1/4	PS		L	48"	15'		25'	130	162	152	148	144	144	136	136			110	20	26	22	12	12	12	12	14			14	3+	3-	3-	3-	3-	2-	3+																	101	101	99

Fig. 10; Reaction of 20 dogs to 1/4 unit curare per pound body weight during light plane pentothal sodium anesthesia.

in respirations. Twenty dogs had a decrease in temperature from 0.1 to five degrees. Pedal reflexes were absent in all dogs.

Time of full induction following 1/2 unit varied from 10 to 25 seconds, Fig. 9. Duration of action varied from 12 to 49 minutes. Following the injection of 1/2 unit of curare in surgical Nembutal anesthesia, Dog No. 13 had, at 25 minutes, a pulse of 44. Dog No. 21, from six minutes until 12 minutes following the injection of curare, had a pulse so weak that it could not be counted. That dog had a 12 minute 34 cyanosis. Artificial reppiration was started at five minutes and 30 seconds. The respirations of Dog No. 21 ceased from six minutes to 15 minutes at which time autorespirations started. Prostigmine was given at six minutes, 30 seconds. Respirations of six of the other dogs were shallow. In Dog No. 17-22. following the anesthetic, there was some abdominal relaxation with a slight pedal reflex. Curare was injected and abdominal relaxation occurred in 20 seconds. Death occurred at three minutes, 25 seconds from what was apparently a cardiovascular collapse. The heart beat stopped simultaneously with the respirations. Sixteen dogs had a decrease in temperature varying from 0.5 of one degree to 3.4.degrees. One had an increase of temperature of 0.6 of one degree. There was no change in the temperature of two.

Following Nembutal injection one dog showed very shallow respirations. The 1/2 unit curare caused no visible effects on the depths of the respirations of that animal. In 16 dogs curare caused a complete relaxation of skeletal muscles.

Pentothal Sodium, light plane anesthesia.--The animals given Pentothal Sodium, light plane anesthesia, were unconscious following the administration, but retained all of the reflex movements including crying and struggling. The crying stopped with the typical hoarse note and struggling ceased within just a few seconds. In order to retain a plane of light anesthesia it was necessary to inject occasionally small additional quantities of Pentothal Sodium. If the animals were allowed to come out from under Pentothal Sodium the abdominal tension returned. However, when a small amount of additional Pentothal Sodium was given, the relaxation was kept at a desired degree. Animals given curare following Pentothal Sodium had much the same symptoms as those given Nembutal both in light and surgical anesthesia.

Time of full induction following 1/4 unit curare varied from five seconds to one minute, Fig. 10. Duration of action varied from six minutes to 21 minutes. The degree of relaxation varied from 1- to 3-. There were no notable changes in the pulse or respirations. Fifteen animals had a decrease in temperature of 0.1 to

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour
8	3/8	PS		L		35"	15'		18'	116	136	168	144	132	126	130	125	132		120
4	3/8	PS		L		8"	12'		15'	88	226	212	180	176	156	124	108			104
6	3/8	PS		L		12"	12'		18'	121	118	144	132	130	120	116	116			140
3	3/8	PS		L		30"	9'		12'	140	140	148	128	124	120	124				140
9	3/8	PS		L		40"	10'		20'	108	136	148	140	132	132	120	130	128		120
1	3/8	PS		L		13"	15'		20'	132	146	122	128	134	126	138	140			136
2	3/8	PS		L		7"	30'		37'	120	168	186	172	146	176	160	140	128	110	140
19	3/8	PS		L		25"	15'		20'	120	158	124	128	108	132	130	134			124
17-22-26	3/8	PS		L		15"	15'		25'	100	128	160	140	134	124	116	116	118	124	94
15-28	3/8	PS		L		56"	18'		24'	126	124	126	90	84	72	72	70	80		128
10-23	3/8	PS		L		20"	15'		20'	160	146	140	160	152	148	152	150			166
11-24	3/8	PS		L		30"	15'		20'	144	178	192	168	180	134	150	144			120
14	3/8	PS		L		12"	12'		15'	116	168	160	160	144	160	160	148			132
21	3/8	PS		L		1'	12'		15'	120	190	200	192	186	154	146				132
5	3/8	PS		L		30"	15'		18'	102	124	144	128	120	120	124	132			86
16	3/8	PS		L		30"	20'		25'	88	170	176	176	158	148	164	172	160	155	144
7	3/8	PS		L		60"	12'		15'	120	120	128	144	130	124	100	96			130
13	3/8	PS		L		42"	18'		20'	112	118	96	90	86	60	60	80	86		132
18	3/8	PS		L		13"	15'		20'	72	132	152	134	144	120	108	106			96
12	3/8	PS		L		45"	15'		20'	120	172	176	176	176	164	144	142	134		100

Dog No.	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
8	40	36	28	28	20	18	16	18	18		24	3+	3-	3-	3-	3-	2-	3+	3+	
4	18	24	24	20	17	18	21	20			21	3+	3-	3-	3-	2-	2+	3+		
6	24	32	44	32	24	24	24	22			22	2+	3-	3-	3-	3-	1-	2+		
3	36	30	20	12	12	12	18				24	3+	3-	3-	2-	3+	3+			
9	34	32	24	20	20	20	18	18	18		24	3+	2-	2-	2-	2-	1-	3+	3+	
1	28	32	20	16	26	20	20	26			29	3+	3-	3-	3-	3-	1-	3+		
2	24	22	12	24	8	8	8	8	12	8	36	3+	3-	3-	3-	3-	3-	3-	3-	3-
19	18	40	28	28	20	20	18	18			24	3+	3-	3-	3-	3-	3-	3+		
17-22-26	20	30	24	18	18	16	16	16	20	26	20	3+	3-	3-	3-	3-	3-	1+	3+	3+
15-28	26	30	22	20	20	20	20	24	24		22	3+	3-	3-	3-	3-	3-	1-	3+	
10-23	32	24	20	20	20	26	28	36			20	3+	3-	3-	3-	3-	3-	3+		
11-24	32	20	16	13	14	16	18	22			22	3+	3-	3-	3-	3-	3-	3+		
14	24	44	52	36	28	44	32	32			25	3+	3-	3-	3-	3-	3+	3+		
21	32	38	42	36	32	28	38				28	2+	2-	2-	2-	2-	2+			
5	26	36	20	20	20	20	24	24			36	3+	3-	3-	3-	3-	3-	3+		
16	24	24	20	20	16	12	16	16	16	18	28	3+	3-	3-	3-	3-	2-	1-	3+	3+
7	24	24	24	24	20	20	20	24			26	3+	3-	3-	3-	3-	3+	3+		
13	32	30	20	19	19	20	20	22	20		28	3+	3-	3-	3-	2-	2-	3+	3+	
18	24	28	22	18	16	16	16	18			24	2+	3-	3-	3-	3-	3-	3+		
12	20	24	16	20	16	12	12	14	14		16	3+	3-	3-	3-	3-	3-	3+	3+	

Dog No.	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" [illegible]	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8													102	102	102
4													102	102	102
6													101	101	100
3													101	100	102
9													102	100	101
1													101	102	101
2													102	100	98
19													101	101	101
17-22-26													101	101	100
15-28													101	101	98
10-23													102	100	98
11-24													102	102	102
14													102	103	101
21													103	103	102
5													101	100	101
16													102	101	100
7													101	101	101
13													103	101	99
18													101	100	100
12													101	100	100

Fig. 11; Reaction 20 dogs to 3/8 unit curare per pound body weight during light plane pentothal sodium anesthesia

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour
8	1/2	PS		L		24"	15'		20'	120	132	120	108	96	88	84	86	90		106
4	1/2	PS		L		37"	10'		15'	116	170	160	154	146	128	130	122			128
6	1/2	PS		L		50"	12'		15'	132	150	144	133	119	119	120				136
3	1/2	PS		L		45"	20'		25'	112	120	104	130	130	134	132	126	120		120
9	1/2	PS		L		34"	12'		15'	132	142	146	144	124	124	120	120			136
1	1/2	PS		L		23"	12'		20'	112	142	120	104	100	96	94	100			120
2	1/2	PS		L		40"	13'		20'	160	142	108	100	96	72	80	104			160
19	1/2	PS		L		92"	18'		25'	114	140	118	116	102	90	90	100	100		116
17-22-25	1/2	PS		L		25"	20'		25'	104	156	148	110	110	114	104	136	128	136	126
15-28	1/2	PS		L		17"	15'		20'	104	116	92	84	66	66	64	74	80	84	112
10-23	1/2	PS		L		25"	15'		20'	120	144	128	156	144	144	156	162			144
11-24	1/2	PS		L		30"	15'		20'	100	172	164	132	138	134	130	142			100
14	1/2	PS		L		20"				108	138									
21	1/2	PS		L		40"	9'		12'	96	154	178	166	164	156	147				120
5	1/2	PS		L		35"	15'		20'	104	110	80	68	64	70	78	82	100		104
16	1/2	PS		L		44"	15'		20'	132	122	144	108	130	114	114	110	104		120
7	1/2	PS		L		25"	15'		20'	94	100	196	188	168	158	122	116	106		100
13	1/2	PS		L		24"	15'		18'	108	112	92	62	60	68	70	78	82		108
18	1/2	PS		L		42"	9'		12'	96	152	144	108	144	136	132				134
12	1/2	PS		L		60"	20'		25'	120	156	146	120	100	96	96	100	100	104	154

Dog No.	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
8	20	36	32	20	20	14	12	14	16		22	3+	3-	3-	3-	3-	3-	3+	3+	
4	20	22	14	16	9	20	20	20			20	3+	3-	3-	3-	1+	3+	3+		
6	40	30	24	24	20	20	22				22	3+	3-	3-	3-	2+	3+			
3	18	18	16	18	18	18	20	24	28		18	3+	3-	3-	3-	3-	3-	1-	3+	
9	32	40	26	22	22	18	20	20			24	3+	3-	3-	3-	1-	1+	3+		
1	18	36	24	13	11	16	18	16			16	2+	3-	3-	3-	3-	1+	3+		
2	28	32	28	24	20	12	16	24			32	3+	3-	3-	3-	3-	1+	3+		
19	18	30	22	18	12	12	18	20	22		26	3+	3-	3-	3-	3-	3-	1-	3+	
17-22-25	22	30	24	24	26	22	22	24	22	24	36	2+	3-	3-	3-	3-	3-	3-	3+	3+
15-28	26	28	24	18	18	12	14	14	16	16	18	3+	3-	3-	3-	3-	2-	3+	3+	3+
10-23	24	24	26	16	20	20	22	26			22	3+	3-	3-	3-	3-	3-	3+		
11-24	25	30	22	21	18	18	22	24			26	2+	3-	3-	3-	3-	3-	3+		
14	32	30										1+								
21	36	30	34	32	32	32	28				30	2+	3-	3-	3-	2+	2+			
5	35	16	20	32	42	38	34	24	26		16	3+	3-	3-	3-	3-	3-	3+	3+	
16	28	20	24	28	32	28	28	24	26		28	3+	3-	3-	3-	3-	3-	1-	3+	
7	20	24	28	20	24	24	24	24	22		24	3+	3-	3-	3-	3-	3-	3+	3+	
13	26	28	26	19	15	13	13	16	16		26	3+	3-	3-	3-	2-	1-	3+	3+	
18	16	26	24	26	24	20	22				32	2+	3-	3-	3-	2+	3+			
12	24	22	24	26	24	20	20	24	24	25	24	3+	3-	3-	3-	3-	3-	3-	2+	2+

Dog No.	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" [illegible]	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8													101	101	101
4													102	102	102
6													101	100	100
3													102	102	102
9													101	101	102
1													102	102	101
2													101	101	101
19													102	102	102
17-22-25													102	102	101
15-28													100	100	101
10-23													102	102	102
11-24													102	102	102
14								2'30"					102		
21													103	102	102
5	√3+												102	102	101
16													102	102	102
7													101	101	100
13													100	101	101
18													102	102	101
12													100	100	98

Fig. 12; Reaction 20 dogs to 1/2 unit curare per pound body weight during light plane pentothal sodium anesthesia

two degrees. Three dogs had a rise in temperature of 0.3 to 1.3 degrees. Two showed no temperature change. Sixteen subjects showed a pedal reflex.

Results with 3/8 unit curare were similar to those obtained with 1/4 unit of curare, Fig. 11. Time of complete induction varied from seven seconds to one minute. Duration of action varied from nine minutes to 20 minutes. There were no significant changes in the pulse rate except in Dog No. 21 which developed a pulse of 200 at three minutes which receded to 154 in 15 minutes. Pulse before curare and after anesthetic in Dog No. 21 was 190. There were no marked changes in respirations. Twelve dogs had a pedal reflex. In 15 subjects there was a drop in temperature from 0.1 to 2.4 degrees. There was no change in temperature in one dog. Four animals had a rise of temperature varying from 0.1 to 0.3 degree.

Time of full induction following 1/2 unit curare varied from 17 seconds to one minute, Fig. 12. Duration of action varied from nine minutes to 20 minutes. There were no notable changes in the pulse rate with the exception of one animal which had a drop in pulse to 62 and of Dog. No. 14 which died. There were no important changes in respirations. Eight dogs had a rise in temperature of 0.1 to 0.6 degree. Eight dogs dropped from 0.1 to 1.4 degrees. Three had no change

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	6	9	12	15	20	25	30	1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	6	9	12	15	20	25	30	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	6	9	12	15	20	25	30	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	1/4	PS		S		27"	9'		12'	84	120	140	160	132	116	108	116	120		120	18	24	22	20	20	16	14	12	16		16	1-	3-	3-	1-	2+	3+	3+	3+		101	101	101
4	1/4	PS		S		30"	15'		18'	128	192	172	152	152	144	136	132			140	28	44	36	32	28	28	22	24			32	1+	3-	3-	3-	1-	3+	3+			102	102	103
6	1/4	PS		S		40"	11'		15'	122	120	126	88	80	80	72				124	18	20	24	20	16	12	9				16	2+	2-	2-	2-	1+	2+				100	100	100
3	1/4	PS		S		60"	12'		15'	104	116	156	128	104	92	116	120			116	24	16	16	16	16	12	16	16			16	1+	3-	3-	3-	2-	3+	3+			102	101	99
9	1/4	PS		S		40"	9'		12'	104	144	136	128	104	100	88	100	120		120	36	38	36	36	28	28	24	24	24		28	2+	2-	2-	1-	1+	3+	3+	3+		102	100	99
1	1/4	PS		S		40"	9'		12'	128	188	162	154	154	146	132	134			140	28	40	34	32	24	24	26	24			30	1+	3-	1-	1-	1+	3+	3+			102	101	103
2	1/4	PS		S		57"	15'		20'	120	154	120	120	133	136	128	128	128		128	14	28	32	48	40	36	36	24	26		24	1-	3-	3-	3-	3-	3-	2+	3+		102	101	98
19	1/4	PS		S		17"	9'		12'	130	168	160	148	140	140	134	132			140	24	28	24	24	20	26	28	30			24	1+	3-	3-	2-	2+	2+	2+			101	101	102
17-22-26	1/4	PS		S		35"	6'		9'	94	144	124	110	92	84	84	84			108	20	28	22	18	18	14	22	22			34	1+	3-	3-	3+	3+	3+	3+			102	102	99
15-28	1/4	PS		S		30"	15'		20'	126	146	130	110	110	104	104	90	90	86	84	22	24	26	18	18	16	16	20	24	24	12	1+	2-	2-	1-	1-	1-	2+	3+	3+	101	100	101
10-23	1/4	PS		S		40"	7'		9'	132	170	164	133	148	152	140	140			160	36	28	26	24	24	22	26	30			24	1+	3-	1-	2+	2+	3+	3+			102	101	102
11-24	1/4	PS		S		60"	9'		12'	96	148	152	132	128	80	96	120			144	24	24	16	34	32	28	28	36			28	1+	3-	3-	1-	3+	3+	3+			101	102	103
14-29	1/4	PS		S		36"	9'		15'	92	108	132	136	108	100	98	104	102		104	18	22	22	36	16	16	20	16	20		20	1+	3-	3-	3-	1+	1+	3+	3+		101	100	102
21	1/4	PS		S		45"	10'		20'	140	172	200	180	180	160	180	152	164		142	22	36	40	40	32	36	28	24	28		26	2+	2-	2-	2-	1+	1+	3+	3+		102	102	102
5	1/4	PS		S		55"	10'		12'	128	132	128	112	112	120	104	104			128	40	28	24	24	24	28	24	24			24	3+	3-	3-	3-	3+	3+	3+			102	102	101
16	1/4	PS		S		35"	10'		12'	116	144	160	160	160	156	144				112	28	28	16	28	28	24	28				27	1+	1-	1-	1-	3+	3+				101	102	102
7	1/4	PS		S		30"	9'		20'	92	104	120	140	104	96	100	104	100		104	16	20	20	22	16	16	16	14	20		20	3+	3-	2-	2-	1-	1-	1+	3+		100	100	100
13	1/4	PS		S		45"	15'		20'	128	132	120	108	100	100	100	80	80	76	76	20	24	20	16	16	16	20	20	28	26	26	2+	2-	2-	2-	2-	1-	2+	3+	3+	101	101	101
18	1/4	PS		S		35"	6'		9'	88	134	120	104	92	80	80	80			100	28	30	20	20	20	16	20	16			16	1-	3-	2-	1+	3+	3+	3+			101	101	100
12	1/4	PS		S		95"	15'		20'	108	168	180	174	156	168	174	168	144		120	24	24	36	24	24	18	18	16	22		24	2-	3-	3-	3-	3-	3-	1+	2+		101	100	100

Fig. 13; Reaction of 20 dogs to 1/4 unit of curare per body weight during surgical pentothal sodium anesthesia

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	6	9	12	15	20	25	30	1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	6	9	12	15	20	25	30	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	6	9	12	15	20	25	30	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	3/8	PS		S		25"	18'		20'	96	140	180	156	138	132	132	136	134	132	132	24	18	24	24	19	14	18	16	20	20	30	1+	2-	3-	3-	3-	3-	2-	3+	3+	102	102	104
4	3/8	PS		S		25"	12'		15'	100	180	180	156	150	144	138	122			122	28	30	42	36	30	25	22	22			24	2+	3-	3-	3-	2-	3+	3+			102	102	102
6	3/8	PS		S		35"	9'		12'	120	133	186	156	144	132	132				130	30	30	36	30	24	18	18				42	1+	3-	3-	3-	2+	3+				101	101	102
3	3/8	PS		S		25"	15'		20'	86	148	158	120	96	96	80	120			74	34	24	32	28	24	24	24	22			30	1+	3-	3-	3-	2-	2-	2+			101	101	102
9	3/8	PS		S		35"	20'		25'	110	134	168	186	168	150	146	144	146	140	118	28	30	36	30	30	26	28	24	18	25	36	2+	3-	3-	3-	3-	2-	1-	2+	3+	101	101	102
1	3/8	PS		S		25"	12'		15'	100	184	176	180	148	138	136	120			122	26	34	40	36	28	24	22	22			26	1+	3-	3-	3-	2-	3+	3+			102	102	102
2	3/8	PS		S		25"	12'		18'	122	192	182	160	160	160	128	130	136		150	24	24	24	24	24	22	28	24	24		24	1+	3-	3-	3-	3-	1+	3+	3+		101	101	100
19	3/8	PS		S		30"	18'		25'	124	180	166	150	150	134	134	120	124		116	36	30	42	34	34	22	22	24	24		24	1+	3-	3-	3-	3-	3-	1+	3+		102	102	102
17-22-25	3/8	PS		S		35"	15'		25'	100	154	130	106	98	98	98	100	112		100	24	24	28	24	24	20	20	20	24		26	1-	3-	3-	3-	3-	3-	1+	3+		102	101	100
15-28	3/8	PS		S		25"	20'		25'	114	148	160	168	156	148	144	148	148		116	18	24	24	24	20	16	16	18	22		12	2-	3-	3-	3-	3-	3-	3-	2+		102	100	101
10-23	3/8	PS		S		35"	12'		15'	100	180	174	153	148	144	152				113	20	30	24	24	20	24	28				20	1+	3-	3-	3-	3-	3+				102	101	99
11-24	3/8	PS		S		55"	12'		15'	116	192	180	172	152	144	128	150			136	28	16	20	24	24	24	20	24			28	2+	2-	2-	2-	2-	2+	3+			102	102	102
14-29	3/8	PS		S		24"	15'		20'	84	100	86	74	74	70	62	84			106	20	26	18	16	16	12	12	24			26	2+	3-	3-	3-	3-	2-	3+			100	100	102
21	3/8	PS		S		40"	12'		15'	105	158	210	188	180	166	164	156			126	24	34	38	36	36	36	28	28			28	1+	3-	3-	3-	1-	3+	3+			102	102	102
5	3/8	PS		S		37"	12'		15'	112	120	160	152	144	136	124	124	120		146	28	28	32	36	34	32	24	24	28		28	2+	3-	3-	3-	3-	2+	3+	3+		102	102	100
16	3/8	PS		S		25"	20'		25'	80	160	160	136	128	128	120	120	116	112	120	24	24	28	24	24	24	24	22	20	22	24	2-	3-	3-	3-	3-	3-	3-	2+	3+	102	103	101
7	3/8	PS		S		15"	15'		20'	80	100	84	72	72	66	60	84			102	22	27	18	18	18	12	12	24			24	2+	3-	3-	3-	3-	2-	2+			100	100	102
13	3/8	PS		S		17"	12'		15'	136	133	74	72	78	82	86	84			120	24	20	18	24	24	22	26	24			30	2+	2-	2-	2-	1-	3+	3+			101	101	101
18	3/8	PS		S		25"	15'		20'	96	148	136	112	100	100	96	98			93	28	20	24	20	24	20	20	22			32	3-	3-	3-	3-	3-	3-	1+			101	101	101
12	3/8	PS		S		27"	15'		20'	112	138	146	144	140	132	132	120	124		100	25	26	24	24	18	18	20	24	24		20	1-	3-	3-	3-	3-	2-	2+	3+		101	100	102

Fig. 14; Reaction of 20 dogs to 3/8 unit of curare per pound body weight during surgical pentothal sodium anesthesia

in temperature. Dog No. 14 died two and one half minutes following 1/2 unit of curare. The heart and respirations ceased at the same time.

Pentothal Sodium, surgical anesthesia.--Time of full induction following 1/4 unit curare varied from 17 seconds to one minute, Fig. 13. Duration of action varied from six to 15 minutes. The degree of abdominal relaxation varied from 1- to 3-. There were no significant changes in the pulse rate or respiratory rate. There was a decrease in temperature in 14 animals of from 0.2 to 1.1 degrees. There was no change in three dogs.

Time of full induction with 3/8 unit of curare varied from 24 seconds to one minute, seven seconds, Fig. 14. Duration of action varied from nine minutes to 20 minutes. The abdominal relaxation was 3- in all dogs except one which had a 2- relaxation. There were no important changes in pulse or respiration. Thirteen had a decrease in temperature of from 0.2 to 1.6 degrees. There was an increase of temperature in three dogs of from 0.1 to 0.6 degree. There was no temperature change in four dogs.

Time of complete induction with 1/2 unit of curare varied from 10 seconds to 56 seconds, Fig. 15. Duration of action varied from 10 minutes to 20 minutes. Abdominal relaxation was 3- in all dogs. With the exception of Dog No. 21 and Dog No. 7 there were no changes

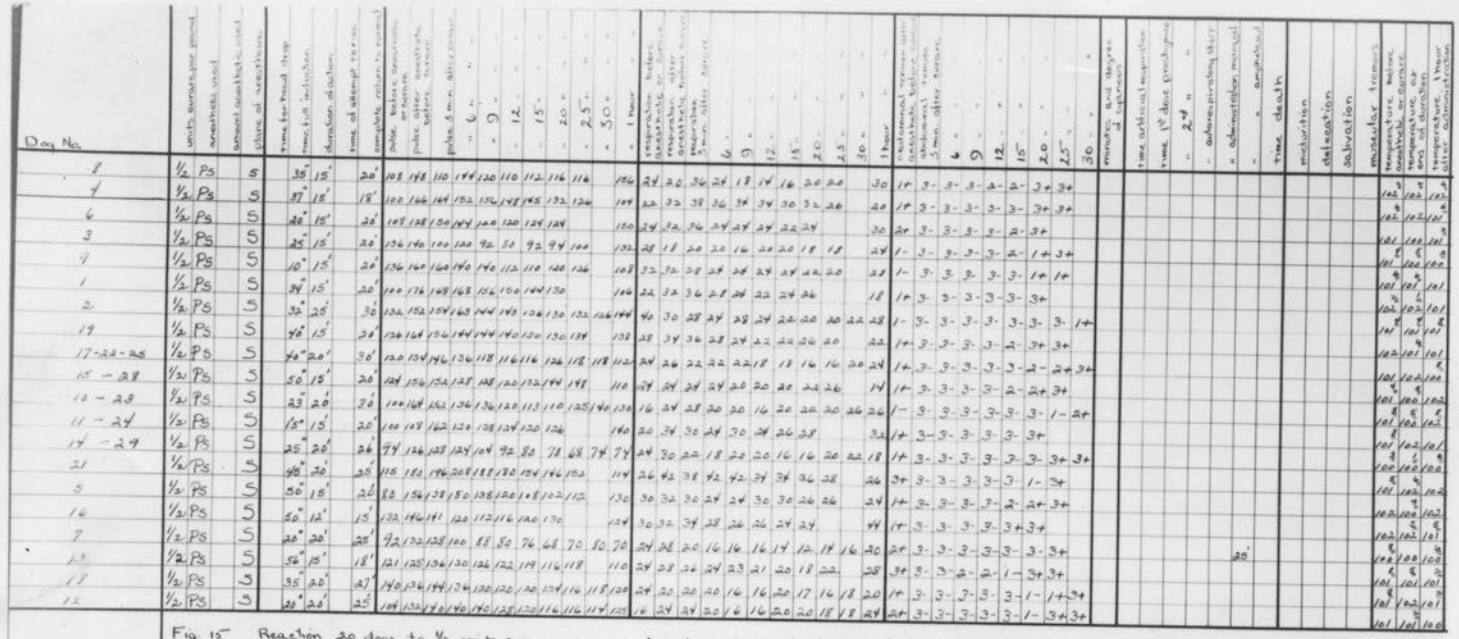


Fig 15 Reaction 20 dogs to ½ unit curare per pound body weight during surgical pentothal sodium anesthesia

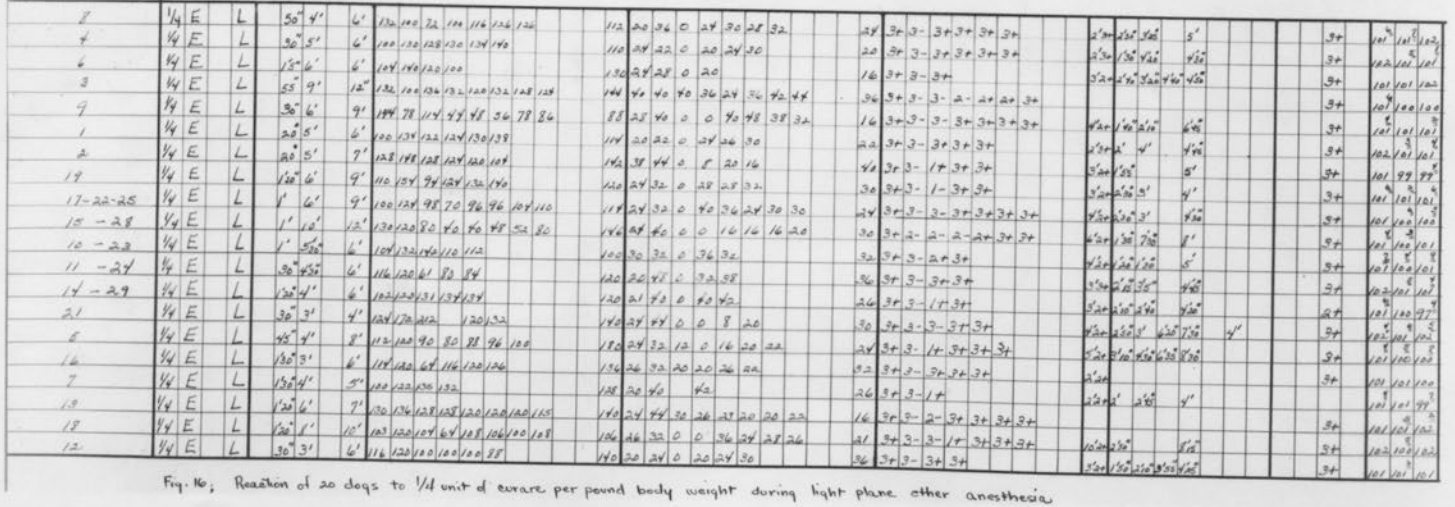


Fig. 16; Reaction of 20 dogs to 1/4 unit of curare per pound body weight during light plane ether anesthesia

in the pulse. Dog No. 21 developed a tachycardia. The pulse of Dog No. 7, at 25 minutes, was so weak that Amphetasul was administered. There were no significant changes in respirations except in Dog No. 7, whose respirations were diaphragmatic and jerky for nine minutes following the injection of curare. Six dogs had a rise in temperature varying from 0.2 to 1.1 degrees. Eleven dogs had a decrease in temperature from 0.2 to 2.9 degrees. Three dogs showed no change in temperature.

Anal sphincter relaxation.--Anal relaxation was profound in all animals receiving curare in all experiments with the exception of the 1/4 unit dose of curare given alone.

Ether with curare.--Following ether in light plane anesthesia the dogs had a good pedal reflex and a 3- abdominal tension. The picture presented, following the injection of curare, was as a whole the same with both light plane and surgical anesthesia and both 1/4 and 1/8 unit doses, Fig. 16-19. Respirations became labored within a minute of two. The ether mask was almost immediately removed from all dogs. The dogs immediately started recovering from the anesthetic, showed extreme discomfort and made spasmodic attempts to breathe. The respiratory muscles remained paralyzed longer than some of the other skeletal muscles. This was shown by the animals pawing at the air while still unable to draw

air into their lungs. Most became cyanotic and would have become more so had not artificial respiration been initiated. When artificial respiration was checked previous to the time that autorespirations were possible, the animals showed discomfort and made convulsive efforts to breathe. Their recovery in most cases was rather rapid following the removal of the ether cone and administration of prostigmine.

Time of complete induction with 1/4 unit of curare varied from 20 seconds to one minute, 30 seconds. Duration of action varied from three minutes to nine minutes. The pulse in 18 dogs became weak and somewhat thready. Dog No. 21 developed a pulse rate of 212 at three minutes, at six minutes it was too rapid to record and at nine minutes it had diminished to 120. Two dogs retained a fairly strong pulse following the injection of curare. Respirations of all 20 dogs became shallow and 18 of them developed very jerky, diaphragmatic respirations.

Just following the administration of curare the heart of Dog No. 7 slowed almost to a stop. Prostigmine was administered at two minutes and 24 seconds, and at three minutes the pulse was back to 122, but very weak and thready.

Fifteen of the dogs required artificial respiration at three minutes. With four of them it was

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
8	1/4	E		S		1'45"	4'		6'	140	98	112	116	112	116					124
4	1/4	E		S		35"	6'		7'	120	140	144	160	166	156	140				120
6	1/4	E		S		1'	6'		6'	128	120	100	60	64	70					120
3	1/4	E		S		40"	12'		14'	130	140	144	140	136	108	120				138
9	1/4	E		S		30"	6'		9'	124	100	68	40	48	44	60	68	74		86
1	1/4	E		S		1'	3'		5'	120	134	120	100	130						123
2	1/4	E		S		1'	6'		9'	100	136	160	120	126						184
19	1/4	E		S		1'				120	138									
17-22-25	1/4	E		S		40"	6'		9'	104	164	148	92	100	104					130
15-28	1/4	E		S		40"	4'		6'	152	160	132	90	150	144					140
10-23	1/4	E		S		50"	2'		4'30"	116	96	108	96	104						120
11-24	1/4	E		S		35"	6'30"		7'	126	144	148	158	144	140					130
14-29	1/4	E		S		1'30"	5'		9'	134	112	130	136	124						136
21	1/4	E		S		30"				110	148									
5	1/4	E		S		1'15"	6'		8'	140	152	160	92	112	108	114				130
16	1/4	E		S		1'40"	4'		6'	120	130	68	98	104	114					123
7	1/4	E		S		1'	6'		9'	138	108	135	132	126						132
13	1/4	E		S		55"	4'		6'	150	220	224	220	200	180					180
18	1/4	E		S		1'10"	6'		7'	108	152	144	110	98						136
12	1/4	E		S		1'	5'		6'	98	136	160	128	124						136

Dog No.	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
8	20	36	40	38	34	34					6	2+	3-	2+	2+	3+				
4	32	36	0	28	30	32	26				40	1+	3-	1-	3+	3+	3+			
6	24	28	16	0	48	48					20	2+	2-	2-	3+					
3	32	52	32	0	42	36	40				28	2+	3-	3-	3-	2-	3+			
9	20	25	12	0	0	40	44	36	32		34	1+	3-	3-	3+	3+	3+	3+	3+	
1	28	50	36	30	30						38	3+	3-	1-	3+					
2	42	42	20	28	30						44	1+	3-	3-	3+					
19	30	32										1-								
17-22-25	22	44	0	40	44	46					22	2+	3-	3-	3+	3+				
15-28	34	40	0	36	40	32					32	1+	3-	3+	3+	3+				
10-23	34	32	24	36	30						24	3+	2+	3+	3+					
11-24	32	38	0	36	30	32					28	1+	3-	1-	3+	3+				
14-29	22	44	0	36	30						34	3+	3-	1+	3+					
21	20	34																		
5	24	20	0	0	44	54	30				28	1+	1-	1-	3+	3+	3+			
16	28	36	22	22	24	28					18	1+	3-	3+	3+	3+				
7	20	40	20	48	36						40	3+	3-	3+	3+					
13	32	44	0	80	40	30					50	3+	1-	2+	3+	3+				
18	32	40	44	46	36						22	1+	2-	2-	3+					
12	18	36	24	28	36						24	1+	3-	3+	3+					

Dog No.	minutes and degree of apnea	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	2'2+										3+		101^{8}	101^{4}	101^{8}
4	1'2+	2'10"	2'30"		3'10"						3+		101^{5}	101^{3}	101^{3}
6	2'2+	5'55"	6'		7'50"		6'40"				3+		101	101	102
3	1'2+	2'30"			3'25"						3+		102	100	100
9	5'2+	3'40"	4'30"	6'50"	9'30"		5'				3+		101^{4}	101^{2}	101^{6}
1	3'2+										3+		101^{6}	102	101^{4}
2	5'1+										3+		101^{8}	101^{8}	100^{7}
19		1'20"	2'30"					2'45"			3+		101^{6}		
17-22-25	3'2+	2'20"			3'40"						3+		102	102^{4}	102
15-28	3'2+	2'	2'30"		4'50"						3+		101^{4}	100^{9}	102
10-23	2'2+	1'			2'50"						3+		102	101	100
11-24	3'2+	1'50"	2'20"		4'						3+		102	101^{9}	101^{2}
14-29	3'1+	2'40"			4'20"						3+		100^{8}	100^{4}	100^{2}
21		45"	1'15"				2'	2'30"					101^{4}		
5	4'2+	1'55"	5'5"		6'45"						3+		100^{4}	100^{8}	101^{2}
16	3'1+										3+		101^{4}	100^{5}	100^{4}
7	2'2+	3'35"			3'55"								100^{8}	100	100
13	2'2+	1'15"			4'35"						3+		101^{4}	102^{3}	102
18											3+		103^{4}	103	103
12	3'2+										3+		102	102	102^{4}

Fig. 17: Reaction of 20 dogs to 1/4 unit curare per pound body weight during surgical ether anesthesia

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
8	1/8	E		L		45"	5'		7'	100	100	96	148	165	152	146				96
4	1/8	E		L		30"	3'		5'	148	100	120	126	130						132
6	1/8	E		L		45"	3'		6'	140	120	172	160	160						132
3	1/8	E		L		30"	6'		9'	128	140	120	132	132	138					134
9	1/8	B		L		30"	6'		9'	132	108	135	132	100	96					76
1	1/8	E		L		30"	3'		5'	140	130	112	124	130						132
2	1/8	E		L		20"	9'		12'	102	160	180	184	184	160	164				150
19-26	1/8	E		L		30"	4'		6'	138	144	116	118	130	132					116
17-22-25	1/8	E		L		50"	3'		6'	104	156	148	126	100	106					110
15-28	1/8	E		L		55"	5'		6'	126	172	184	170	160	148					156
10-23	1/8	E		L		30"	6'		9'	104	146	120	128	184	136					132
11-24	1/8	E		L		45"	3'		5'	124	148	112	124	126	134					132
14-29	1/8	E		L		1'10"	6'		8'	126	124	140	126	124						126
21-31	1/8	E		L		1'30"	6'		9'	108	148	144	128	126	132					112
5	1/8	E		L		50"	4'		7'	132	140	180	138	144	132	126				142
16	1/8	E		L		1'30"	3'		6'	132	128	120	126	124						114
7	1/8	E		L		1'	6'		9'	124	120	140	128	120						122
13	1/8	E		L		1'5"	5'		6'	126	162	180	176	164	156					150
18	1/8	E		L		45"	3'		6'	104	162	152	136	126						112
12	1/8	E		L		30"	3'		6'	110	144	120	140	142						128

Dog No.	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
8	36	36	20	20	32	32	26				44	3+	1-	1-	3+	3+	3+			
4	44	48	40	36	30						38	3+	1-	3+	3+					
6	24	36	32	40	45						44	2+	1-	3+						
3	26	20	12	24	34	40					26	1+	2-	1-	3+	3+				
9	36	40	20	48	44	40					32	3+	3-	3-	3+	3+				
1	40	48	38	36	30						34	3+	1-	3+	3+					
2	24	24	48	44	44	32	36				28	3+	1-	1-	1-	3+	3+			
19-26	30	36	40	34	30	34					36	3+	2-	3+	3+	3+				
17-22-25	34	40	0	32	36	40					20	3+	2-	3+	3+	3+				
15-28	22	28	0	48	40	44					30	3+	1-	3+	3+	3+				
10-23	20	22	16	24	28	36					24	1+	2-	1-	3+	3+				
11-24	24	44	38	36	38	34					24	3+	1-	3+	3+	3+				
14-29	22	40	20	0	44						32	1+	3-	3-	3+					
21-31	26	34	26	30	24	38					28	2+	1-	1-	2+	3+				
5	40	40	40	0	44	30	32				36	3+	3-	1+	3+	3+	3+			
16	24	28	40	30	26						32	3+	1+	3+	3+					
7	24	40	18	0	48						36	1+	3-	3-	3+					
13	26	30	0	64	50	48					34	3+	1+	3+	3+	3+				
18	26	46	32	36	34						26	3+	1-	3+	3+					
12	24	56	40	36	38						18	1+	3-	3+	3+					

Dog No.	minutes and degree of apnea	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	2'2+								+	+	3+		101^{4}	101^{8}	102
4	1'2+										3+		102	102^{6}	103
6	1'1+								+	+	3+		101^{4}	101	102
3	2'1+										3+		101^{8}	101	101^{4}
9	2'2+	3'35"			3'55"						3+		101^{4}	102	100^{2}
1	1'2+										3+		102	102^{6}	102^{9}
2											3+		101^{8}	101	102^{5}
19-26	1'1+	3'30"			4'						3+		101^{8}	102^{4}	102^{4}
17-22-25	2'2+	2'40"			3'45"						3+		102	101^{5}	102
15-28	2'1+	2'			4'						3+		101^{6}	101^{8}	100^{4}
10-23	2'1+										3+		101^{8}	101	101^{2}
11-24	2'1+										3+		101	102^{8}	103
14-29	2'2+	5'10"	6'10"		7'						3+		101	100^{8}	100
21-31											3+		101^{6}	101^{4}	102^{4}
5	2'2+	5'40"			6'00"						3+		101^{8}	102^{6}	102^{5}
16	3'2+										3+		102^{8}	102^{6}	101
7	2'2+	5'30"	6'30"		7'								101	100^{6}	100
13	1'2+	1'35"			3'45"						3+		101^{4}	101^{6}	100
18											3+		101^{8}	101^{8}	102^{4}
12	1'1+										3+		101	101^{6}	102^{4}

necessary to continue artificial respirations into the six minute period. In one dog, which had 12 very shallow respirations at three minutes, it was necessary to administer artificial respiration at six minutes. Eighteen dogs developed a cyanosis varying from 2+ to 3+. Prostigmine was administered to 15 dogs. With four animals the second dose of prostigmine was required. Seven showed a pedal reflex at the height of the curare action. Sixteen had a drop in temperature varying from 0.3 to two degrees. Three dogs had a rise in temperature varying from 0.1 to 0.5 degrees. In one the temperature remained unchanged.

The time of complete induction when ether, surgical anesthesia, was used with 1/4 unit of curare varied from 30 seconds to one minute, 45 seconds, Fig. 17 and Fig. 19. Duration of action varied from two minutes to six minutes, 30 seconds. The actions of the pulse and respirations described under 1/4 unit of curare with ether, light plane anesthesia, were similar to those under surgical anesthesia. However, only 11 dogs were administered artificial respiration. Dog No. 19 died at two minutes and 45 seconds, following the administration of prostigmine at two minutes, 30 seconds. Death was apparently caused from a cardiovascular collapse because heart and respirations ceased at the same time. The same occurred with Dog No. 21 which died at two

minutes, 30 seconds, following the administration of prostigmine at two minutes. Seventeen animals developed a cyanosis. It was necessary to administer prostigmine to eight, including those that died. There was a temperature decrease in 10 subjects from 0.1 to two degrees. The temperature in five dogs increased from 0.2 to 0.8 degree. In three there was no change in temperature.

Under ether surgical anesthesia, time of induction with 1/8 unit curare varied from 27 seconds to one minute 30 seconds, Fig. 19. Duration of action varied from one minute to six minutes. The pulse and respiratory symptoms under surgical anesthesia were similar, with few exceptions, to those under light plane ether anesthesia. It was necessary to administer artificial respiration to eight dogs. Eighteen developed cyanosis. Ten were administered artificial respiration and two in addition were administered prostigmine. Abdominal tension following curare varied from 2+ to 3-. Twelve dogs had an increase in temperature varying from 0.1 to 2.4 degrees. Five had a drop in temperature varying from 0.1 to 0.5 degree.

The 1/8 unit injection of curare, Fig. 18, with ether, light plane anesthesia did not have quite the severe effect on the pulse and respirations that the 1/4 unit , Fig. 16, had in the light plane ether anesthesia. However, the pulse in 11 dogs was weak and

Dog No.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal
8	1/8	E		S		1'30"	6'		8'
4	1/8	E		S		27"	3'		4'
6	1/8	E		S		1'	3'		6'
3	1/8	E		S		30"	6'		9'
9	1/8	E		S		37"	6'		9'
1	1/8	E		S		33"	3'		4'
2	1/8	E		S		30"	3'		6'
19-26	1/8	E		S		42"	3'		6'
17-22-25	1/8	E		S		1'20"	3'		6'
15-28	1/8	E		S		1'	6'		8'30"
10-23	1/8	E		S		40"	6'		9'
11-24	1/8	E		S		35"	3'		4'20"
14-29	1/8	E		S		1'20"	6'		9'
21-31	1/8	E		S		1'15"	6'		9'
5	1/8	E		S		1'	1'		3'
16	1/8	E		S		1'30"	3'		6'
7	1/8	E		S		1'15"	6'		9'
13	1/8	E		S		1'30"	6'		7'
18	1/8	E		S		55"	4'		6'
12	1/8	E		S		1'20"	4'		6'

Dog No.	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15	" 20	" 25	" 30	" 1 hour
8	160	168	144	120	120	124					132
4	126	120	124	120	116						112
6	104	120	95	60	64	80					132
3	126	160	130	136	144	130					140
9	132	118	146	134	104	126					144
1	126	120	120	130	140						112
2	120	128	144	142	136						148
19-26	180	138	124	124	138	130					116
17-22-25	108	144	120	106	100	104					110
15-28	148	144	154	160	162	148	144				142
10-23	108	156	140	140	146	152					126
11-24	100	124	120	120	114						112
14-29	126	108	130	124	118						124
21-31	104	142	128	104	100	106	109				116
5	126	118	120	140	136	120					136
16	114	138	126	130	132						140
7	126	104	138	126	118						120
13	132	138	156	160	156	140	140				156
18	96	124	106	100	96						116
12	116	136	114	128	134						122

Dog No.	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6	9	12	15	20	25	30	1 hour
8	48	30	26	20	19	20					32
4	28	40	46	40	32						40
6	24	28	0	24	24	36					30
3	30	32	0	22	30	36					40
9	40	30	20	44	42	40					28
1	24	36	42	40	24						42
2	28	40	32	32	42						34
19-26	20	24	44	42	36	40					44
17-22-25	24	40	0	24	36	30					30
15-28	26	26	0	54	46	44	40				28
10-23	16	28	0	22	30	36					26
11-24	26	34	44	36	32						30
14-29	24	28	0	42	38						30
21-31	22	34	24	26	30	32	28				28
5	24	22	28	30	32	26					30
16	30	27	44	33	26						26
7	20	26	0	36	40						36
13	30	22	0	60	46	40	32				40
18	22	34	26	24	30						28
12	26	37	23	27	30						14

Dog No.	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
8	1+	2-	1-	3+	3+				
4	1+	2-	3+	3+					
6	1+	1-	3+	3+					
3	1+	1-	1-	3+	3+				
9	1-	3-	3-	3+	3+				
1	1+	2-	3+	3+					
2	1+	1-	2+	3+					
19-26	1+	3-	3+	3+	3+				
17-22-25	1+	2-	3+	3+	3+				
15-28	1+	2-	2-	3+	3+	3+			
10-23	1+	1-	1-	3+	3+				
11-24	1+	2-	3+	3+					
14-29	1+	3-	3-	3+					
21-31	1-	2-	2-	2+	3+	3+			
5	1+	2+	3+	3+	3+				
16	3+	1-	3+	3+					
7	1+	3-	3+	3+					
13	1+	2-	2-	3+	3+	3+			
18	1+	2-	3+	3+					
12	1-	3-	2+	3+					

Dog No.	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" respiratory start	" administration [illegible]	" [illegible]		time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
8	3'1+											3+		101^{9}	101^{2}	101^{5}
4	1'1+											3+		101^{5}	102^{4}	102
6	1'2+	3'			4'						+	3+		101	101	101^{5}
3	1'2+	2'40"			3'40"							3+		101^{5}	102	102
9	2'2+	3'50"			4'30"							3+		101^{4}	101	99^{6}
1	2'+											3+		101^{5}	102^{4}	100^{5}
2	3'1+											1+		101^{5}	101^{5}	102^{9}
19-26	2'1+											3+		101^{8}	102^{8}	102^{8}
17-22-25	2'1+	2'35"			3'10"							3+		101^{5}	101^{9}	102^{6}
15-28	2'1+	1'30"			5'							3+		102	102	102
10-23	2'2+	2'30"			3'45"							3+		101^{2}	102	102
11-24	1'1+											3+		101^{3}	102^{2}	102
14-29	3'2+	1'45"	2'30"		4'							3+		102	101^{5}	100^{8}
21-31												3+		101	103^{5}	102^{4}
5	3'1+	1'35"			2'25"							3+		102	101^{5}	102
16	3'2+											3+		102^{3}	101^{3}	102
7	2'2+	2'	3'		3'30"									101	101^{8}	100^{9}
13	2'2+	1'15"			4'10"							3+		102	102^{4}	102^{8}
18												3+		101	101^{5}	102^{5}
12	3'1+											3+		101^{8}	101^{6}	101

Fig. 19; Reaction of 20 dogs to 1/8 unit of curare per pound body weight during surgical ether anesthesia

thready for periods varying from six to 12 minutes. Time of complete induction varied from 20 seconds to one minute, 30 seconds. Duration of action varied from three minutes to nine minutes. Nine dogs had moderate pulse. It was necessary to administer artificial respiration to only six dogs. The respirations in all were labored and some jerky and diaphragmatic in action. It was necessary to administer prostigmine to only two dogs. Eleven animals had a pedal reflex. Two had involuntary defecation and micturition. A decrease of temperature occurred in nine dogs varying from 0.2 to 0.8 degree. In 11 dogs there was an increase of temperature varying from 0.1 to 1.4 degrees. Abdominal tension following curare varied from 1+ to 3-.

The effect of curare on blood.--As a control, blood examinations were made three days prior to receiving any injection of curare. On each of the three days while curare alone was being injected, samples of blood were taken from each dog and examined. During the following two weeks samples of blood were taken at three day intervals. During this two weeks curare was being administered simultaneously with Nembutal. There were no indications in red or white blood cell counts or in hemaglobin that curare affected the red or white cells or the hemaglobin.

In none of the dogs was there an indication of

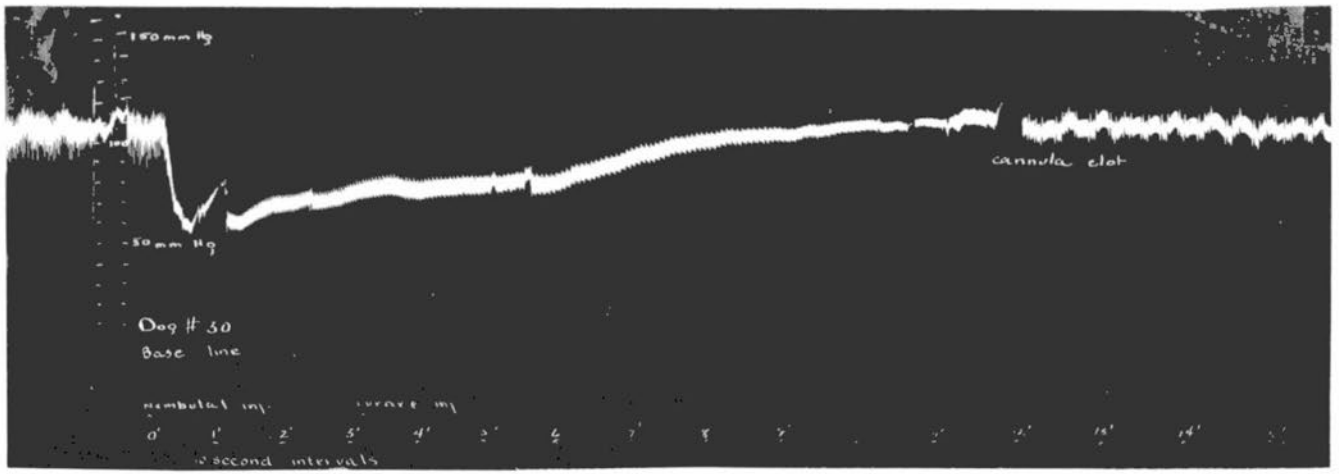


Fig. 20; Kymographic tracing of Dog No. 30 under nembutal surgical anesthesia, following 3/8 unit curare per pound of body weight

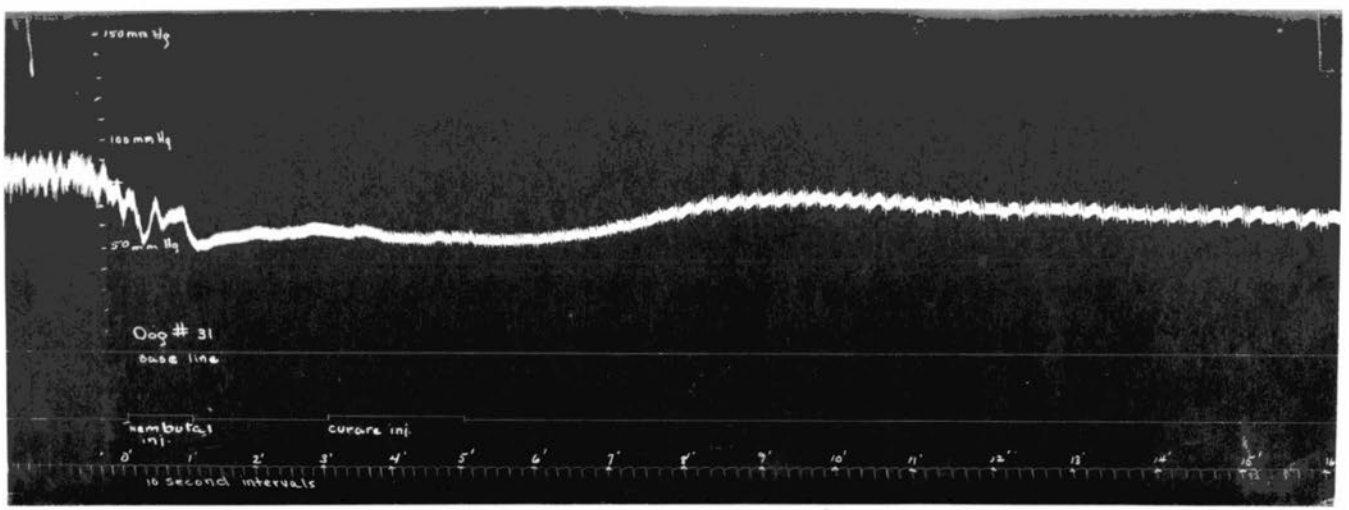


Fig. 21 Kymographic tracing of Dog No. 31 under nembutal surgical anesthesia following 3/8 unit curare per pound of body weight.

any accumulative effect on the individual animal from day to day. There was no thrombosis or phlebitis noted in the veins used for injections in spite of the fact that relatively frequent injections had been made.

Effect of curare on blood pressure.--A period of two minutes was taken for the intravenous injection of curare in all of these experiments on blood pressure.

Nembutal, surgical anesthesia and 3/8 unit of curare.--The kymographic tracing of Dog No. 30, Fig. 20, showed that during injection of Nembutal, the blood pressure dropped 35 millimeters of mercury within 25 seconds. Following Nembutal there was a slow steady increase in blood pressure which was broken only by a very short drop of four millimeters following the injection of curare. The blood pressure continued to climb until at the end of 11 minutes the blood pressure reached its level prior to Nembutal. This level was regained in 11 and one half minutes.

During and following the injection of Nembutal Dog No. 31 had a decrease in blood pressure of approximately 22 millimeters, and then the blood pressure continued approximately level until the injection of curare, Fig. 21. One minute after the injection of curare a steady increase of pressure occurred until the before Nembutal level had been reached. It continued at that level for the duration of anesthesia.

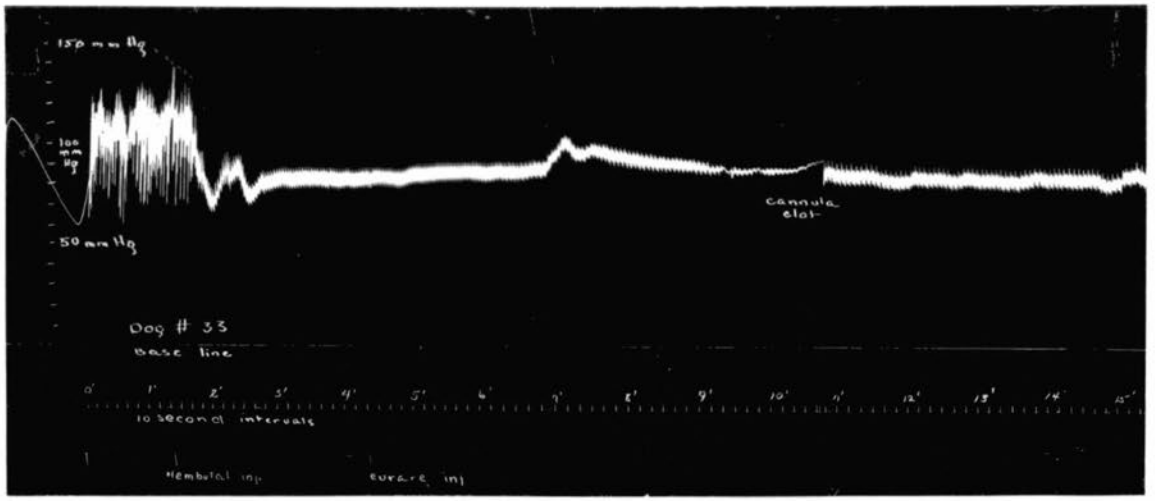


Fig 22. Kymographic tracing of Dog No. 33 under nembutal surgical anesthesia, following 1/8 unit curare per pound body weight

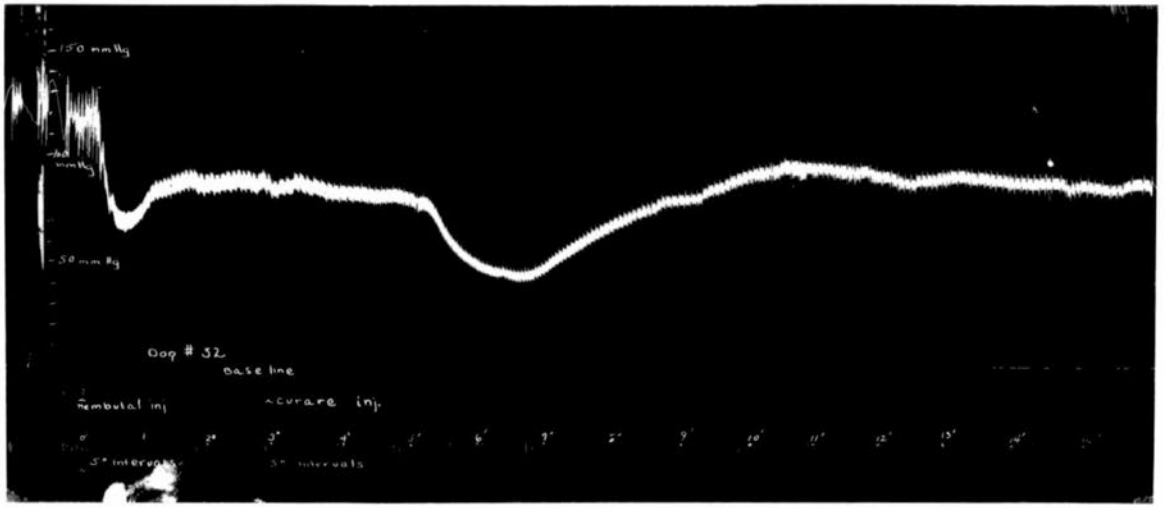


Fig. 25 Kymographic tracing of Dog No. 32 under nembutal surgical anesthesia, following 3/8 unit [illegible] per pound body weight

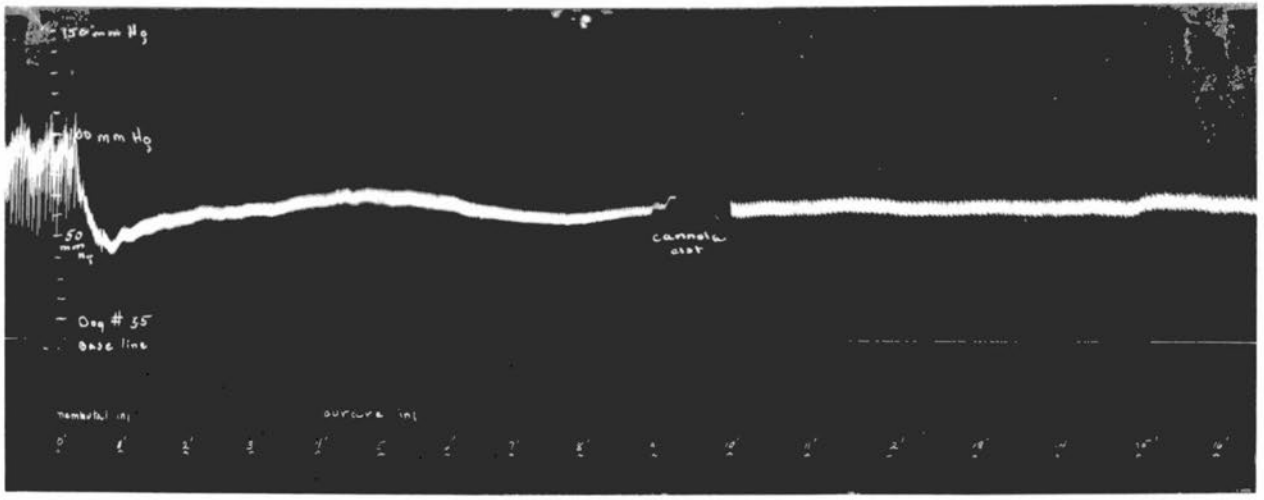


Fig. 24 Kymographic tracing of Dog No. 35 under nembutal surgical anesthesia, following 3/8 unit curare per pound body weight

Following Nembutal Dog No. 32 had a drop within 25 seconds of 35 millimeters, Fig. 22. There was then an almost immediate rise of 18 millimeters. It continued at that level until about 20 seconds after the injection of curare when the pressure dropped in a gentle curve of 30 millimeters. The entire drop in blood pressure took two minutes. There was then a steady increase in blood pressure for four minutes, from which time the blood pressure continued at the same figure as the pre-Nembutal level.

During the injection of Nembutal Dog No. 33 had a very slight fluctuation in blood pressure with an almost immediate recovery, Fig. 23. The blood pressure continued at the same level until 15 seconds after the curare injection, at which time it was raised 15 millimeters. Within two minutes following this rise, the pressure had again returned to the previous level.

During the injection of Nembutal Dog No. 35, Fig. 24, had a decrease in blood pressure of 30 millimeters, followed by a steady increase of 20 millimeters until the injection of curare. During and following the injection of curare there was a fall of 10 millimeters occurring over a period of two minutes at which time the pressure returned to the pre-Nembutal level.

Pentothal Sodium, surgical anesthesia and 3/8 unit curare.--During the injection of Pentothal Sodium

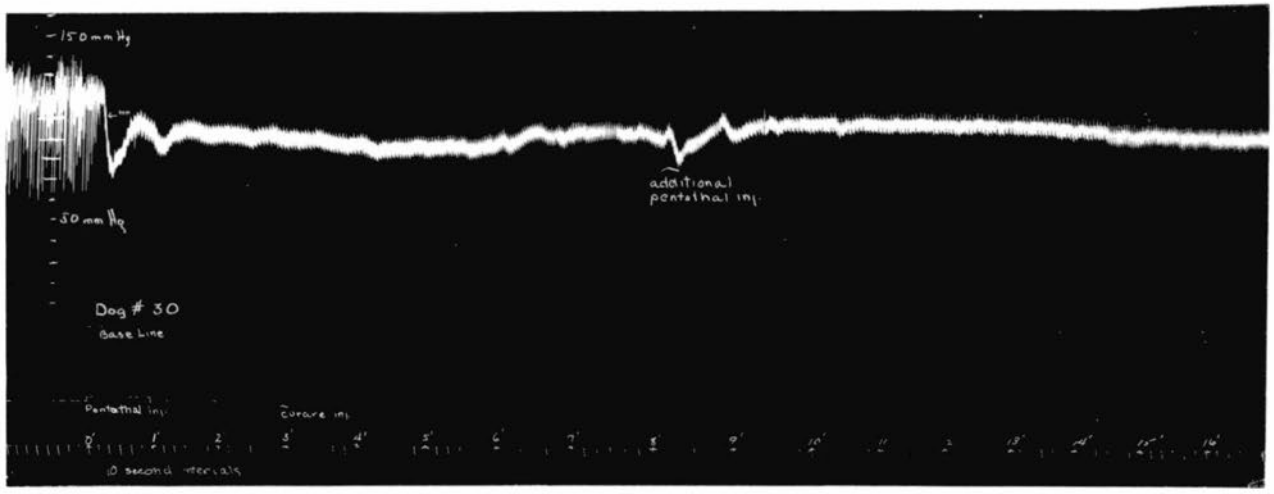


Fig. 25. Kymographic tracing of Dog No. 30 under pentothal surgical anesthesia., following 3/8 unit curare per pound body weight

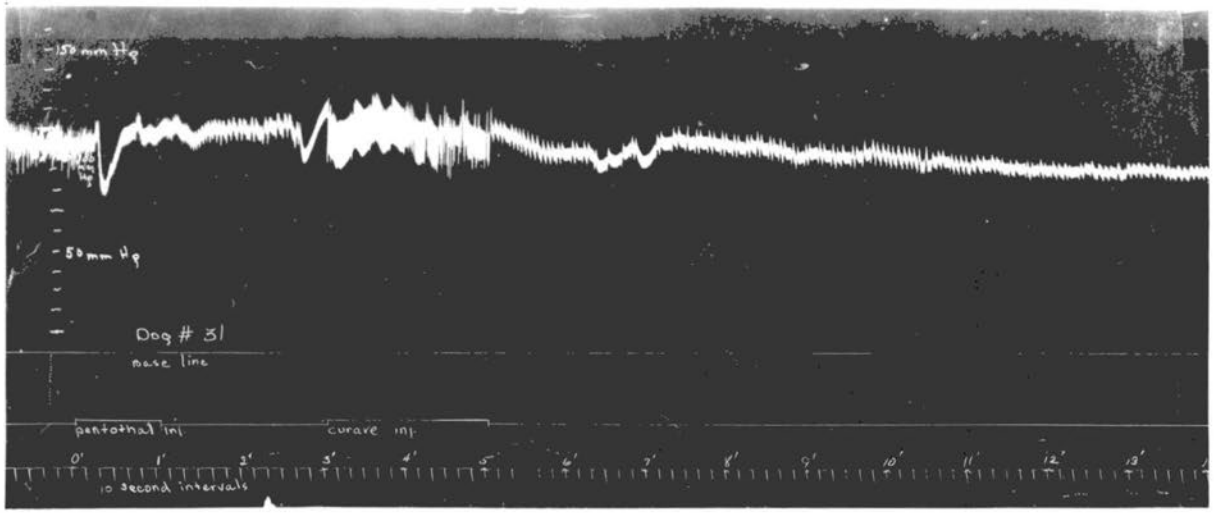


Fig 26 Kymographic tracing of Dog No. 31 under pentothal surgical anesthesia following 9/8 unit curare per pound body weight

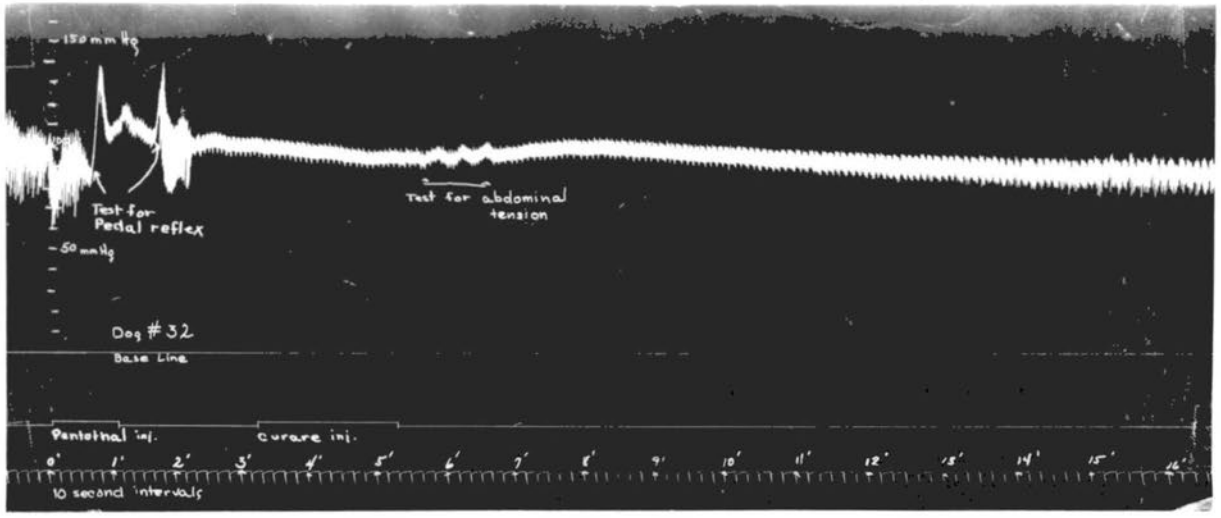


Fig. 27 Hypotensive tracing of Dog No. 32 under pentothal surgical anesthesia following 3/8 unit curare per pound body weight

in Dog No. 30 there was a drop in blood pressure of 30 millimeters of mercury, Fig. 25. This occurred in 10 seconds. There was then a rather sharp rise of 20 millimeters of mercury occurring within 30 seconds. One and one half minutes following the injection of curare there was a rise of eight millimeters. It continued at this level until an additional Pentothal Sodium injection was given. During this injection there was a very short dip of eight millimeters followed within 40 seconds by a rise of 20 millimeters. The blood pressure continued at this level for the duration of the anesthesia.

During the injection of Pentothal Sodium, within a period of 10 seconds, Dog No. 31 showed a sharp drop of 20 millimeters, Fig. 26. There was an almost immediate recovery and an increase of eight millimeters of blood pressure within 30 seconds. This continued through the injection of curare. During that injection there was a greatly increased stroke volume. In the one and one half minutes following the injection of curare a 10 millimeter drop in blood pressure occurred. It then leveled off at the previous level which was maintained for the duration of anesthesia.

During the injection of Pentothal Sodium Dog No. 32 showed a rise of 30 millimeters within a period of 10 seconds, Fig. 27. Within 20 seconds the pressure had dropped 20 millimeters. The blood pressure remained

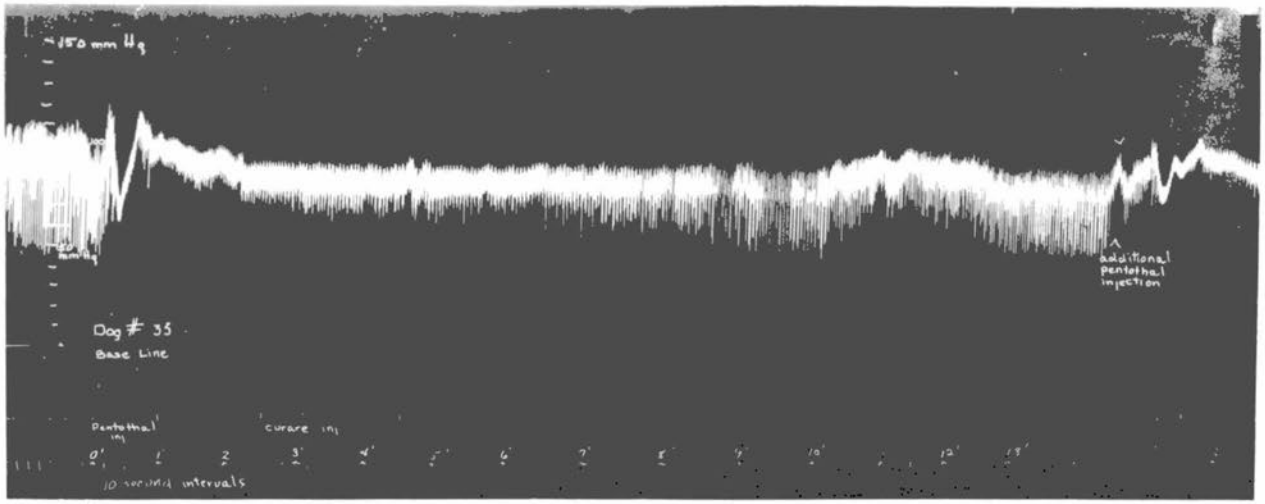


Fig. 28 Kymographic tracing of Dog No. 33 under pentothal surgical anesthesia following 3/8 unit curare per pound body weight

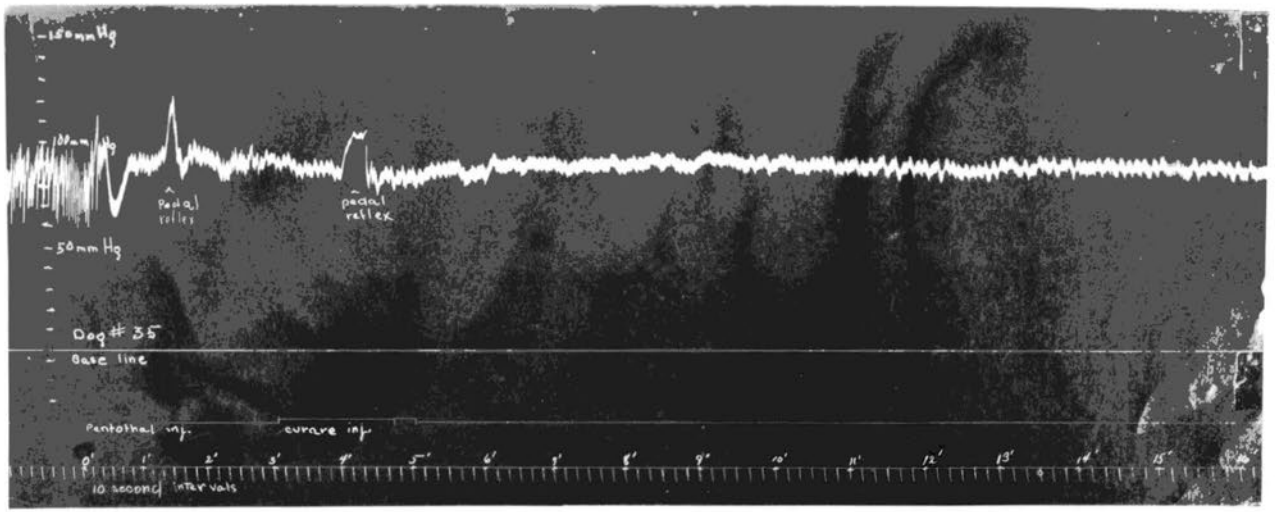


Fig 29 Kymographic tracing of Dog No. 35 under pentothal surgical anesthesia following 3/8 unit curare per pound body weight

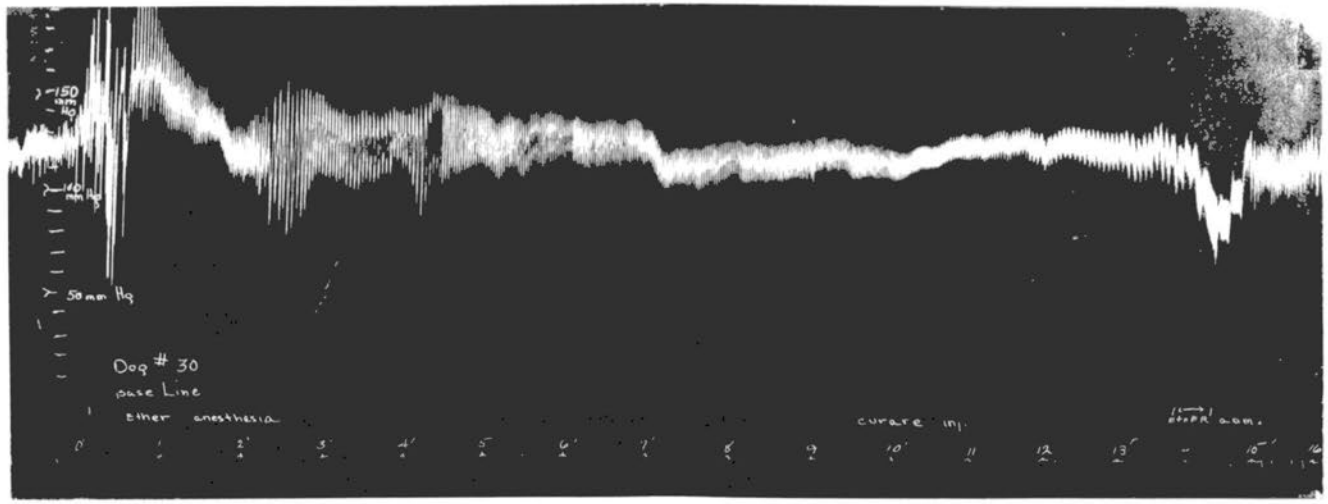


Fig 30 Kymographic tracing of Dog No. 30 under ether surgical anesthesia following 1/8 unit curare per pound body weight

at this level for the duration of anesthesia, unaffected by curare.

During the injection of Pentothal Sodium Dog No. 33, Fig. 28, showed a drop of 15 millimeters of mercury. There was then a sharp rise of 30 millimeters. Within one minute it returned to the pressure level prior to the injection of Pentothal Sodium. The injection of curare caused no fluctuation in blood pressure. The pressure remained at the same level for the duration of anesthesia.

Dog No. 35 showed a 20 millimeter drop, occurring in 10 seconds following the injection of Pentothal Sodium, Fig. 29. Recovery occurred in 20 seconds and the pressure remained at that level during the duration of the anesthesia, undisturbed by the injection of curare.

Ether anesthesia and 3/8 unit curare.--Dog No. 30 following the immediate rise in blood pressure and rapid return to the previous level which occurred during the administration of ether, the blood pressure remained fairly steady, Fig. 30. Following the injection of curare, the ether cone was removed because of the dog's difficulty with respirations. The ether cone was replaced for a period of 15 seconds and there was an immediate sharp drop in blood pressure of 50 millimeters. When the ether cone was removed, the blood pressure again regained the previous level.

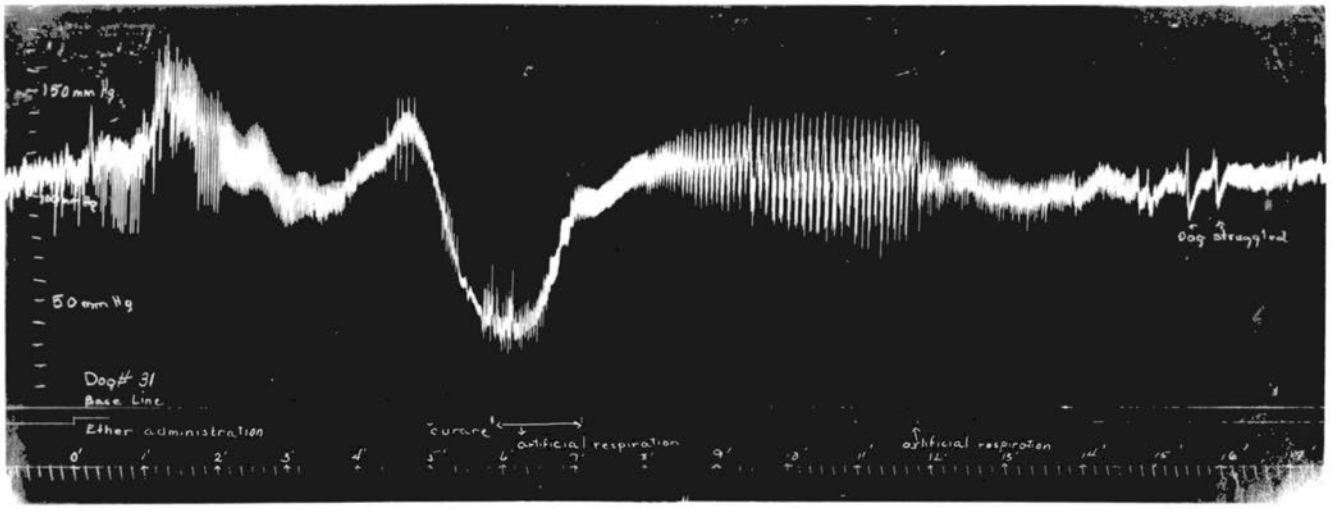


Fig 31 Kymographic tracing of Dog No. 31 under ether surgical anesthesia following ½ unit curare per pound body weight

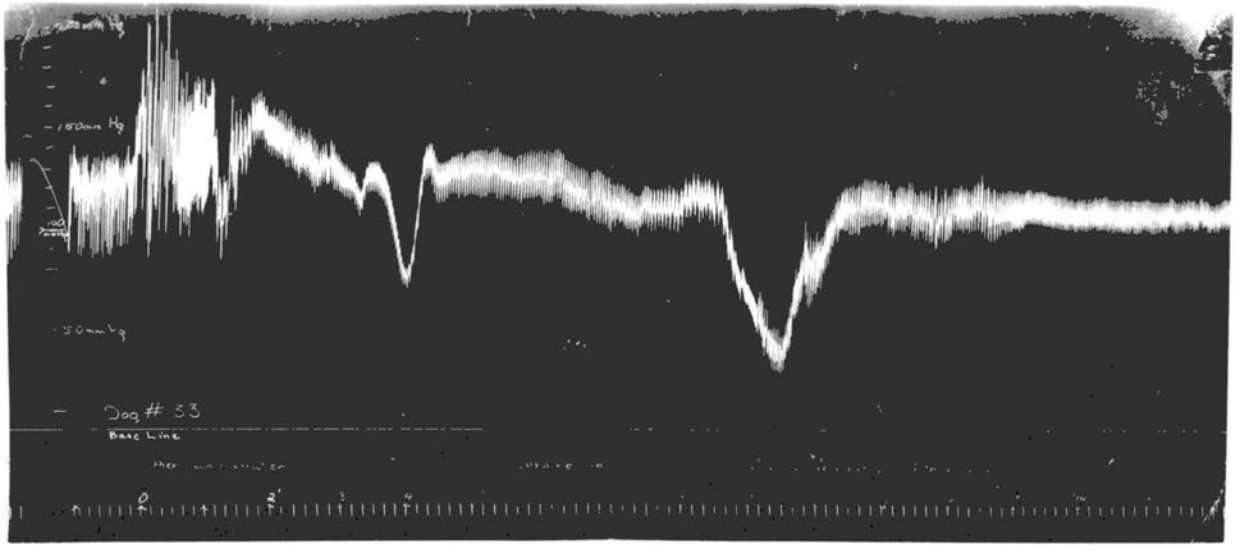


Fig. 32. Kymographic tracing of Dog No. 33 under ether surgical anesthesia following 1/8 unit curare per pound body weight

There was a rise of blood pressure in Dog No. 31 during the administration of ether and then a return to normal, after which a gradual decline to the previous level occurred, Fig. 31. This level was maintained for one minute. The following minute there was a gain in pressure of 40 millimeters. Curare injection was started and during the injection, within a period of 50 seconds, there was a drop in blood pressure of 100 millimeters. Artificial respiration was necessary for one minute, 15 seconds while curare was still being injected. During this period the blood pressure increased 80 millimeters and stayed at approximately that level until the animal came out of the ether. The ether cone was removed when artificial respiration was started.

On Dog No. 32 following the characteristic early rise in blood pressure during ether administration, the blood pressure returned to the level previous to anesthesia and remained there with slight fluctuations until curare was given, Fig. 32. During the injection of curare the pressure started a slow rise from 105 millimeters to 135 millimeters. There was then a sudden and precipitious drop of 85 millimeters of mercury. The ether cone was removed and artificial respiration was given for 25 seconds following which there was a rise of 100 millimeters, within a period of one minute. The blood pressure then fluctuated slightly for the

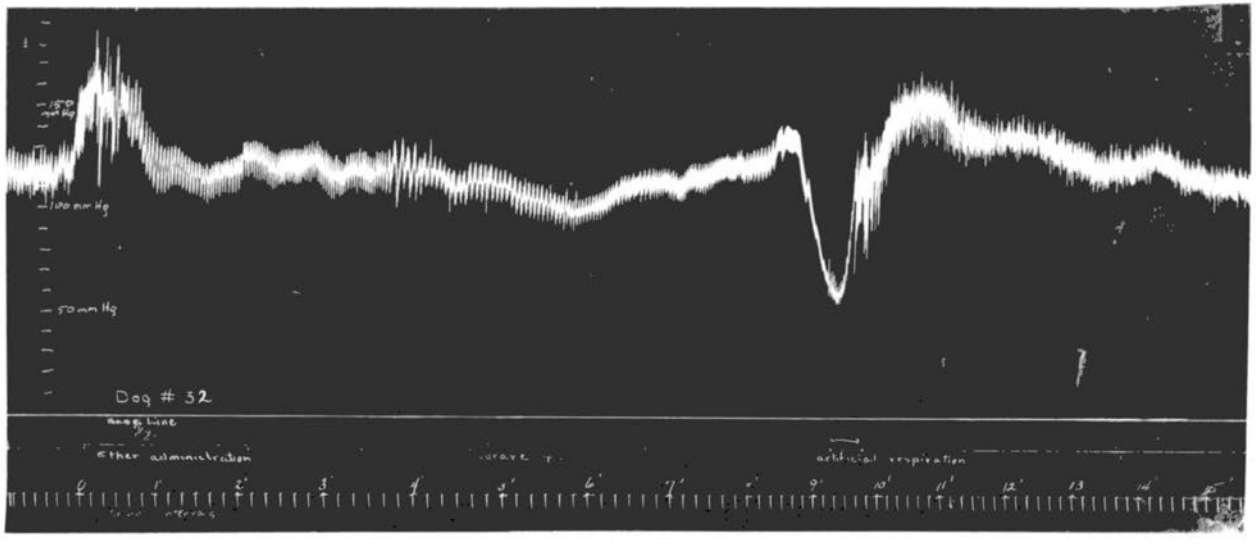


Fig 33 Kymographic tracing of Dog No. 32 under ether surgical anesthesia following 1/8 unit curare per pound body weight

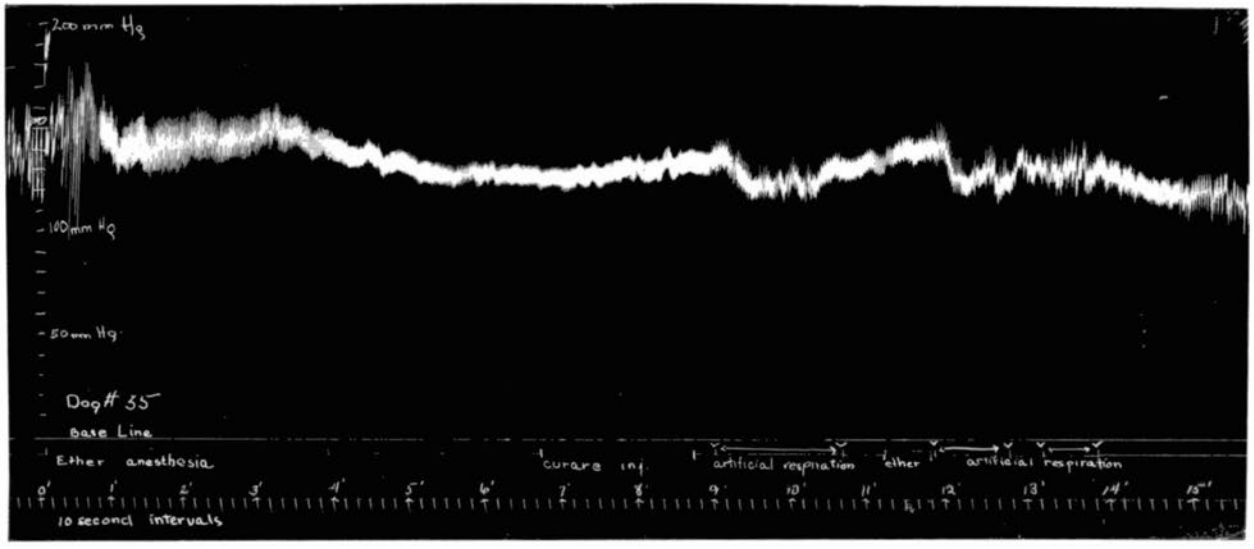


Fig. 34 Kymographic tracing of Dog No. 35 under ether surgical anesthesia following 1/8 unit curare per pound body weight.

duration of the anesthesia.

Following ether administration in Dog No. 33, a drop and recovery of 50 millimeters occurred, Fig. 33. The blood pressure was approximately level during the injection of curare. Fifty seconds after the injection there was a sharp decrease of 70 millimeters in blood pressure. The ether cone was removed. Artificial respiration was given for 50 seconds. Following artificial respiration there was an increase of 70 millimeters in a period of one minute. Blood pressure remained level during the recovery stage.

Dog No. 35 showed little fluctuation in blood pressure at any time, Fig. 34. However, 15 seconds after the injection of curare, artificial respiration was given for a period of one minute, 45 seconds. An attempt at giving ether was again made 30 seconds later. There seemed to be just a little gain in blood pressure, but artificial respiration was necessary for the second and third times.

Chapter V

DISCUSSION

The results concerning the action of curare found in this study were as a whole the same as those found by other investigators. There were, however, some minor differences. The investigation of curare as an adjuvant to general anesthetics obtained both positive and negative results.

The injection of 1/4 unit of curare showed few visible symptoms, but 1/2 unit of curare produced a skeletal muscle paralysis in all of the dogs and respiratory paralysis in one. The respirations of all varied from shallow to diaphragmatic. Since 1/4 unit produced no visible effects and 1/2 unit produced a respiratory paralysis in one dog, it would appear that a safe and effective therapeutic dosage of curare, as far as respiratory paralysis is concerned, would be somewhere between 1/4 and 1/2 units per pound of body weight. The changes in pulse rate with the 1/4 unit dose were not significant. The 1/2 unit dose of curare caused a marked bradycardia in seven dogs, the pulse of one dropping as low as 36 and the others varied between 50 and 60. Bennett (6), in 1940-41 wrote that curare did not affect the circulation

in animals, however, he did say that small amounts of the drug injected rapidly produced cardiac failure in animals while large amounts can be given slowly without any toxic symptoms. He did not mention the amount of time which constituted a rapid injection. Ausherman and Brannen (3), October 1947, wrote that they had found slow administration of curare unnecessary in anesthesia. The animals in the early part of this study received curare at time intervals of from one-half to one minute and a half. Bennett (5), 1941, wrote that McIntyre had given up to 50 times the lethal dose of curare without fatality by keeping up artificial respiration. He did not mention the time taken by McIntyre for the injection of this 50 times lethal dose. According to an article of Cash and Hoekstra (13), 1943, 100 times the so-called lethal dose of curare had been given with no animal deaths occurring as long as artificial respiration was maintained. They did not mention the time taken for this injection. Perlstein and Weinglass (36) found that bradycardia developed only after animals had been curarized for a considerable period of time. During later experiments in this study, two full minutes were taken for the injection of the curare, but since these injections were made following anesthetic, the results cannot be compared with those obtained when curare was given alone. In view of the findings of these other investigators, it is possible that the

the bradycardia caused by the injections of curare alone in this study were possibly caused by curare being administered too rapidly.

The symptoms caused by 3/4 unit of curare were considerably more exaggerated. There was a much more profound paralysis. It is interesting to note that those dogs suffering respiratory paralysis regained the use of their leg muscles before regaining the use of their respiratory muscles. This was evidenced by the fact that they pawed the air in an effort to breathe. This disagreed with the writings of Cole (14), in 1945, who wrote that the first muscles recovering were the diaphragm and the intercostal muscles. The paralysis, however, did seem to occur first in the larger muscles of the head, neck, extremities, the intercostals and diaphragm last. This agreed with the writings of Bennett (5), Cullen (15), Cole (14), but disagreed with Sollmann (41), 1944, who wrote that the abdominal muscles were the last to be paralyzed following those of the appendages.

Bennett (5) and Cullen (15) wrote that sensory nerves were not affected and that there was no analgesic action. Gray, Spradling and Fechner (24), 1941, wrote that there was a selective depressive action on motor nerve endings, but that the action on sensory endings were entirely excluded. In these experiments, when an animal was completely paralyzed, it showed definite

evidence of pain when tested for pedal reflex. It also showed extreme discomfort while unable to breathe, apparently completely alert mentally.

Cullen (15), 1942, wrote that the action of curare was obtained within one minute following its injection. In this study the results were obtained within 30 seconds to two minutes.

Lenahan (33), 1945, wrote that normal function returns when curare disappears from the circulation. According to him the average time for disappearance is 30 minutes. The return to normal range in this study varied from seven to 30 minutes when curare was given alone.

Bennett (5) wrote that reflexes may be somewhat diminished but not abolished. This was found true in this study. All of the dogs receiving 3/4 unit of curare were paralyzed. Thirteen of them retained a pedal reflex at the height of curare action.

McIntyre (34), in 1947, observed frequent salivation, retching, vomiting and sometimes defecation. These reactions were observed in these experiments following the injection of curare into unanesthetized dogs. Micturition was also observed. McIntyre attributed these phenomena to be of almost certain central origin.

In this study it was found that both slight decreases and increases in temperature occurred following

the injection of curare. There were more decreases in temperature than increases. Reichert (39), in 1891, ran an extensive series of experiments concerning the changes in body temperature in dogs. He ascribed the increases of temperature to an increase of heat production and the fall to an increase of heat dissipation. Sollman (41), 1944, wrote that curare produced a peripheral vasomotor depression. It is possible that the dissipation was due to this peripheral vasomotor depression relaxing vessels and allowing escape of heat. The increase of temperature may have been caused by excitement or alarm. The dogs paralyzed with curare were most certainly excited and alarmed.

Cummins (18), in 1942, wrote that prostigmine is a spectacular and perfect drug to be used as an antidote for curare. One dog in this series of experiments died at 13 minutes regardless of the fact that he had been given one cubic centimeter of 1-2000 prostigmine at two minutes and another at five minutes. After the second injection this dog apparently made a recovery. He arose to his feet at seven minutes and walked. Thinking that he was safely over the effects of curare, little attention was paid him until he was noticed huddled on the floor gasping for breath. Artificial respiration was again initiated but he died before another dose of prostigmine could be given. Autopsy reports revealed

nothing abnormal except a slight congestion of the lungs. The death of this dog suggests the advisability of a study being made concerning the amount of prostigmine necessary as an antidote for a curarized dog. It also suggests that one should not place too great a confidence in a dog's apparent return to normal following the use of prostigmine.

Nembutal, 3/4 grain, light plane anesthesia.-- It is evident from this series of studies that the action of Nembutal enhances the effects of curare and that the reverse is also true. One fourth unit per pound of body weight given alone showed little effect, but 1/4 unit of curare used simultaneously with a light plane Nembutal anesthesia produced a rather remarkable effect. The animals which were hung at a 45 degree angle had a 3+ abdominal tension and were struggling and crying. Within a few seconds following the injection of 1/4 unit of curare the struggling and crying ceased. The animals hung there more completely relaxed than they would have been had they been given a full surgical dose of Nembutal. Sixteen of these dogs, however, did show some degree of pedal reflex. The time of induction varied from 12 seconds to one and a half minutes. The duration of action varied from six minutes to 25 minutes. The abdominal relaxation following curare varied from 1- to 3-. This relaxation was not as good as that obtained

with the 3/8 unit injection of curare, but it was as a whole superior to that obtained from the usual surgical dose of Nembutal. Micturition, defecation, salivation, and muscular tremors were negative and there were no other reactions. The chief disadvantage of the 1/4 unit injection was the relatively short duration of the maximum relaxation in some of the dogs.

When 3/8 unit injection of curare was made during Nembutal light plane anesthesia, the time of induction varied from 10 seconds to one minute and a half. The duration of action varied from nine to 30 minutes. Crying and struggling ceased almost immediately and there was a far more perfect relaxation than is ordinarily seen following Nembutal surgical anesthesia. Slight pedal reflex occurred in 12 dogs, but the abdominal and skeletal relaxation was so complete that it would seem that any surgery could be undertaken with great convenience to the surgeon. There were no objectionable symptoms except a loss of temperature varying from 0.8 to four degrees. However, it is well known that Nembutal alone will cause that amount of reduction in temperature. Since the dogs receiving curare alone showed both rising and lowering of temperature it seems reasonable to assume that curare may have contributed in a very minor degree to the lowering of temperature in some dogs, but it is possible too that curare may have contributed somewhat

to the prevention of temperature lowering in some dogs. This assumption is further justified by the fact that one dog had a rise in temperature of 0.2 degrees.

The various changes in the rate of the pulse and respirations were well within those normally seen under Nembutal anesthesia.

Following the injection of 1/2 unit of curare the symptoms were approximately the same as those following the 3/8 unit. The time of induction varies from 15 seconds to one minute. The duration of action varied from 12 minutes to 35 minutes. The 1/2 unit, however, produced some undesirable symptoms, two dogs developing a bradycardia and one dog developing a tachycardia of over 200. Although it was not necessary to give artificial respiration to any of the dogs, two of them developed a cyanosis. The results of these experiments indicate that 1/2 unit of curare used with Nembutal may be dangerous.

During this series of experiments with light plane Nembutal anesthesia there was an almost immediate relaxation of the abdominal muscles. With the 1/4 and 3/8 unit injections there was no apparent respiratory depression or untoward effect on the heart. Since the 1/2 unit caused some undesirable symptoms and the injection of 1/4 unit, although having no apparent undesirable symptoms, did not in all cases give a complete

relaxation nor did the relaxation last as long, it seems that the 3/8 unit per pound of body weight would be the therapeutic dose of choice for light plane Nembutal anesthesia.

Dogs suffering severe shock caused by injuries, disease or prolonged labor during parturition, have frequently been known to become anesthetized by a fourth of the usual dose of Nembutal. However, relaxation is usually far from complete in these dogs. The results of these studies seem to imply that 3/8 unit of curare may be indicated in those cases. Cullen (16), in 1945, wrote that he used curare cautiously in the presence of shock but that it was probably advantageous, because it is possible to carry the patient in light anesthesia and prevent adding to the shock by increasing the depth of the anesthesia. The Squibb Memoranda (37), September 1947, wrote that poor risk patients are able to take prolonged surgery which, without the supplemental use of curare, would be considered impractical and contraindicated.

Nembutal, 1 grain, surgical anesthesia.--None of the dogs receiving one grain of Nembutal per five pounds had complete abdominal relaxation. There was slight struggling and crying by some of the dogs while hung at a 45 degree angle. The susceptibility of dogs to Nembutal varies. An experienced veterinary

anesthetist will give Nembutal to desired effect. Animals which have been debilitated by any condition such as shock, disease, age, etc., require less Nembutal than normal animals. Healthy, strong animals sometimes require more Nembutal than the one grain to produce surgical anesthesia. Because one grain per five pounds of body weight is the generally advised dose for surgical anesthesia, that was the amount used in this series of experiments.

One-fourth unit of curare produced a very satisfactory relaxation in most cases of surgical Nembutal anesthesia. However, in three cases the abdominal relaxation did not exceed 2-. The duration of action varied from 10 to 38 minutes. The degree of relaxation was superior to that obtained in most veterinary surgery. There were no untoward symptoms.

Time of full induction after 3/8 unit of curare varied from seven to 45 seconds. Three-eighth unit of curare produced a 3- relaxation which varied in duration from 14 to 60 minutes. It would seem that the degree of relaxation achieved would be of great advantage in various types of surgery. The variations in pulse and respirations were within the normal range found during surgical Nembutal anesthesia.

The time of induction after 1/2 unit of curare varied from 10 to 25 seconds. Duration of action varied

from 12 to 49 minutes. The abdominal relaxation was excellent but 1/2 unit injection of curare following surgical anesthesia produced some danger symptoms. One dog had a bradycardia of 44, another dog for six minutes had a pulse too weak to be recorded. It was necessary to administer artificial respiration to two dogs and administer prostigmine to both. Six of the other dogs developed shallow respirations and death occurred in one dog at three minutes, 25 seconds from what was apparently a cardiovascular collapse, because the respirations ceased at the same time the heart ceased.

That death seemed to bear out the statement of McIntyre (34), 1947, that the classical concept of curare causing death from respiratory failure because of peripheral muscular paralysis was far from adequate. McIntyre said that artificial respiration alone may completely fail to resuscitate. He believed that cardiovascular collapse could occur.

This series of experiments with Nembutal seem to indicate the feasibility of using curare as an adjuvant to Nembutal anesthesia. The 1/4 unit dose appears to be inadequate in some cases. The 1/2 unit dose is apparently too dangerous for general use without further study. The 3/8 unit injection seemed to produce the desired results with none of the objectionable symptoms. Looking at it from that standpoint, it would seem that

the difference of 1/8 unit would be an extremely narrow margin of safety. It must be remembered that it is the 1/8 unit per pound and not 1/8 unit per dog. For example, in a 20 pound dog there would be a safety margin of 2 1/2 units. Pedal reflexes were absent in all dogs under surgical anesthesia following the injection of curare.

Pentothal Sodium, light plane anesthesia.-- Animals injected with Pentothal Sodium to produce light plane anesthesia were injected to effect. They were unconscious following administration but retained reflex movements such as crying and struggling when hung at a 45 degree angle.

When the desired stage of anesthesia was produced, the syringe was removed from the needle and the curare was injected from another syringe. The syringe of Pentothal Sodium was then refitted to the needle. Because Pentothal Sodium is rapidly eliminated from the body, it was necessary to occasionally inject small additional quantities of Pentothal Sodium to maintain the desired plane of anesthesia.

When 1/4 unit of curare was injected the relaxation achieved was fair, varying from 1- to 3-. However, the duration of action was short, varying from six to 15 minutes. It is difficult to say, with the series of experiments of Pentothal Sodium, whether it was the Pentothal or the curare which was eliminated first.

However, an effort was made to keep the plane of anesthesia even until the effects of the curare were eliminated. No objectionable symptoms were detected except some loss in temperature which will occur with Pentothal Sodium alone. Dog No. 21 developed a tachycardia of 200.

Three-eighth unit of curare produced a good degree of relaxation varying from 2- to 3- and lasting from nine minutes to 20 minutes.

Following the 1/2 unit injection of curare the duration of action varied from nine to 20 minutes. The time of induction varied from 17 seconds to one minute. Abdominal relaxation was 3- om all dogs. Dog No. 14 died at two and a half minutes following the 1/2 unit of curare. The heart and respirations ceased at the same time. The death of this dog also bears out McIntyre's (34) statement that it is possible for death to occur from a cardiovascular collapse.

The experiments with light plane Pentothal anesthesia gave somewhat similar reactions to those of curare with Nembutal. In general curare seemed to have a shorter degree of action. This shorter degree of action in Pentothal seems to indicate a difference in the degree of the mutual enhancing action of Nembutal and curare and Pentothal Sodium and curare.

Pentothal Sodium, surgical anesthesia.--Pentothal Sodium, surgical anesthesia, was given to

effect. Surgical anesthesia was taken to be that stage of anesthesia in which there was a slight palpebral reflex but no pedal reflex. Repeated injections of Pentothal were occasionally necessary to hold the animal under surgical anesthesia until the effects of curare were eliminated.

The symptoms of 1/4, 3/8, and 1/2 unit were similar to those under light plane anesthesia. Even the degree of relaxation and time of action were similar to those under light plane anesthesia. Because of the maximum efficiency and lack of undesirable symptoms, 3/8 unit of curare would seem to be the best therapeutic dose with light plane and surgical Pentothal Sodium anesthesia as well as light plane and surgical Nembutal anesthesia.

Stewart (42), 1942, stated that when a patient was going under curare he complained of a tightness of the throat and huskiness of the voice. This husky note was noticed in all dogs under light plane Nembutal and Pentothal Sodium while going under the effects of curare. The high-pitched cry invariably changed to a hoarse low note.

Because of the slight precipitate formed when Nembutal and curare and when Pentothal Sodium and curare are mixed, neither anesthetic was combined with curare prior to intravenous injection.

Indications for curare as an adjuvant to general anesthesia of the dog.--It was noted that all doses of curare alone, except the 1/4 unit dose, and all doses of curare with Nembutal or Pentothal Sodium produced a very marked relaxation of the anal sphincter. It would seem that the anal relaxation obtained with curare would be of definite advantage in any operation involving the anus or the rectum. Griffith and Johnson (26), July 1942, wrote that curare produced a very satisfactory anal relaxation for hemorrhoidectomy.

Griffith and Johnson (26), July 1942, wrote that they had found curare useful in achieving relaxation in healthy young adults. Ausherman and Branned (3), October 1947, wrote that they used curare in both upper and lower abdominal surgery, particularly in the husky, muscular type of individual. It is also true in veterinary medicine that the young and vigorous animal requires more anesthetic to obtain the desired degree of relaxation. It is that type of animal which is most apt to come from under Nembutal anesthesia before the surgery is completed. When an animal begins to breath convulsively causing the viscera to protrude through the incision, it would seem, from the facts gathered in this study, that an injection of the proper dosage of curare would eliminate these disagreeable symptoms without necessitating additional anesthetic.

Cole (14), January 1945, wrote that he had used curare on patients with a wide range of age. The age varied from three to 91 years. Curare produced no undesirable effects. It seems possible that curare would be indicated in surgery of old animals or in any other poor risk patients. The light plane of anesthesia allowed by curare should certainly produce less morbid results.

McIntyre (34), 1947, advised the use of curare as an aid in the reduction of fractures and dislocations. According to him, the number of such cases treated with curare was small but the results had been uniformly good. The marked skeletal relaxation obtained indicates that curare would be an excellent adjuvant to general anesthesia when repairing fractures and dislocations in animals.

Whitacre and Fisher (50), December 1944, wrote that the use of curare had decreased the amount of anesthesia ordinarily required for Cesarean sections, thus decreasing the incidence of severe respiratory depression of the baby. Nembutal anesthesia, except in emergencies, is ordinarily considered contraindicated for Cesarean surgery in animals. However, Pentothal Sodium is frequently used, particularly in English Bulldogs because of their short compressed nasal canal making ether difficult to administer. There is sometimes a very slight degree of narcosis in the puppies. It seems that

the use of curare allowing a light plane anesthesia would reduce the degree of narcosis in the puppies.

It also seems possible that the rapidly eliminated Pentothal Sodium used in light plane combined with curare could make an excellent anesthetic for a bitch that has lost her vitality and strength from overlong parturient labor.

Diaphragmatic hernia is an operation, which it seems would particularly lend itself to the use of Nembutal and curare. In that operation extreme relaxation of not only the abdominal muscles but the respiratory muscles as well is needed. An animal entirely quiet, except for the fluctuations of the lungs, would greatly facilitate that or any other chest surgery. A paralysis of the respiratory muscles in that operation would be of no moment, because the animal must be intubated and administered artificial respiration. However, further study is necessary to determine the amount of curare which would produce the desired effects with safety. According to the work of Perlstein and Weinglass (36), 1944, and McIntyre (34), 1947, the margin of safety is extremely wide when artificial respiration is given in such a manner.

Ether anesthesia with curare.--Ether in light plane anesthesia and surgical anesthesia, followed by either 1/8 or 1/4 unit of curare produced marked effects

on both respirations and pulse. Respirations rapidly became labored and shallow. In most dogs respirations ceased almost immediately. The pulse became weak and thready. In all dogs it was necessary to remove the ether mask immediately following the injection of curare. Dog No. 21 died at two minutes, 30 seconds, following the administration of prostigmine at two minutes. Dog No. 21 had exhibited a tachycardia in practically every experiment through the series. Tachycardia was frequently caused by the anethetic before curare was administered. However, curare did seem to increase the pulse further. Dog No. 19 also died. Although prostigmine was beneficial in a large number of dogs, it is a notable fact that these dogs died following its use, indicating more conclusively that it is not entirely reliable in one cubic centimeter doses of 1-2000 solution.

Until further studies are made it would seem that curare is definitely contraindicated following the use of ether. These findings correspond with those of Whitacre and Fisher (49), 1945, who wrote that large doses of curare in light plane ether anesthesia may precipitate severe circulatory depression and that in the presence of deep ether anesthesia even small doses of curare may cause severe circulatory reactions. Ausherman and Brannen (3), October 1947, wrote that if ether in any amount had been introduced into the system before

curare had been given, it is best to reduce the estimated dose of curare.

Effects of curare on blood pressure.--All of the effects of curare on blood pressure found in the Review of Literature concerned the injection without a simultaneous use of an anesthetic. In this study no experiments were done on the effect of curare alone on blood pressure. Since 3/8 unit of curare was taken to be the nearest to an ideal therapeutic dose, that amount was used with surgical anesthesia, produced by Nembutal and Pentothal Sodium. One-eighth unit was used in determining the effects of ether and curare on blood pressure.

Nembutal and Pentothal Sodium produced short but rather marked effects on the blood pressure. Curare showed no change at all following Pentothal Sodium and only a very short dip in blood pressure occurred in two dogs following the use of Nembutal.

Blood pressure in ether anesthesia following curare showed very marked fluctuations. However, the sharp dips in blood pressure were followed by a rise when artificial respiration was applied. This is a possible indication that the blood pressure could be maintained if the animal were intubated and administered constant artificial respiration while being given ether.

Suggested problems for further study.--

1. Effects of curare on devitalized animals.

2. Differences in effects on the cardiovascular system of rapid and slow injections of curare.

3. Use of curare in fractures.

4. Benefits of curare in specific surgery.

5. Effects of curare on the abdominal viscera with particular attention to its action in such surgery as intestinal anastomosis.

6. The use of curare in treatment of chorea.

7. The use of curare in controlling convulsions which occur in distemper.

8. Effects of curare on the pregnant female.

9. The use of further smaller doses of curare for prolonging the effects of the initial dose in anesthesia.

10. The use of slow absorbing curare such as the curare in oil manufactured by Abbott and Company.

11. Investigation to determine the dose of prostigmine to serve as an antidote for curare in the dog.

12. Amounts of curare which may be safely given to an intubated animal in order to quieten the respiratory muscles.

13. Histological changes in nervous system induced by curare.

Chapter VI

SUMMARY

In this study of curare as an adjuvant to general anesthesia in the dog, dogs of various ages and sizes were used. The effects of curare administered without anesthesia were investigated. In these experiments 1/4 unit seemed to produce very little effect, and 1/2 unit seemed to produce certain danger symptoms. For that reason, while investigating the effects of curare used in conjunction with light plane and surgical anesthesia, it was decided to use as a first dose 1/4 unit of curare and increase the quantity in each series of experiments by 1/8 unit until a dangerous margin was found. An apparently dangerous margin was found to be 1/2 unit of curare per pound of body weight when used in conjunction with both light plane and surgical anesthesia with both Nembutal and Pentothal Sodium.

Since, in ether anesthesia, 1/4 unit of curare per pound of body weight proved dangerous, the dose was reduced to 1/8 unit which also proved dangerous. Since 1/8 unit was dangerous and did not produce a desirable degree of relaxation, no further studies were made concerning curare with ether.

In the limited series of experiments made in this study, 3/8 unit of curare was found to have little effect on the blood pressure during surgical anesthesia produced by Nembutal or Pentothal Sodium. During ether anesthesia, 1/8 unit of curare dropped the blood pressure to dangerous levels.

In determining the effects of curare administered alone and used in conjunction with light and surgical plane anesthesia, 19 experiments were performed on each of 20 dogs. The results obtained from these experiments seemed to indicate very little use for curare without anesthesia. One-fourth unit of curare per pound of body weight may be of some benefit when used with either Nembutal or Pentothal Sodium in light plane or surgical anesthesia. Three-eights unit of curare per pound of body weight was indicated by this series of studies as being the most advantageous therapeutic dose with Nembutal or Pentothal Sodium in light plane or surgical anesthesia.

This limited series of studies seems to indicate a possibility that curare may find a wide and useful field in veterinary surgery.

A P P E N D I X

APPENDIX TABLE OF CONTENTS

APPENDIX TABLE OF CONTENTS--Continued

Dog No. 8	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to norm	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour "	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 5, 1948	1/4									136		138	128	123	118	122	122	124	126	112	36		38	46	48	38	48	28	30	26	34		3+	3+	3+	3+	3+																102^{3}	102^{4}	102^{3}
" 7 "	1/2				1'30"	2'	6'	8'	11'	120		140	96	80	76	78	87	96	104	132	20		40	62	44	44	36	32	26	24	32		3-	3-	2+	3+	3+												+		1+		102^{3}	102^{3}	102^{3}
" 9 "	3/4				25"	1'30"	12'	14'	25'	116		146	88	68	64	70	88	94	100	124	32		48	54	0	32	26	28	24	24	48		3-	3-	3-	3-	1+	1+	3+	3+	3'5+	8'	11'		14'30"				+		3+	6'	103	103	103^{3}
" 19 "	1/4	N	3/4	L		15"	10'		12'	108	112	156	124	156	124	112	112	112	124	124	24	20	24	24	20	12	12	12	12	14	12	3+	2-	2-	2-	2+	3+	3+															101^{2}	100	99
" 21 "	3/8	N	3/4	L		15"	12'		15'	116	120	124	100	96	104	100	92	100		92	16	48	32	20	12	20	12	14	14		14	3+	3-	3-	3-	2-	3+	3+	3+														102	101	100
" 24 "	1/2	N	3/4	L		30"	20'		25'	120	112	100	120	100	108	116	116	118	120	120	18	16	20	16	16	12	14	12	11	14	14	3+	3-	3-	3-	3-	3-	2-	3+	3+													102	101	101
" 26 "	1/4	N	1	S		25"	19'		22'	80	106	100	124	120	110	100	90	80	84	112	20	16	28	24	24	26	20	18	18	18	14	1-	3-	3-	3-	3-	3-	3-	2+	2+													101^{8}	101^{3}	101
" 28 "	3/8	N	1	S		25"	14'		18'	120	100	130	120	112	108	104	100	92	92	112	12	20	14	14	12	14	14	12	12	14	16	1+	3-	3-	3-	3-	1-	2+	2+	3+													100^{2}	100	98^{3}
March 2 "	1/2	N	1	S		13"	35'		40'	144	144	134	124	116	108	108	112	112	112	144	24	28	36	16	12	12	10	10	14	12	28	1+	3-	3-	3-	3-	3-	3-	3-	3-													101^{4}	100^{6}	97
" 6	1/4	PS		L		20"	9'		11'	132	140	136	136	136	120	108	132			136	20	24	16	12	12	12	12	14			16	3+	2-	2-	2-	2+	3+	3+															101^{6}	100	100
" 9	3/8	PS		L		35"	15"		18'	116	136	168	144	132	126	120	125	132		120	40	36	28	28	20	18	16	18	18		24	3+	3-	3-	3-	3-	2-	3+	3+														102^{4}	102^{6}	103^{4}
" 12	1/2	PS		L		24"	15'		20'	120	132	120	108	96	88	84	86	90		106	20	36	32	20	20	14	12	14	16		22	3+	3-	3-	3-	3-	3-	3+	3+														101	101	101^{6}
" 16	1/4	PS		S		27"	9'		12'	84	120	140	160	132	116	108	116	120		120	18	24	22	20	20	16	14	12	16		16	1-	3-	3-	1-	2+	3+	3+	3+														101^{8}	101^{6}	101^{6}
April 8	3/8	PS		S		25"	18'		20'	96	140	180	152	138	132	132	136	134	132	132	24	18	24	24	19	14	18	16	20	20	30	1+	2-	3-	3-	3-	3-	2-	3+	3+													102^{2}	102^{4}	104^{4}
" 10	1/2	PS		S		35"	15'		20'	108	148	110	144	120	110	112	116	116		156	24	20	36	24	18	14	16	20	20		30	1+	3-	3-	3-	2-	2-	3+	3+														102^{4}	102^{7}	102^{4}
" 16	1/4	E		L		58"	4'		6'	132	100	72	110	116	126	126				112	20	36	0	24	30	28	32				24	3+	3-	3+	3+	3+	3+				2'3+	2'50"	3'25"		5'						3+		101^{4}	101^{2}	102
" 17	1/4	E		S		1'45"	4'		6'	140	98	112	116	112	116					124	20	36	40	38	34	34					6	2+	3-	2+	3+	3+					2'2+										3+		101^{4}	101^{4}	101
" 20	1/8	E		L		45"	5'		7'	100	100	96	140	165	152	146				96	36	36	20	20	32	32	26				44	3+	1-	1-	3+	3+	3+				2'3+								+	+	3+		101^{6}	101^{6}	102
" 22	1/8	E		S		1'10"	6'		8'	160	168	144	120	120	124					132	48	30	26	20	19	20					32	1+	2-	1-	3+	3+					3'1+										3+		101^{4}	101^{2}	101^{2}

Dog No. 5																																																							
Feb. 7, 1948	1/2				30"	1'	9'	10'	11'	120		102	82	62	64	86	90	92	88	120	24		36	34	56	54	40	26	26	22	42		3-	3-	3-	3+	3+												+	+			102^{6}	102^{8}	102^{4}
" 5	1/4									84		128	122	126	110	114	118	120	122	128	30		28	36	34	36	24	26	26	26	30		3+	3+	3+	3+	3+																101^{8}	101^{6}	102
" 9	3/4				15"	26"	7'	8'	9'	108		112	82	76	86	92	100			120	26		0	42	36	32	26	28			26		3-	3-	3+	3+	3+	3+			2'3+	2'45"	3'30"		5'				+	+	3+	7'	102^{6}	102^{4}	102^{8}
" 14	1/4	N	3/4	L		40"	50'		60'	106	126	120	128	112	128	98	96	94	92	110	20	44	24	24	20	22	20	18	18	22	48	3+	3-	3-	3-	3-	3-	3-	3-	3-													101^{6}	100	98
" 21	3/8	N	3/4	L		70"	25'		30'	120	148	100	84	72	68	72	72	76	76	86	44	40	16	12	12	16	16	14	16	16	16	3+	3-	3-	3-	3-	3-	3-	3-	3-													102^{3}	99	99
" 24	1/2	N	3/4	L		45"	20'		30'	108	120	140	140	112	84	100	96	96	96	100	20	40	20	20	16	16	14	15	16	16	20	3+	3-	3-	3-	3-	3-	2-	3+	3+													102^{5}	100^{6}	100
" 27	1/4	N	1	S		23"	20'		25'	100	88	100	88	84	80	78	78	82	90	82	40	20	16	12	20	16	20	20	20	22	20	1+	3-	3-	3-	3-	3-	1-	3+	3+													103^{4}	99	99^{8}
" 28	3/8	N	1	S		25"	25'		30'	80	110	112	112	120	120	120	118	124	126	112	40	22	20	16	16	16	18	12	16	20	32	1+	3-	3-	3-	3-	3-	3-	3+	3+													102^{4}	98^{8}	97
March 5	1/2	N	1	S		17"	15'		26'	98	114	118	96	84	90	94	100			114	20	30	20	20	16	16	18	20			30	3+	3-	3-	3-	3-	3-	3+															101^{8}	102	105^{4}
" 9	1/4	PS		L		7"	9'		11'	120	118	110	98	84	88	94				120	20	34	24	24	18	18	20				30	3+	1-	1-	1-	3+	3+																102^{4}	102	101
" 12	3/8	PS		L		30"	15"		18'	102	126	144	128	120	120	124	132			86	26	36	20	20	20	20	24	24			36	3+	3-	3-	3-	3-	3-	3+															101	100^{8}	101
" 16	1/2	PS		L		35"	15'		20'	104	110	80	68	64	70	78	82	100		104	35	16	20	32	42	38	34	24	26		16	3+	3-	3-	3-	3-	3-	3+	3+		4'3+												102^{4}	102^{4}	101^{4}
April 8	1/4	PS		S		55"	10'		12'	128	132	128	112	112	120	104	104			128	40	28	24	24	24	25	24	24			24	3+	3-	3-	3-	3+	3+	3+															102^{6}	102^{4}	101^{4}
" 10	3/8	PS		S		37"	12'		15'	112	120	160	152	144	136	124	124	120		146	28	28	32	36	34	32	24	24	28		28	2+	3-	3-	3-	3-	2+	3+	3+														102	102	101^{4}
" 15	1/2	PS		S		50"	15'		26'	80	156	138	150	138	120	108	102	112		130	30	32	30	24	24	30	30	26	26		24	1+	3-	3-	3-	3-	2-	2+	3+														102	101^{2}	102
" 17	1/4	E		L		45"	4'		8'	112	120	90	80	88	96	100				180	24	32	12	0	16	20	22				24	3+	3-	1+	3+	3+	3+				5'2+	3'10"	4'30"	6'35"	5'30"						3+		101^{6}	100^{6}	101
" 20	1/4	E		S		1'15"	6'		8'	140	152	160	72	112	108	114				130	24	20	0	0	44	54	30				28	1+	1-	1-	3+	3+	3+				4'2+	1'55"	5'5"		6'45"						3+		101^{6}	100^{4}	101
" 22	1/8	E		L		50"	4'		7'	132	140	180	138	144	132	126				142	40	40	40	0	44	30	32				36	3+	3-	1+	3+	3+	3+				2'2+	5'40"			6'50"						3+		101^{6}	102^{4}	102^{4}
" 23	1/8	E		S		1'	1'		3'	126	118	120	140	136	120					136	24	22	28	30	32	26					30	1+	2+	3+	3+	3+					2'4+	1'35"			2'25"						3+		102	101^{4}	102

Dog No. 4	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	" 6 " "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiration start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 5, 1948	1/4									100		126	120	114	116	112	118	114	110	120	24		24	22	24	26	22	24	22	22	24		3+	3+	3+	3+	3+																	104	103^{8}	103
" 7	1/2				1'45"	2'30"	11'	14'	16'	88		136	98	80	76	80	86	90	97	124	20		30	55	52	48	37	33	28	26	24		3-	3-	3-	2+	3+	3+			4'1+									+	1+	8'	103	103	103
" 9	3/4				1'30"	2'	12'	14'	16'	88		104	116	88	80	82	89	94	102	108	24		36	58	64	62	46	34	36	36	32		3-	3-	3-	3-	3+	3+			5'1+								+		1+		103^{4}	102^{8}	103^{4}
" 14	1/4	N	3/4	L		45"	9'		15'	100	144	136	104	112	88	100	128			158	16	32	24	28	28	22	18	16			12	3+	2-	2-	2-	1+	3+	3+															103^{4}	100	97^{8}
" 21	3/8	N	3/4	L		20"	28'		25'	88	156	144	136	116	108	108	120	120	112	120	28	28	20	20	20	28	24	28	24	24	22	3+	3-	3-	3-	3-	3-	3-	2+	3+													103^{2}	99	99^{4}
" 24	1/2	N	3/4	L		30"	28'		24'	88	140	160	136	148	128	120	108	116	108	120	12	10	12	12	12	12	14	12	12	12	24	3+	3-	3-	3-	3-	3-	3-	3+	3+													101^{8}	100	97^{6}
March 3	1/4	N	1	S		10"	38'		42'	164	188	184	176	146	144	156	152	138	144	150	16	20	16	16	16	16	15	12	14	16	16	1+	3-	3-	3-	3-	3-	3-	3-	3-													102^{4}	100	99^{4}
" 4	3/8	N	1	S		20"	35'		40'	84	162	156	148	148	144	144	124	116	116	168	20	30	16	12	12	12	12	12	16	16	16	2+	3-	3-	3-	3-	3-	3-	3-	3-													102^{4}	101	99
" 5	1/2	N	1	S		10"	40'		58'	84	180	148	140	132	132	128	116	116	130	188	24	20	12	12	12	12	12	12	12	12	20	1+	3-	3-	3-	3-	3-	3-	3-	3-													102^{6}	99^{2}	98^{4}
" 6	1/4	PS		L		30"	6'		8'	132	124	167	160	154	132	144				132	24	20	16	18	18	18	22				12	3+	1-	1-	3+	3+	3+																102^{4}	102^{6}	102^{8}
" 9	3/8	PS		L		8"	12'		15'	88	224	212	180	176	156	124	108			106	18	24	24	20	17	18	21	20			21	3+	3-	3-	3-	2-	2+	3+															102^{8}	102	102^{2}
" 16	1/2	PS		L		37"	10'		15'	116	170	160	154	146	128	130	122			128	20	22	14	16	9	20	20	20			20	3+	3-	3-	3-	1+	3+	3+															102^{8}	102^{4}	103^{2}
April 9	1/4	PS		S		30"	15'		18'	128	192	172	152	152	144	136	132			148	28	44	36	32	28	24	22	24			32	1+	3-	3-	3-	1-	3+	3+															102^{8}	102^{4}	103^{2}
" 10	3/8	PS		S		25"	12'		15'	100	180	180	156	150	144	138	122			122	28	30	42	36	30	35	22	22			24	2+	3-	3-	3-	2-	3+	3+															102^{2}	102	102^{8}
" 15	1/2	PS		S		37"	15'		18'	100	166	164	152	156	148	145	132	126		104	22	32	38	36	34	34	30	32	26		20	1+	3-	3-	3-	3-	3-	3+	3+														102^{4}	102	101^{4}
" 17	1/4	E		L		30"	5'		6'	100	130	128	130	134	140					110	24	22	0	20	24	30					20	3+	3-	3+	3+	3+	3+				2'3+	1'30"	4'20"		4'30"						3+		102	101^{6}	101^{1}
" 20	1/4	E		S		35"	6'		7'	120	140	144	160	166	152	140				120	32	36	0	28	30	32	26				40	1+	3-	1-	3+	3+	3+				1'3+	2'10"	2'30"		3'10"						3+		101^{6}	101^{4}	101^{2}
" 22	1/8	E		L		30"	3'		5'	148	100	120	126	130						132	44	48	40	36	30						38	3+	1-	3+	3+						1'2+										3+		102	102^{8}	103
" 23	1/8	E		S		27"	3'		4'	126	120	124	120	116						112	28	40	46	40	32						40	1+	2-	3+	3+						1'1+										3+		101^{6}	102^{4}	102

Dog No. 16	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	" 6 " "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiration start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 10, 1948	1/4									100		104	102	100	96	98	94	102	100	88	30		26	24	24	22	22	26	24	22	16		3+	3+	3+	3+	3+																102	102	102^{4}
" 11	1/2				1'	1'30"	6'	7'	9'	100		110	80	100	104	98	96	101	104	84	18		24	26	24	22	26	28	26	30	8		1-	1-	3+	3+	3+														1+		101^{8}	102	102^{4}
" 12	3/4				1'30"	2'	7'	8'	9'	96		116	76	105	112	114	108	108	106	108	18		24	28	22	22	24	26	26	24	20		3-	1-	3+	3+	3+																102	102^{4}	102
" 27	1/4	N	3/4	L		31"	9'		12'	100	80	100	108	104	100	104	116			96	40	24	20	20	20	20	20	20			20	3+	2-	1-	1-	3+	3+	3+															103^{6}	101	101^{4}
March 2	3/8	N	3/4	L		15"	25'		30'	72	124	136	128	108	104	108	96	92	98	124	18	12	14	14	14	12	14	12	12	12	12	3+	3-	3-	3-	3-	3-	3-	2-	3+													102^{4}	99	97
" 4	1/2	N	3/4	L		18"	30'		35'	108	160	128	120	120	120	114	96	90	88	160	32	24	12	10	10	10	9	8	8	10	24	3+	3-	3-	3-	3-	3-	3-	2-	1-													101^{6}	98	97
" 6	1/4	N	1	S		15"	19'		20'	80	98	100	110	106	100	102	114	112		120	24	24	20	22	18	15	18	22	24		20	3+	3-	3-	3-	2-	2-	1-	3+														100^{6}	99	96^{4}
" 11	3/8	N	1	S		15"	49'		60'	80	124	138	124	104	100	102	98	94	98	120	20	16	13	13	13	11	11	12	11	10	24	1+	3-	3-	3-	3-	3-	3-	3-	3-													102^{4}	102	102
" 15	1/2	N	1	S		18"	35'		45'	84	132	138	134	100	96	96	90	88	90	136	28	30	12	10	10	14	9	8	8	12	20	1+	3-	3-	3-	3-	3-	3-	3-	3-													102^{6}	102^{6}	102
" 16	1/4	PS		L		10"	9'		12'	86	132	120	94	96	112	92				118	16	24	20	16	14	16	16				30	2+	2	2-	1-	3+	3+																102^{4}	102^{4}	101^{8}
" 18	3/8	PS		L		30"	20'		25'	88	170	176	176	158	148	164	172	160	155	144	24	24	20	20	16	12	16	16	16	18	28	3+	3-	3-	3-	3-	2-	1-	3+	3+													102	101	101^{4}
April 10	1/2	PS		L		44"	15'		20'	132	122	144	108	120	114	114	110	104		120	28	20	24	28	32	28	28	24	26		28	3+	3-	3-	3-	3-	3-	1-	3+														102	102^{4}	102^{4}
" 13	1/4	PS		S		35"	10'		12'	116	144	160	160	160	156	144				112	28	28	16	28	28	24	28				27	1+	1-	1-	1-	3+	3+																101^{8}	102	102
" 16	3/8	PS		S		25"	20'		25'	80	160	160	136	128	128	120	120	116	112	120	24	24	28	24	24	24	24	22	22	22	24	2-	3-	3-	3-	3-	3-	3-	2+	3+													102^{4}	103	101^{4}
" 20	1/2	PS		S		50"	12'		15'	132	146	141	120	112	116	120	130			124	30	32	34	28	26	26	24	24			44	1+	3-	3-	3-	3-	3+	3+															102	102^{4}	101^{6}
" 21	1/4	E		L		1'30"	3'		6'	114	120	64	116	120	126					136	26	32	20	20	26	22					32	3+	3-	3+	3+	3+					2'2+										3+		101	101	100
" 22	1/4	E		S		1'40"	4'		6'	120	130	68	98	104	114					123	28	36	22	22	24	28					18	1+	3-	3+	3+	3+					3'1+										3+		101^{6}	100^{8}	101^{4}
" 24	1/8	E		L		1'20"	3'		6'	132	128	120	126	124						114	24	28	40	30	26						32	3+	1+	3+	3+						3'2+										3+		102^{4}	102^{6}	101
" 26	1/8	E		S		1'38"	3'		6'	114	138	126	130	132						120	30	27	44	33	26						26	3+	1-	3+	3+						3'2+										3+		102^{4}	101^{2}	102

Dog No. 6	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	〃 6 〃	〃 9 〃	〃 12 〃	〃 15 〃	〃 20 〃	〃 25 〃	〃 30 〃	〃 1 hour	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	6 〃	9 〃	12 〃	15 〃	20 〃	25 〃	30 〃	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 〃	9 〃	12 〃	15 〃	20 〃	25 〃	30 〃	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	〃 2nd dose 〃	〃 autorespiratory start	〃 administration metrazol	〃 〃 [illegible]	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 5, 1948	¼									148		124	100	116	116	120	123	130	133	135	24		26	28	24	24	25	23	25	24	24		3+	3+	3+	3+	3+																103^{2}		102
〃 7	½				45"	1'	11'	13'	23'	120		104	34	36	40	48	84	90	112	108	28		40	24	24	24	22	24	23	24	25		3-	3-	3-	1-	1-	3+	3+	3+	2'1+								+	+	3+	11'	101^{2}	100	101
〃 9	¾				45"	1'	11'	13'	22'	120		90	36	36	41	50	81	93	110	116	28		40	26	24	24	24	24	24	25	24		3-	3-	3-	2-	1-	3+	3+	3+	2'1+								+	+	3+	11'	101	100	101^{6}
〃 14	¼	N	¾	L		40"	20'		27'	112	100	120	115	104	90	89	85	80	80	90	24	20	24	20	16	14	12	14	14	16	20	3+	1-	1-	1+	1+	1+	2+	3+	3+													101	100	101^{6}
〃 21	⅜	N	¾	L		45"	12'		20'	128	116	140	128	116	88	72	78	80	84	100	22	16	24	24	20	16	12	12	14	16	16	3+	3-	3-	3-	3-	1-	1+	3+	3+													101	97	95
〃 24	½	N	¾	L		45"	15'		23'	120	68	64	72	68	64	64	57	68	68	70	20	20	16	12	16	12	12	12	12	12	16	3+	3-	3-	3-	1+	1+	2+	3+	3+									+				101^{8}	98^{4}	99
〃 26	¼	N	1	S		25"	15'		19'	100	90	86	90	100	100	104	112	108	105	100	20	16	16	12	12	14	14	16	16	16	16	1+	2-	2-	1-	1-	1+	1+	1+	1+													101^{6}	99	97
〃 27	⅜	N	1	S		45"	18'		20'	92	104	76	80	92	100	100	102	104	104	106	20	20	20	20	20	16	16	18	18	18	22	2+	3-	3-	3-	3-	3-	2+	2+	2+													102	97	96
March 1	½	N	1	S		20"	20'		25'	100	108	116	120	100	84	76	73	68	68	65	24	20	12	10	10	10	9	10	8	9	10	2+	3-	3-	3-	3-	3-	2+	2+	2+													101^{4}	98^{4}	98
〃 6	¼	PS		L		5"	21'		25'	144	140	138	136	134	130	126	128	160		112	24	24	24	20	16	20	18	18	20		24	3+	2-	2-	2-	2-	2-	2-	3+														101	97	100
〃 7	⅜	PS		L		12"	12'		18'	121	118	144	132	120	120	116	116			148	24	32	44	32	24	24	24	22			22	2+	3-	3-	3-	3-	1-	2+															101^{6}	101	100^{4}
〃 13	½	PS		L		50"	12'		15'	132	150	144	133	119	119	120				136	40	30	24	24	20	20	22				22	3+	3-	3-	3-	2+	3+																101^{4}	100	100
〃 16	¼	PS		S		40"	11'		15'	122	120	126	88	80	80	72				124	18	20	24	20	16	12	9				16	2+	2-	2-	2-	1+	2+																100^{8}	100	100
April 8	⅜	PS		S		35"	9'		12'	120	133	156	156	144	132	132				130	38	30	36	30	24	18	18				42	1+	3-	3-	3-	2+	3+																101^{4}	101	102^{4}
〃 10	½	PS		S		20"	15'		20'	108	128	150	144	120	120	124	124			150	24	32	36	24	24	24	22	24			30	2+	3-	3-	3-	3-	2-	3+															101	100	101^{8}
〃 16	⅛	E		L		15"	6'		6'	104	140	120	100							130	24	28	0	20							16	3+	3-	3+							3'2+	2'40"	3'20"	4'40"	4'50"						3+		101	101	102
〃 17	¼	E		S		1"	6'		6'	128	120	100	60	64	70					120	24	28	16	0	48	48					20	2+	2-	2-	3+						2'2+	5'35"	6'		7'50"		6'40"				3+		101	101	102
〃 20	⅛	E		L		45"	3'		6'	140	120	172	160	160						132	24	36	32	40	45						44	2+	1-	3+							1'1+								+	+	3+		101^{8}	101	102
〃 22	⅛	E		S		1'	3'		6'	104	120	95	60	64	80					133	24	28	0	24	24	36					30	1+	1-	3+	3+						1'2+	3'			4'					+	3+		101	101	101^{4}
Dog No. 7																																																							
Feb. 5, 1948	¼									88		94	100	103	106	106	104	104	132	88	20		24	24	24	24	22	24	24	22	22		3+	3+	3+	3+	3+																101^{4}		101^{8}
〃 7	½				45"	1'	7'	5'	9'	104		104	94	70	76	80	88	90	90	92	24		30	22	20	18	18	22	24	26	32		3-	3-	2-	3+																8'	101	100^{4}	100
〃 9	¾				1'	1'	9'	9'	25'	96		120	80	80	85	90	126	126		136	24		6	0	20	20	25	24	24		24		3-	3-	3-	3+	3+				1'2+	5'			7'				+	+	3+		103	100^{8}	102^{4}
〃 14	¼	N	¾	L		1'	20'		25'	100	120	100	90	90	100	115	120	123		80	20	32	26	26	28	30	30	32	30	25	44	3+	3-	3-	1-	1-	1-	1-	3+														101^{8}	100	97^{6}
〃 21	⅜	N	¾	L		130"	25'		30'	108	128	120	112	96	94	80	86	86	90	80	20	16	16	16	12	12	12	12	12	12	16	3+	3-	3-	3-	3-	3-	3-	3+														101	97	94
〃 24	½	N	¾	L		35"	25'		25'	102	90	132	120	116	100	88	76	70	76	68	16	20	16	12	12	12	12	12	12	12	16	3+	3-	3-	3-	3-	3-	3-	3+	3+													101^{6}	100	100
〃 27	¼	N	1	S		15"	15'		20'	108	140	128	130	104	104	100	100	106		72	18	14	14	12	12	12	17	18	20		24	3+	2-	2-	2-	2-	2-	2+															101	98	96
〃 28	⅜	N	1	S		35"	25'		30'	104	104	108	96	80	72	72	76	80	85	116	16	8	16	16	12	12	12	12	8	8	12	2+	3-	3-	3-	3-	3-	3-	2-	2+													101	98	97^{2}
March 1	½	N	1	S		20"	20'		25'	98	88	120	112	92	88	80	72	68	64	132	24	24	14	12	10	10	10	10	10	10	12	1-	3-	3-	3-	3-	3-	3-	1+	1+													100^{6}	100	100^{4}
〃 6	¼	PS		L		1'	7'		10'	104	120	128	104	100	96	96				128	18	28	18	18	16	16	16				18	3+	2-	2-	1+	3+	3+																101^{8}	100	97^{6}
〃 9	⅜	PS		L		60"	12'		15'	120	120	128	144	130	124	100	96			130	24	24	24	24	20	20	20	24			26	3+	3-	3-	3-	3-	3+	3+															101^{6}	101	101^{6}
〃 12	½	PS		L		25"	15'		20'	94	100	116	188	168	128	120	116	106		100	20	24	28	20	24	24	24	24	22		24	3+	3-	3-	3-	3-	3-	3+	3+														101^{4}	101	101^{2}
〃 16	¼	PS		S		30"	9'		20'	92	104	120	140	104	96	100	104	100		104	16	20	20	22	16	16	16	14	20		20	3+	3-	2-	2-	1-	1-	1+	3+														100^{6}	100	100^{2}
April 9	⅜	PS		S		15"	15'		20'	80	100	84	72	72	66	60	84			102	20	27	18	18	18	12	12	24			24	2+	3-	3-	3-	3-	2-	2+															100^{6}	100	102^{2}
〃 10	½	PS		S		20"	20'		25'	92	132	128	100	88	80	76	68	70	80	70	24	28	20	16	16	16	14	12	14	16	20	2+	3-	3-	3-	3-	3-	3-	3+								25'						100^{8}	100	100^{4}
〃 14	¼	E		L		130"	4'		5'	100	122	135	132							128	20	40		42							26	3+	3-	1+							2'2+	2'	2'45"		4'						3+		101^{6}	101	97^{3}
〃 21	¼	E		S		1"	6'		9'	138	108	135	132	126						132	20	40	20	48	36						40	3+	3-	3+	3+						2'2+	3'55"			3'55"						3+		100^{3}	100	100
〃 23	⅛	E		L		1"	6'		9'	124	120	140	128	120						122	24	40	18	0	48						36	1+	3-	3-	3+						2'2+	5'30"	6'30"		7'						3+		101	100^{6}	100
〃 25	⅛	E		S		135"	6'		9'	126	104	138	126	118						120	20	26	0	36	40						36	1+	3-	3+	3+						2'2+	2'	3'		3'55"						3+		101	101^{6}	101^{2}

Dog No. 3

Dog No. 3	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal
Feb 5, 1948	1/4								
" 7 "	1/2				30"	45"	9'	11'	12'
" 9 "	3/4				1'30"	2'	8'	9'	17'
" 14 "	1/4	N	3/4	L		45"	8'		9'
" 21 "	3/8	N	3/4	L		13"	12'		15'
" 24 "	1/2	N	3/4	L		35"	15'		20'
" 26 "	1/4	N	1	S		15"	12'		15'
" 27 "	3/8	N	1	S		13"	18'		20'
" 28 "	1/2	N	1	S		30"	12'		15'
March 5 "	1/4	PS		L		30"	9'		14'
" 13 "	3/8	PS		L		30"	9'		12'
" 15 "	1/2	PS		L		45"	20'		25'
" 17 "	1/4	PS		S		60"	12'		15'
April 9 "	3/8	PS		S		25"	15'		20'
" 14 "	1/2	PS		S		25"	15'		20'
" 21 "	1/4	E		L		55"	9'		12'
" 22 "	1/4	E		S		40"	12'		14'
" 23 "	1/8	E		L		30"	6'		9'
" 25 "	1/8	E		S		38"	6'		9'

Dog No. 3	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb 5, 1948	120		126	100	110	108	120	118	131	134	100
" 7 "	96		100	48	50	52	48				120
" 9 "	100		98	40	36	40	48	98			113
" 14 "	112	140	116	92	88	92					155
" 21 "	108	124	128	112	116	96	100				100
" 24 "	148	148	108	88	76	96	100	124			140
" 26 "	148	156	88	100	100	100	88	96			135
" 27 "	160	120	156	140	140	136	120	120	116		112
" 28 "	184	144	144	144	148	160	200	208	216	180	112
March 5 "	144	196	160	156	132	156	156	152			176
" 13 "	140	140	148	128	124	120	124				140
" 15 "	112	120	136	130	130	134	132	126	120		120
" 17 "	104	116	156	128	104	92	116	120			116
April 9 "	86	148	158	120	96	96	80	120			74
" 14 "	136	140	100	120	92	80	92	94	100		132
" 21 "	132	100	136	132	120	132	128	124			144
" 22 "	130	140	144	140	136	108	120				138
" 23 "	128	140	120	132	132	138					134
" 25 "	126	160	130	136	144	150					140

Dog No. 3	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb 5, 1948	26		28	30	24	26	26	26	24	24	32
" 7 "	20		28	24	22	22	24				32
" 9 "	24		40	20	18	16	24	26			40
" 14 "	20	16	44	40	36	28					24
" 21 "	24	16	16	16	12	12	24				24
" 24 "	36	12	16	10	8	8	12	12			24
" 26 "	20	24	16	16	16	15	16	16			16
" 27 "	14	16	8	8	12	14	12	12	12		12
" 28 "	12	20	12	10	10	12	16	20	18	18	12
March 5 "	20	28	12	12	16	16	16	16			28
" 13 "	36	30	20	12	12	12	18				24
" 15 "	18	18	16	18	18	18	20	24	28		18
" 17 "	24	16	16	16	16	12	16	16			16
April 9 "	34	24	32	28	24	24	24	22			30
" 14 "	28	18	20	20	16	20	20	18	18		24
" 21 "	40	40	40	36	24	36	42	44			36
" 22 "	32	52	32	0	42	36	40				28
" 23 "	26	20	12	24	34	40					26
" 25 "	30	32	0	22	30	36					40

Dog No. 3	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	minutes and degree of cyanosis
Feb 5, 1948		3+	3+	3+	3+	3+				
" 7 "		3-	3-	3-	3+	3+				2'1+
" 9 "		3-	3-	3-	3+	3+	3+			2'1+
" 14 "	3+	2-	2-	1+	3+					
" 21 "	3+	3-	3-	3-	3+	3+				
" 24 "	3+	3-	3-	3-	3-	3-	3+			
" 26 "	2+	3-	3-	3-	2-	3+	3+			
" 27 "	1+	3-	3-	3-	3-	3-	3+	3+		
" 28 "	3+	3-	3-	3-	3-	3+	3+			
March 5 "	3+	3-	3-	2-	1-	3+	3+			
" 13 "	3+	3-	3-	2-	3+	3+				
" 15 "	3+	3-	3-	3-	3-	3-	1-	3+		
" 17 "	1+	3-	3-	3-	2-	3+	3+			
April 9 "	1+	3-	3-	3-	2-	2-	2+			
" 14 "	1-	3-	3-	3-	3-	2-	1+	3+		
" 21 "	3+	3-	3-	2-	2+	2+	3+			
" 22 "	2+	3-	3-	3-	2-	3+				1'2+
" 23 "	1+	2-	1-	3+	3+					2'1+
" 25 "	1+	1-	1-	3+	3+					1'2+

Dog No. 3	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetasul	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb 5, 1948												102^{4}	102^{8}	102^{2}
" 7 "								+	+	1+	10'	102^{8}	102^{8}	102^{4}
" 9 "								+		1+	9'	101^{4}	102	102^{8}
" 14 "												101	100^{8}	101
" 21 "											9'	101^{8}	101^{8}	101
" 24 "											14'	101^{8}	101	101^{4}
" 26 "												101^{2}	100^{8}	99^{4}
" 27 "												101^{8}	100	96
" 28 "											6'	101^{4}	98	97½
March 5 "												101^{2}	101	100
" 13 "												101^{8}	100^{1}	102^{4}
" 15 "												102^{4}	102	102^{4}
" 17 "												102	101	99
April 9 "												101^{8}	101	102^{5}
" 14 "												101^{4}	100^{8}	100^{2}
" 21 "										3+		101^{4}	100	101
" 22 "	2'30"			3'35"						3+		102	100	100
" 23 "										3+		101^{4}	101	101^{2}
" 25 "	2'45"			3'45"						3+		101^{8}	102	102

Dog No. 13

Dog No. 13	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal
Feb. 10, 1948	1/4								
" 11 "	1/2				1'30"	2'	5'	4'	6'
" 12 "	3/4				2'	2'30"	16'	18'	26'
" 19 "	1/4	N	3/4	L		30"	15'		20'
" 21 "	3/8	N	3/4	L		30"	30'		40'
" 24 "	1/2	N	3/4	L		45"	15'		18'
" 27 "	1/4	N	1	S		25"	21'		24'
" 28 "	3/8	N	1	S		17"	15'		18'
March 2 "	1/2	N	1	S		15"	49'		60'
" 6 "	1/4	PS		L		30"	7'30"		10'
" 11 "	3/8	PS		L		42"	18'		20'
" 13 "	1/2	PS		L		24"	15'		18'
" 17 "	1/4	PS		S		45"	15'		20'
April 9 "	3/8	PS		S		17"	12'		15'
" 13 "	1/2	RS		S		56"	15'		18'
" 14 "	1/4	E		L		1'20"	6'		7'
" 21 "	1/4	E		S		53"	4'		6'
" 22 "	1/8	E		L		15"	5'		6'
" 25 "	1/8	E		S		1'30"	6'		7'

Dog No. 13	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb. 10, 1948	100		106	98	96	90	92	94	92	90	88
" 11 "	132		160	136	120	120	100	106	112	120	136
" 12 "	96		103	80	47	36	58	81	90	100	69
" 19 "	140	150	160	84	124	112	100	104	110		102
" 21 "	124	104	92	98	76	68	72	80	72	64	72
" 24 "	152	80	68	72	68	56	56	56	48	52	88
" 27 "	124	140	112	84	68	68	64	68	60	66	60
" 28 "	100	106	100	100	84	72	68	72	80		76
March 2 "	84	62	88	72	60	72	56	48	44	60	62
" 6 "	104	128	92	76	80	76	80	90			92
" 11 "	112	118	96	90	86	60	60	80	86		132
" 13 "	108	112	92	62	60	68	70	78	82		108
" 17 "	128	132	120	108	100	100	100	80	80	76	76
April 9 "	136	133	74	72	78	82	86	84			120
" 13 "	121	125	136	130	126	122	119	116	118		110
" 14 "	130	136	128	128	120	120	120	115			140
" 21 "	150	220	224	220	200	110					180
" 22 "	126	162	180	176	164	152					150
" 25 "	132	138	152	160	156	140	140				156

Dog No. 13	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb. 10, 1948	24		26	26	24	24	24	22	26	24	25
" 11 "	24		24	30	26	28	26	24	22	24	24
" 12 "	14		30	26	22	22	20	24	24	30	20
" 19 "	24	32	20	20	12	24	20	20	20		26
" 21 "	16	24	20	14	20	24	20	22	20	24	20
" 24 "	20	12	16	14	14	12	12	14	12	14	20
" 27 "	20	16	12	12	12	12	12	14	12	14	16
" 28 "	16	20	12	14	12	16	14	16	14		14
March 2 "	18	14	10	8	8	8	8	6	8	10	14
" 6 "	22	22	18	20	16	16	18	18			18
" 11 "	32	30	20	19	19	20	20	22	20		28
" 13 "	26	28	26	19	15	13	13	16	16		26
" 17 "	20	24	20	16	16	16	20	20	28	26	26
April 9 "	24	20	18	24	24	22	26	24			30
" 13 "	24	28	26	24	23	21	20	18	22		28
" 14 "	24	44	30	26	23	20	20	22			16
" 21 "	32	44	0	80	40	30					50
" 22 "	26	30	0	64	58	48					34
" 25 "	30	22	0	60	46	40	32				40

Dog No. 13	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	minutes and degree of cyanosis
Feb. 10, 1948		3+	3+	3+	3+	3+				
" 11 "		2-	3+	3+	3+	3+				
" 12 "		3-	3-	3-	3-	2-	3+	3+	3+	3'1+
" 19 "	3+	3-	3-	3-	2-	2-	3+	3+		
" 21 "	3+	3-	3-	3-	3-	3-	3-	3-	2-	
" 24 "	3+	3-	3-	3-	1-	1-	3+	3+	3+	5'1+
" 27 "	1+	3-	3-	3-	3-	3-	1-	3+	3+	
" 28 "	2+	3-	3-	3-	3-	2-	3+	3+		
March 2 "	3+	3-	3-	3-	3-	3-	3-	3-	3-	5'1+
" 6 "	3+	2-	2-	3+	3+	3+	3+			
" 11 "	3+	3-	3-	3-	2-	2-	3+	3+		
" 13 "	3+	3-	3-	3-	2-	1-	3+	3+		
" 17 "	2+	2-	2-	2-	2-	1-	2+	3+	3+	
April 9 "	2+	2-	2-	2-	1-	3+	3+			
" 13 "	3+	3-	3-	2-	2-	1-	3+	3+		
" 14 "	3+	3-	2-	3+	3+	3+	3+			
" 21 "	3+	1-	2+	3+	3+					2'2+
" 22 "	3+	1+	3+	3+	3+					1'2+
" 25 "	1+	2-	2-	3+	3+	3+				2'2+

Dog No. 13	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetasul	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 10, 1948												100^{8}	101	101^{2}
" 11 "												101^{4}	101	104
" 12 "								+	+	2+	12'	100^{8}	100	101
" 19 "												102^{2}	99	97^{5}
" 21 "												101^{4}	98	98^{2}
" 24 "												101^{8}	98^{4}	99^{2}
" 27 "												100^{8}	99	98^{4}
" 28 "												102	100	96^{5}
March 2 "												100^{8}	97	97
" 6 "												100	100^{2}	99^{5}
" 11 "												103	101^{8}	99^{5}
" 13 "												101^{8}	101	101^{5}
" 17 "												101^{4}	102	101
April 9 "												101^{8}	101^{4}	101^{2}
" 13 "												101^{8}	101^{8}	101^{2}
" 14 "										3+		101	101^{8}	102^{2}
" 21 "	1'15"			4'35"						3+		101^{4}	102^{2}	102
" 22 "	1'33"			5'45"						3+		101^{5}	101^{4}	100
" 25 "	1'15"			4'10"						3+		102	102^{2}	102^{4}

Dog No. 9

Dog No. 9	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb. 5, 1948	1/4									120		126	116	112	114	120	122	122	134	120
" 7 "	1/2				20"	40"	9'	12'	15'	88		100	64	52	54	66	74	76	102	124
" 9 "	3/4				20"	50"	14'	18'	20'	80		86	36	40	46	58	64	86	84	132
" 19 "	1/4	N	3/4	L		30"	9'		15'	100	152	142	122	112	128	126	128			134
" 21 "	3/8	N	3/4	L		15"	20'		25'	80	120	140	96	84	76	80	80	86	100	76
" 25 "	1/2	N	3/4	L		25"	25"		40'	94	80	133	128	112	104	130	120	120	124	80
March 3 "	1/4	N	1	S		12"	20'		30'	134	132	114	108	100	108	84	76	76	82	76
" 4 "	3/8	N	1	S		7"	40'		55"	80	96	116	96	120	116	72	84	80	78	96
" 5 "	1/2	N	1	S		45"	25"		35'	120	140	126	104	104	100	88	84	84	84	140
" 6 "	1/4	PS		L		18"	9'		15'	124	152	140	128	150	154	146	132			140
" 10 "	3/8	PS		L		40"	12'		20'	108	136	148	140	132	132	120	130	128		120
" 13 "	1/2	PS		L		34"	12'		15'	132	142	146	144	124	124	120	120			136
" 17 "	1/4	PS		S		40"	9'		12'	104	144	136	128	104	100	88	100	120		120
April 8 "	3/8	PS		S		35"	20'		25'	110	134	168	186	168	152	146	144	146	140	118
" 10 "	1/2	PS		S		10"	15"		20'	136	161	160	140	140	112	110	120	126		108
" 15 "	1/4	E		L		30"	6'		9'	144	78	114	44	48	56	78	86			88
" 17 "	1/4	E		S		30"	6'		9'	124	100	68	40	48	44	60	68	74		86
" 20 "	1/8	E		L		30"	6'		9'	132	108	135	132	110	96					76
" 22 "	1/8	E		S		37"	6'		9'	132	118	140	134	134	126					144

Dog No. 9	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour "	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
Feb. 5, 1948	24		27	24	22	20	24	24	24	26	24		3+	3+	3+	3+	3+			
" 7 "	32		20	22	16	16	18	16	22	24	32		3-	3-	3-	3-	3+			
" 9 "	24		20	14	12	18	20	20	18	22	32		3-	3-	3-	3-	1+	3+	3+	3+
" 19 "	24	32	12	12	12	12	12	14			20	3+	1-	2-	2-	1+	3+	3+		
" 21 "	16	32	28	20	20	18	20	20	20	22	16	3+	3-	3-	3-	3-	3-	3-	3+	3+
" 25 "	20	16	16	16	16	16	16	16	18	18	14	3+	3-	3-	3-	3-	3-	2-	2-	1-
March 3 "	28	20	16	16	16	16	16	14	14	16	16	1+	3-	3-	3-	3-	3-	2-	1+	1+
" 4 "	30	16	12	11	12	13	12	12	10	10	24	2-	3-	3-	3-	3-	3-	3-	3-	3-
" 5 "	24	24	12	10	10	9	12	12	12	12	32	1+	3-	3-	3-	3-	3-	3-	2-	2+
" 6 "	28	22	32	20	24	24	22	26			20	3+	1-	3-	3-	1+	3+	3+		
" 10 "	34	32	24	20	20	20	18	18	18		24	3+	2-	2-	2-	2-	1-	3+	3+	
" 13 "	32	42	26	22	22	18	20	20			24	3+	3-	3-	3-	1-	1+	3+		
" 17 "	36	38	36	36	28	28	24	24	24		28	2+	2-	2-	1-	1+	3+	3+	3+	
April 8 "	28	30	36	30	30	26	28	24	18	25	36	2+	3-	3-	3-	3-	2-	1-	2+	3+
" 10 "	32	32	28	24	24	24	24	22	20		28	1-	3-	3-	3-	3-	3-	1+	1+	
" 15 "	28	40	0	0	40	48	38	32			16	3+	3-	3-	3+	3+	3+	3+		
" 17 "	20	25	12	0	0	40	44	36	32		34	1+	3-	3-	3+	3+	3+	3+	3+	
" 20 "	36	40	20	48	44	40					32	3+	3-	3-	3+	3+				
" 22 "	40	30	20	44	42	40					28	1-	3-	3-	3+	3+				

Dog No. 9	minutes and degrees of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetasul	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 5, 1948													101^{4}	101^{4}	101^{3}
" 7 "													102^{6}	102^{6}	102^{4}
" 9 "	4½+												101^{8}	101^{6}	102
" 19 "													102	99	98
" 21 "													101^{8}	100	99^{2}
" 25 "													104^{2}	101^{8}	99^{2}
March 3 "													100^{6}	100	96^{8}
" 4 "													101	100	97^{4}
" 5 "													101	98	96^{4}
" 6 "													100^{6}	99^{3}	99^{4}
" 10 "													100^{2}	100^{6}	103
" 13 "													101	101	100^{6}
" 17 "													100^{2}	100	99
April 8 "													101^{6}	101^{4}	102
" 10 "													101^{4}	101^{4}	101
" 15 "	4½+	1'40"	2'10"		6'45"						3+		101^{4}	101	101^{4}
" 17 "	5½+	3'40"	4'30"	6'50"	9'30"		5'				3+		101^{4}	101^{2}	101^{5}
" 20 "	2½+	3'35"			3'05"						3+		101^{4}	102	101^{2}
" 22 "	2½+	3'55"			4'30"						3+		101^{5}	101	99^{4}

Dog No. 18

Dog No. 18	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb 10, 1948	1/4									74		92	88	76	78	80	84	86	86	88
" 11 "	1/2				1'	25"	9'	8'	15'	82		86	64	57	64	74	80	86	86	100
" 12 "	3/4				15"	35"	25'	27'	30'	84		80	42	48	56	48	44	56	52	108
" 20 "	1/4	N	3/4	L		30"	15'		25'	80	144	120	112	104	100	112	108	108	104	104
" 23 "	3/8	N	3/4	L		35"	25'		35'	77	112	180	184	150	136	118	84	112	96	108
" 25 "	1/2	N	3/4	L		30"	35'		43'	96	120	108	104	88	68	64	64	64	78	112
" 26 "	1/4	N	1	S		15"	8'		10'	84	156	156	150	140	132	128	128			98
March 4 "	3/8	N	1	S		20"	20'		30'	72	112	122	120	112	110	106	92	92	92	112
" 5 "	1/2	N	1	S		25"	25"		35'	92	124	104	108	108	84	88	88	84	96	104
" 6 "	1/4	PS		L		20"	9'		12'	92	156	144	128	120	128	120				124
" 10 "	3/8	PS		L		13"	15"		20'	72	132	152	132	144	120	108	116			96
" 13 "	1/2	PS		L		40"	9'		12'	96	152	144	108	144	136	132				134
" 18 "	1/4	PS		S		35"	6'		9'	88	134	120	104	92	80	80	80			100
April 10 "	3/8	PS		S		25"	15'		28'	96	148	136	112	100	100	96	98			93
" 13 "	1/2	PS		S		35"	20'		27'	140	136	144	136	120	120	120	124	116	118	120
" 14 "	1/4	E		L		130"	8'		10'	113	120	104	64	108	106	110	108			106
" 21 "	1/4	E		S		110"	6'		7'	118	152	144	100	98						136
" 22 "	1/8	E		L		45"	3'		6'	104	162	152	136	126						112
" 24 "	1/8	E		S		55"	4'		6'	96	124	116	100	96						116

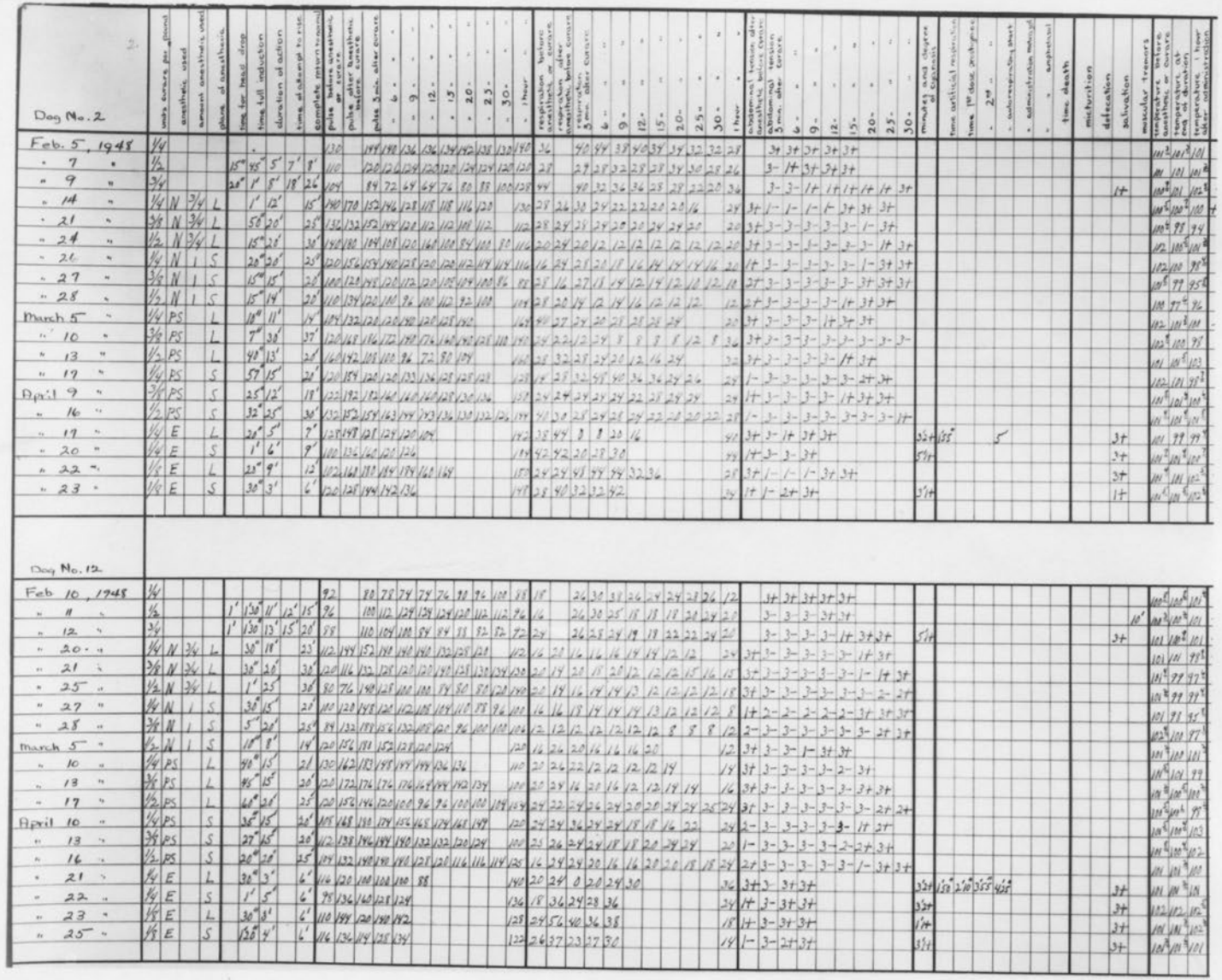
Dog No. 18	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour "	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
Feb 10, 1948	40		44	46	36	40	42	34	30	28	24		3+	3+	3+	3+	3+			
" 11 "	24		30	28	30	26	26	30	24	24	24		3-	3-	3-	1+	3+	3+		
" 12 "	16		24	0	0	24	20	18	22	18	24		3-	3-	3-	3-	3-	3-	1-	3+
" 20 "	24	28	16	16	16	16	20	16	16	16	16	3+	1-	1-	1-	1-	1-	1+	3+	3+
" 23 "	24	18	16	12	8	9	8	8	8	12	20	3+	3-	3-	3-	3-	3-	3-	3-	1+
" 25 "	18	18	12	12	8	8	6	6	6	10	22	3+	3-	3-	3-	3-	3-	3-	3-	3-
" 26 "	12	16	12	10	8	8	8	8			23	1-	2-	2-	1+	2+	2+	2+		
March 4 "	14	8	8	8	8	8	8	8	12	8	18	1-	3-	3-	3-	3-	3-	3-	1+	2+
" 5 "	16	20	12	8	8	7	7	8	8	10	20	1+	3-	3-	3-	3-	3-	3-	1-	1+
" 6 "	20	26	12	12	10	12	16				20	3+	2-	1-	1-	2+	3+			
" 10 "	24	28	22	18	16	16	16	18			24	2+	3-	3-	3-	3-	3-	3+		
" 13 "	16	26	24	26	24	20	22				32	2+	3-	3-	3-	2+	3+			
" 18 "	28	30	20	20	20	16	20	16			16	1-	3-	2-	1+	3+	3+	3+		
April 10 "	28	20	24	20	24	20	20	22			32	3-	3-	3-	3-	3-	3-	1+		
" 13 "	24	20	20	20	16	16	20	17	16	18	20	1+	3-	3-	3-	3-	3-	1-	1+	3+
" 14 "	26	32	0	0	36	24	28	26			21	3+	3-	3-	1+	3+	3+	3+		
" 21 "	32	40	44	46	36						22	1+	2-	2-	3+					
" 22 "	26	46	32	36	34						26	3+	1-	3+	3+					
" 24 "	22	34	26	24	30						28	1+	2-	3+	3+					

Dog No. 18	minutes and degrees of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetasul	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb 10, 1948													104	104	103
" 11 "	2½+												101^{8}	101^{6}	101^{6}
" 12 "	7½+	4'25"			10'30"				+	+	3+	11'	101^{5}	101^{5}	101^{4}
" 20 "													101^{2}	100	99^{2}
" 23 "													101^{4}	100^{8}	99
" 25 "	1½+												101^{4}	99^{8}	99
" 26 "													101	100^{8}	99
March 4 "													101^{5}	100	98^{2}
" 5 "													102^{3}	100^{3}	98^{3}
" 6 "													102^{4}	100^{6}	100^{4}
" 10 "													101	100^{2}	100^{3}
" 13 "													102	102	101
" 18 "													101^{6}	101	100
April 10 "													101^{4}	101^{8}	101
" 13 "													101^{6}	102	101^{4}
" 14 "	10½+	2'50"			8'15"						3+		102	100^{6}	102
" 21 "											3+		102^{4}	103	103
" 22 "											3+		101^{6}	101^{6}	102^{8}
" 24 "											3+		101	101^{4}	102^{5}

Dog No 1.	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb 5, 1948	1/4									140		128	124	124	118	110	116	124	124	120
" 7 "	1/2				10"	28"	10'	12'	15'	100		128	104	88	76	84	84	96	98	124
" 9 "	3/4				15"	35"	12'	14'	15'	120		116	104	90	78	86	86	94	106	120
" 14 "	1/4	N	3/4	L		30"	12'		15'	120	142	126	144	120	120	126				140
" 21 "	3/8	N	3/4	L		45"	9'		15'	100	152	140	132	128	120	104				104
" 23 "	1/2	N	3/4	L		40"	13'		18'	115	116	120	131	140	104	106	108			108
" 26 "	1/4	N	1	S		15"	15'		20'	108	144	140	136	112	100	100	96			112
" 27 "	3/8	N	1	S		10"	20'		25'	88	104	104	112	104	100	84	80	84	80	106
" 28 "	1/2	N	1	S		20"	15'		20'	100	160	140	120	112	100	116	100	100	92	104
March 6 "	1/4	PS		L		7"	9'		14'	124	124	108	138	140	146	140				108
" 9 "	3/8	PS		L		13"	15'		20'	132	146	122	128	134	126	138	140			136
" 12 "	1/2	PS		L		23"	12'		20'	112	142	120	104	100	96	94	100			120
April 9 "	1/4	PS		S		40"	9'		12'	128	188	162	154	154	146	132	134			140
" 10 "	3/8	PS		S		25"	12'		15'	100	184	176	150	148	138	136	120			122
" 15 "	1/2	PS		S		34"	15'		20'	110	176	168	168	156	150	144	130			106
" 17 "	1/4	E		L		20"	5'		6'	100	134	122	124	130	138					114
" 20 "	1/4	E		S		1'	3'		5'	120	134	120	100	130						123
" 22 "	1/8	E		L		30"	3'		5'	140	130	112	124	130						132
" 23 "	1/8	E		S		33"	3'		4'	126	130	120	130	140						112

Dog No 1.	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "	1 hour "	abdominal tension after anesthetic before curare	abdominal tension 3 min. after curare	6 "	9 "	12 "	15 "	20 "	25 "	30 "
Feb 5, 1948	28		26	24	24	26	20	20	22	24	28		3+	3+	3+	3+	3+			
" 7 "	24		22	18	18	20	20	24	24	20	20		3-	3-	3-	1+	3+			
" 9 "	28		38	60	54	46	38	28	30	40	20		3-	3-	3-	3-	3+			
" 14 "	28	18	24	18	20	18	18				14	3+	2-	2-	2-	1-	3+			
" 21 "	22	20	24	20	20	20	16				16	3+	3-	3-	3-	1+	3+			
" 23 "	24	16	28	24	16	12	20	20			16	3+	3-	3-	3-	3-	1+	3+		
" 26 "	12	20	16	16	16	16	14	12			12	1+	3-	3-	3-	3-	2-	3+		
" 27 "	12	16	12	12	12	12	12	12	14	12	12	1-	3-	3-	3-	3-	3-	3-	3+	3+
" 28 "	12	20	16	14	16	14	14	14	11	16	14	1+	3-	3-	3-	3-	1-	3+	3+	3+
March 6 "	24	20	20	18	20	20	18				20	3+	2-	2-	2-	1+	3+			
" 9 "	28	32	20	16	26	20	20	26			29	3+	3-	3-	3-	3-	1-	3+		
" 12 "	18	36	24	13	11	16	18	16			16	2+	3-	3-	3-	3-	1+	3+		
April 9 "	28	40	34	32	24	24	26	24			30	1+	3-	1-	1-	1+	3+	3+		
" 10 "	26	34	40	36	28	24	22	22			26	1+	3-	3-	3-	2-	3+	3+		
" 15 "	22	32	36	28	24	22	24	26			18	1+	3-	3-	3-	3-	3-	3+		
" 17 "	20	22	0	24	26	30					22	3+	3-	3+	3+	3+				
" 20 "	28	50	36	30	30						38	3+	3-	1-	3+					
" 22 "	40	48	38	36	30						34	3+	1-	3+	3+					
" 23 "	24	36	42	40	34						42	1+	2-	3+	3+					

Dog No 1.	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" when respiratory start	" administration metrazol	" " amphetasol	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb 5, 1948													101^{6}	101^{8}	101^{4}
" 7 "													101^{8}	101	102
" 9 "	4'1+											4'	101^{3}	102	101^{9}
" 14 "													100^{4}	99	99^{6}
" 21 "													101	99^{8}	95^{8}
" 23 "												10'	101	99^{2}	96
" 26 "													100^{2}	99^{4}	97^{8}
" 27 "													101^{8}	101	95^{4}
" 28 "													101^{8}	98^{8}	96
March 6 "													101	102^{2}	100^{2}
" 9 "													101^{8}	102	101^{4}
" 12 "													102^{3}	102^{2}	101^{8}
April 9 "													102^{4}	101^{8}	103^{2}
" 10 "													102	102	102^{4}
" 15 "													102^{4}	102^{1}	101
" 17 "	2'3+	2'	4'	-	4'45"						3+		102	101^{3}	101^{8}
" 20 "	3'3+										3+		101^{6}	102	101^{4}
" 22 "	1'2+										3+		102	102^{8}	102^{8}
" 23 "	2'1+										3+		101^{6}	102^{8}	101^{6}


Dog No. 2
Feb. 5, 1948
" 7 "
" 9 "
" 14 "
" 21 "
" 24 "
" 26 "
" 27 "
" 28 "
March 5 "
" 10 "
" 13 "
" 17 "
April 9 "
" 16 "
" 17 "
" 20 "
" 22 "
" 23 "
Dog No. 12
Feb 10, 1948
" 11 "
" 12 "
" 20 "
" 21 "
" 25 "
" 27 "
" 28 "
March 5 "
" 10 "
" 13 "
" 17 "
April 10 "
" 13 "
" 16 "
" 21 "
" 22 "
" 23 "
" 25 "

Dog No. 19

Date	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour
Feb 10, 1948	1/4									112		99	86	86	88	98	114	120	120	100
" 12 "	1/2				30"	30"	7'	9'	9'	104		76	80	86	94	100	102	102	100	100
" 20 "	3/4				30"	30"	6'	9'	9'	108		68	74	76	84	90	90	100	100	140
" 21 "	1/4	N	3/4	L		1'	15'		20'	94	128	128	128	140	140	140	160	154		100
" 24 "	3/8	N	3/4	L		12"	25'		30'	108	116	132	128	116	104	108	104	124	100	96
" 28 "	1/2	N	3/4	L		30"	25'		35'	120	100	120	146	150	156	162	150	144	146	132
March 2 "	1/4	N	1	S		30"	15'		20'	108	108	144	136	134	134	130	130	136		142
" 3 "	3/8	N	1	S		40"	25'		35'	96	100	168	170	174	156	156	140	140	132	108
" 5 "	1/2	N	1	S		25"	20'		30'	100	166	144	136	114	104	104	108	108	110	136
" 6 "	1/4	PS		L		34"	6'		12'	130	160	114	120	120	126	138				120
" 9 "	3/8	PS		L		25"	15'		20'	120	158	124	128	128	132	130	134			124
" 12 "	1/2	PS		L		32"	18'		25'	114	140	118	116	112	90	90	100	100		116
April 10 "	1/4	PS		S		17"	9'		12'	130	168	160	148	140	140	134	132			140
" 14 "	3/8	PS		S		30"	18'		25'	124	180	166	150	150	134	134	120	124		116
" 18 "	1/2	PS		S		40"	15'		20'	126	164	156	144	144	140	130	130	134		138
" 20 "	1/4	E		L		1'30"	6'		9'	110	154	94	124	132	140					120
" 22 "	1/4	E		S		1'				120	138									

Date	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "
Feb 10, 1948	24		20	20	28	20	24	26	24	24	20		3+	3+	3+	3+	3+			
" 12 "	28		36	40	44	36	30	30	30	30	44		3-	3-	3+	3+	3+			
" 20 "	28		0	40	36	36	40	32	32	32	28		3-	1-	3+	3+	3+			
" 21 "	32	24	24	20	16	20	20	28	24		12	3+	3-	3-	3-	3-	1-	3+	3+	
" 24 "	32	24	16	16	16	16	12	12	12	12	40	3/	3-	3-	3-	3-	3-	3-	1-	3+
" 28 "	16	20	20	32	34	36	30	30	32	26	30	3+	3-	3-	3-	3-	3-	3-	3-	1+
March 2 "	16	20	18	26	28	24	24	24	24		20	1-	3-	3-	3-	3-	3-	1+	2+	
" 3 "	20	22	28	34	20	24	24	26	26	26	14	1+	3-	3-	3-	3-	3-	3-	3-	1+
" 5 "	20	24	18	18	14	14	16	16	12	12	12	1+	3-	3-	3-	3-	3-	3-	1+	3+
" 6 "	24	32	28	20	20	20	22				18	3+	2-	2-	1+	3+	3+			
" 9 "	18	40	28	28	20	20	18	18			24	3+	3-	3-	3-	3-	3-	3+		
" 12 "	18	30	22	18	12	12	18	20	22		26	3+	3-	3-	3-	3-	3-	1-	3+	
April 10 "	24	28	24	24	20	26	28	30			24	1+	3-	3-	2-	2+	2+	2+		
" 14 "	36	30	42	34	34	22	22	24	24		24	1+	3-	3-	3-	3-	3-	1+	3+	
" 18 "	28	34	36	28	24	22	22	26	20		22	1+	3-	3-	3-	3-	2-	3+	3+	
" 20 "	24	32	0	28	28	32					30	3+	3-	1-	3+	3+				
" 22 "	30	32										1-								

Date	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb 10, 1948													101^{6}	101^{8}	102
" 12 "	1'2+	1'20"	2'30"		2'45"				+	+	3+		101^{2}	101^{4}	102^{4}
" 20 "	3'2+	2'	2'45"		4'30"				+	+	3+	7'	101^{8}	101	99^{4}
" 21 "													101^{8}	98	94^{4}
" 24 "													101	99^{2}	98^{6}
" 28 "													101^{2}	99	98
March 2 "													101	101	97
" 3 "													101^{2}	99	98
" 5 "													101	101	99
" 6 "													101	101^{4}	99^{8}
" 9 "													101^{4}	101^{2}	101
" 12 "													102	102^{2}	102
April 10 "													101	101	102
" 14 "													102	102	102^{4}
" 18 "													102	101^{6}	101
" 20 "	3'2+	2'30"	3'		4'						3+		101^{4}	101^{2}	101^{4}
" 22 "		1'30"	2'30"					2'45"			3+		101^{6}		

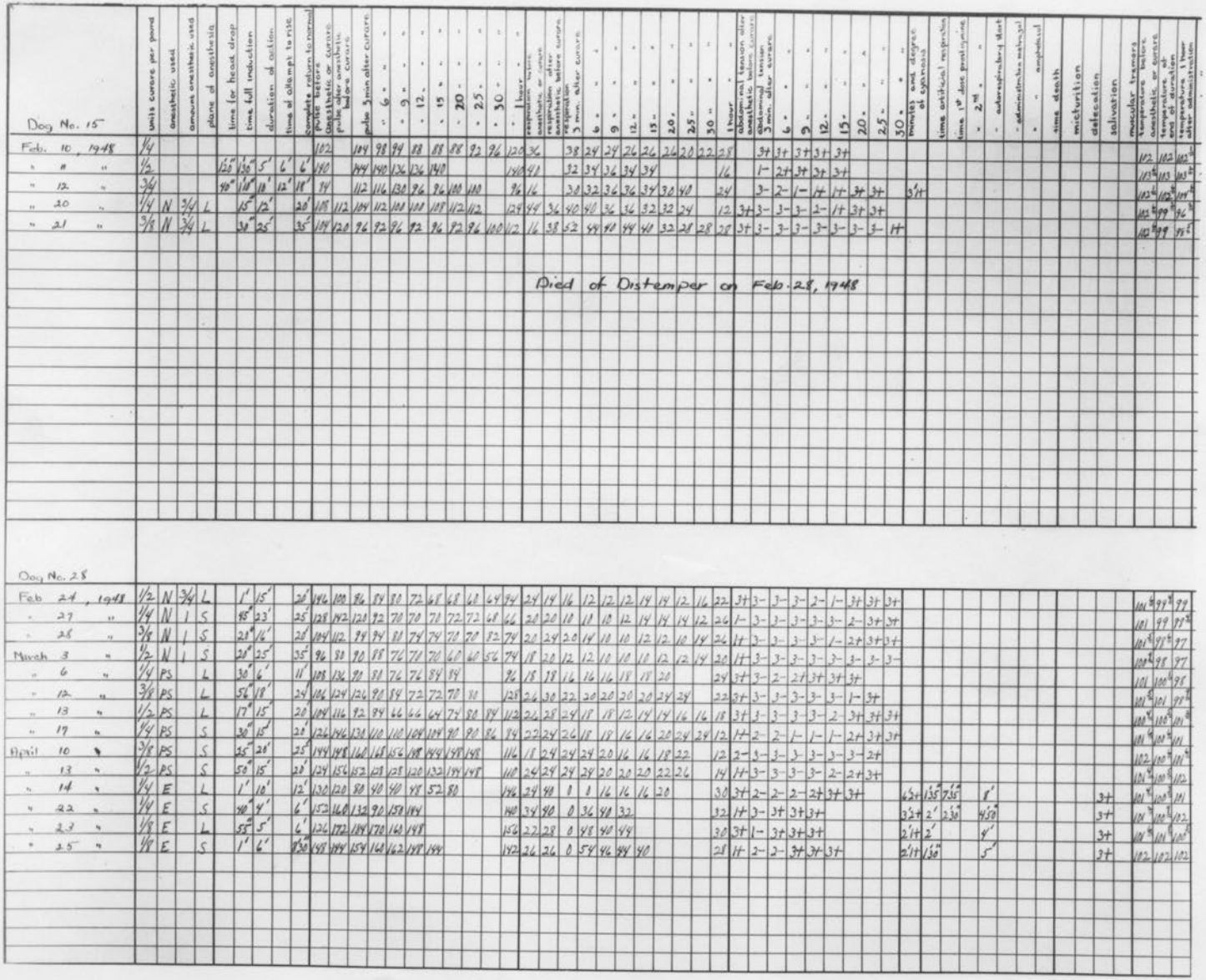
Dog No. 26

Date	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour
April 23, 1948	1/8	E		L		30"	4'		6'	138	144	116	118	130	132					116
" 25 "	1/8	E		S		42"	3'		6'	130	138	124	124	138	130					116

Date	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "
April 23, 1948	30	36	40	34	30	34					36	3+	2-	3+	3+	3+				
" 25 "	20	24	44	42	36	40					44	1+	3-	3+	3+	3+				

Date	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
April 23, 1948	1'1+	3'30"			4'						3+		101^{8}	102^{4}	102^{4}
" 25 "	2'1+										3+		101^{8}	102^{2}	102^{4}

Dog No. 19	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time teh induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	" 1 hour " "	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min. after curare	6 " " "	9 " " "	12 " " "	15 " " "	20 " " "	25 " " "	30 " " "	1 hour	abdominal tension after anesthetic before convulsions	3 min. after curare	6 " " "	9 " " "	12 " " "	15 " " "	20 " " "	25 " " "	30 " " "	minutes and degree of convulsions	time artificial respiration	time 1st dose prostigmine	" 2nd " "	" subcutaneously shot	" administration atropine	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature, taken anesthetic, or curare	Temperature at end of duration	Temperature 1 hour after convulsions	pedal reflex
Feb. 10, 1948	1/4			.						108		112	105	103	100	114	114	118	118	120	36		48	40	40	44	48	36	36	30	40		3+	3+	3+	3+	3+															102	102	102	
" 11 "	1/2				30"	45'	9'	10'	15'	100		80	76	60	60	108	112	112	106	108	32		42	54	48	44	46	40	36	36	32		3-	3-	3-	1+	3+	3+								1+					101	101	103	+
" 12 "	3/4				30"	30"	6'	8'	12'	86		60	68	76	80	92				112	42		0	36	42	34	36				32		3-	1-	3+	3+												3+	30"	3'	4'		3+				102	102	103	
" 20 "	1/4	N	3/4	L		30"	12'		20'	100	138	148	132	120	106	106	100	104	92	92	22	50	52	44	40	36	40	40	32	32	32	3+	3-	3-	3-	1+	1+	3+													100	101	100	
" 21 "	3/8	N	3/4	L		18"	28'		25'	144	140	136	128	128	136	140	144	144		144	44	46	61	54	54	56	48	40	44		80	3+	3-	3-	3-	3-	3-	3-	3+													104	102	99	
Dog died of Distemper on March 2, 1948																																																				
Dog 22.																																																			
Feb 24, 1948	1/2	N	3/4	L		15"	25'		30'	85	108	120	120	108	104	100	100	100	100	96	24	20	20	28	20	20	24	24	24	24	16	3+	3-	3-	3-	3-	3-	3-	1-	3+													102	100	98	
" 26 "	1/4	N	1	S		28"	20'		25'	112	132	128	112	115	112	116	120	124		100	24	24	16	16	16	12	12	12	12		18	1+	3-	3-	3-	3-	3-	1-	3+													103	102	97	
" 28 "	3/8	N	1	S		15"	25'		30'	92	80	100	98	96	96	88	84	88	96	96	30	16	8	8	8	8	10	16	16	20	12	3+	3-	3-	3-	3-	3-	3-	2-	3+													101	99	99	
March 1 "	1/2	N	1	S		20"				126	132	32									16	28	0																														102			
Dog No. 25																																																				
March 6, 1948	1/4	PS		L		30"	10'		15'	96	142	150	132	118	118	124	124		130	20	28	12	12	14	14	12	16		20	3+	2-	2-	2-	1+	3+	3+																		101	100	100	+
" 10 "	3/8	PS		L		15"	15'		25'	100	128	140	140	134	124	116	116	118	124	94	20	30	24	18	18	16	16	16	20	24	20	3+	3-	3-	3-	3-	3-	1+	3+	3+													101	101	100	
" 13 "	1/2	PS		L		25"	20'		25'	104	156	148	118	118	114	136	136	128	136	106	22	30	24	24	26	22	22	24	22	24	36	2+	3-	3-	3-	3-	3-	3-	3+	3+													102	102	101	
" 16 "	1/4	PS		S		35"	6'		9'	94	144	124	118	92	84	84	84			108	20	28	22	18	18	14	22	22			34	1+	3-	3-	3+	3+	3+	3+														102	102	99	
April 10 "	3/8	PS		S		35"	15'		25'	108	154	130	106	98	98	98	100	112		100	24	24	28	24	24	20	20	20	24		26	1-	3-	3-	3-	3-	1+	3+														102	101	100	
" 13 "	1/2	PS		S		40"	20'		30'	120	134	146	136	118	116	116	126	118	118	112	24	26	22	22	22	18	18	16	16	20	24	1+	3-	3-	3-	3-	3-	2-	2+	3+													101	102	100	
" 14 "	1/4	E		L		1'	6'		9'	100	124	98	76	96	96	104	110		114	24	32	0	30	36	28	30	30			24	3+	3-	3-	3+	3+	3+	3+		95+	35"	3'		95"			3+			101	100	100	
" 21 "	1/4	E		S		40"	6'		9'	104	144	148	92	108	104				130	22	44	0	40	44	46					22	2+	3-	3-	3+	3+				95+	35"	5'		95"			3+			102	102	102	
" 23 "	1/8	E		L		50"	3'		6'	104	156	148	124	100	106				110	34	40	0	32	36	40					20	3+	2-	3+	3+	3+				95+	45"	5'		95"			3+			102	101	102	
" 24 "	1/8	E		S		130"	3'		6'	108	144	120	102	100	104				110	24	40	0	24	36	30					30	1+	2-	3+	3+	3+				95+	45"	5'		95"			3+			101	100	102	


Dog No. 15
Feb. 10, 1948
" 11 "
" 12 "
" 20 "
" 21 "
Died of Distemper on Feb. 28, 1948
Dog No. 28
Feb 24, 1948
" 27 "
" 28 "
March 3
" 6 "
" 12 "
" 13 "
" 17 "
April 10
" 13 "
" 14 "
" 22 "
" 23 "
" 25 "

Dog No. 10

Dog No. 10	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour
Feb. 10, 1948	1/4									128		132	130	126	110	118	118	132	136	124
" 11 "	1/2				10"	45"	5'	7'	9'	80		80	92	84	86					128
" 12 "	3/4				130"	130"	5'	7'	7'	140		90	86	90						124
" 20 "	1/4	N	3/4	L		15"	15'		25'	112	152	140	112	128	120	128	142	132		120
" 21 "	3/8	N	3/4	L		25"	15'		25'	140	136	168	140	190	144	138	138	134		132

Dog No. 10	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "
Feb. 10, 1948	28		30	32	26	26	26	24	22	22	32		3+	3+	3+	3+	3+			
" 11 "	24		28	24	24	24					24		3-	1-	3+	3+				
" 12 "	44		0	38	44						18		3-	2+	3+					
" 20 "	32	44	40	40	48	36	30	26	32		32	3+	3-	3-	3-	3-	3-	1+	3+	
" 21 "	32	44	56	66	64	48	42	36	36		32	3+	3-	3-	3-	3-	1-	1+	3+	

Dog No. 10	minutes and degree of dyspnea	time artificial respiration	time 1st dose prostigmine	" 2nd dose	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 10, 1948													102 [illegible]	102 [illegible]	102 [illegible]
" 11 "											1+		102 [illegible]	103	103
" 12 "	3'3+	2'	2'30"		5'								102 [illegible]	102 [illegible]	103
" 20 "													103 [illegible]	103	98 [illegible]
" 21 "													104 [illegible]	99	94 [illegible]

Died March 2, 1948

Dog No. 23

Dog No. 23	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour
Feb. 24, 1948	1/2	N	3/4	L		45"	15'		30'	132	150	120	100	86	90	102	124			124
" 27 "	1/4	N	1	S		10"	15'		20'	104	164	144	136	136	136	124	120	120		96
" 28 "	3/8	N	1	S		35"	25'		30'	112	102	80	88	100	110	108	96	104	100	88
March 2 "	1/2	N	1	S		30"	25'		30'	144	128	92	100	92	100	100	100	110	100	108
" 5 "	1/4	PS		L		11"	9'		12'	160	164	164	156	132	146					148
" 10 "	3/8	PS		L		20"	15'		20'	160	146	140	160	152	148	152	152			166
" 13 "	1/2	PS		L		25"	15'		20'	120	144	128	156	144	144	156	162			144
April 10 "	1/4	PS		S		40"	7'		9'	132	170	164	153	148	152	140	140			160
" 13 "	3/8	PS		S		35"	12'		15'	110	180	174	153	148	144	152				113
" 14 "	1/2	PS		S		23"	20'		30'	100	164	152	136	136	120	113	110	125	140	130
" 21 "	1/4	E		L		1'	5'30"		6'	104	132	142	110	112						100
" 22 "	1/4	E		S		50"	2'		4'30"	116	96	108	96	104						120
" 23 "	1/8	E		L		30"	6'		9'	104	146	120	128	134	136					132
" 25 "	1/8	E		S		40"	6'		9'	108	156	140	140	146	152					126

Dog No. 23	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	1 hour	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "
Feb. 24, 1948	14	14	18	10	10	8	8	12			16	3+	3-	3-	3-	3-	3-	3+		
" 27 "	12	24	22	20	16	16	16	14	12		12	3+	3-	3-	3-	3-	1-	2+	3+	
" 28 "	20	16	20	20	20	18	16	16	16	16	12	1+	3-	3-	3-	3-	3-	3-	3-	2+
March 2 "	20	32	32	24	16	16	14	13	12	13	16	1+	3-	3-	3-	3-	3-	3-	3-	2+
" 5 "	16	20	20	16	20	26					20	3+	3-	2-	1-	3+				
" 10 "	32	24	20	20	20	26	28	36			20	3+	3-	3-	3-	3-	3-	3+		
" 13 "	24	24	26	16	20	20	22	26			22	3+	3-	3-	3-	3-	3-	3+		
April 10 "	36	28	26	24	24	22	26	30			24	1+	3-	1-	2+	2+	3+	3+		
" 13 "	20	30	24	24	20	24	28				20	1+	3-	3-	3-	3-	3+			
" 14 "	16	24	28	20	20	16	20	22	20	26	26	1-	3-	3-	3-	3-	3-	3-	1-	2+
" 21 "	30	32	0	36	32						32	3+	3-	2+	3+					
" 22 "	34	32	24	36	30						24	3+	2+	3+	3+					
" 23 "	20	22	16	24	28	36					24	1+	2-	1-	3+	3+				
" 25 "	16	28	0	22	30	36					26	1+	1-	1-	3+	3+				

Dog No. 23	minutes and degree of dyspnea	time artificial respiration	time 1st dose prostigmine	" 2nd dose	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 24, 1948													101	101	102 [illegible]
" 27 "													102 [illegible]	100 [illegible]	102 [illegible]
" 28 "													101 [illegible]	100	99 [illegible]
March 2 "													101 [illegible]	98 [illegible]	97
" 5 "													102 [illegible]	100 [illegible]	97 [illegible]
" 10 "													102 [illegible]	100 [illegible]	98 [illegible]
" 13 "													102	102 [illegible]	102 [illegible]
April 10 "													102 [illegible]	101	102 [illegible]
" 13 "													102 [illegible]	101 [illegible]	99 [illegible]
" 14 "													101 [illegible]	100 [illegible]	102 [illegible]
" 21 "	4'3+	1'30"	1'30"		5'						3+		101 [illegible]	100 [illegible]	101 [illegible]
" 22 "	2'3+	1'			2'50"						3+		102	101	100
" 23 "	2'1+										3+		101 [illegible]	101	101 [illegible]
" 25 "	2'3+	2'30"			3'20"						3+		101 [illegible]	102	102

Dog No. 11	unit curare gm. given	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after curare before anesthetic	pulse 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	" 1 hour " "	respiration before anesthetic or curare	respiration after curare before anesthetic	respiration 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	Abdominal reflex after anesthetic before curare	Abdominal reflex 3 min. after curare	" 6 " " "	" 9 " " "	" 12 " " "	" 15 " " "	" 20 " " "	" 25 " " "	" 30 " " "	minutes and degree of cyanosis	time artificial respiration	Time 1st deep gasp, time	" 2nd " "	" spontaneous breathing	" administration ended	" completed	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic	temperature at end of duration	temperature 1 hour after administration
Feb 10, 1948	1/4									120		112	106	106	108	114	118	114	110	158	44		36	30	30	28	36	36	30	30	40	3+	3+	3+	3+	3+																102	102	102
" 11 "	1/2				45"	2'	7'	150"	12'	88		140	124	80	78	70	90	95	94	140	24		52	56	44	36	36	36	38	40	36	28	3-	2-	1+	3+	3+																102	102	102
" 12 "	3/4				30"	30"		4'		132		52	64	40	44						25											3-	3-	3-	3-	3-																102		
Dog No. 21																																																		
Feb. 14 1948	1/4	N	3/4	L	40"	9'		15'		100	140	136	106	110	100	104	128			140	16	30	24	24	22	20	18	16		12	3+	3-	2	2-	2+	3+	3+																102	102	97
" 21 "	3/8	N	3/4	L	25"	21'		24'		98	152	136	124	116	108	100	116	126		120	24	28	20	22	22	22	28	28	24		20	3+	3-	3-	3-	3-	3-	3-	2+	3+														102	99	99
" 24 "	1/2	N	3/4	L	30"	20'		23'		98	144	158	134	144	140	136	118	116	118	126	18	12	14	14	12	10	14	16	16	12	20	3+	3-	3-	2-	3-	3-	3-	3-	3+	3+												101	101	99
" 25 "	1/4	N	1	S	12"	16'		12'		112	120	92	100	120	132	120	100			120	20	20	12	12	20	20	18	16		14	1+	3-	3-	3-	1+	3+	3+																102	99	99
" 28 "	3/8	N	1	S	15"	25'		30'		92	80	100	98	96	96	88	84	88	96	100	20	16	8	8	8	8	10	16	16	20	20	1+	3-	3-	3-	3-	3-	3-	1-	3+												102	100	99
March 1 "	1/2	N	1	S	30"	25'		30'		88	160	144	140	128	120	118	96	92	92	140	28	20	32	24	16	16	16	12	12	12	20	2+	3-	3-	3-	3-	3-	3-	3-	2+												102	99	99
" 5 "	1/4	PS		L	35"	9'		12'		72	80	112	112	120	122					80	22	20	28	22	22	24				20	3+	2-	2-	2-	3+																102	102	102
" 11 "	3/8	PS		L	30"	15'		20'		144	178	172	168	180	152	150	144			120	32	20	16	13	14	16	18	22		22	3+	3-	3-	3-	3-	3-	3-	3+													102	102	102
" 13 "	1/2	PS		L	30"	15'		20'		100	172	164	132	138	134	130	142			108	25	30	22	21	18	18	22	24		26	2+	3-	3-	3-	3-	3-	3+														102	102	102
" 18 "	1/4	PS		S	40"	9'		12'		96	148	152	132	128	98	96	120			148	24	24	16	34	32	28	28	36		28	1+	3-	3-	1-	3+	3+	3+														101	102	102
April 8 "	3/8	PS		S	55"	12'		15'		116	132	128	122	132	144	128	152			136	28	16	20	24	24	24	20	24		28	2+	2-	2-	2-	2-	2+	3+														102	102	102
" 10 "	1/2	PS		S	15"	15'		20'		100	108	162	120	138	124	120	126			142	20	34	30	24	30	24	26	28		32	1+	3-	3-	3-	3-	3-	3+														101	102	101
" 15 "	1/4	E		L	30"	45"		4'		116	120	64	80	84						120	20	48	0	32	38					36	3+	3-	3+	3+					45"	45"	35"		45"			3+				102	101	101
" 17 "	1/4	E		S	35"	45"		7'		126	144	188	158	144	140					130	32	38	0	36	31	32				28	1+	3-	1-	3+	3+					45"	35"	35"		45"			3+				102	101	101
" 20 "	1/8	E		L	35"	3'		5'		124	148	112	124	126	134					132	24	44	38	36	38	38				24	3+	1-	3+	3+	3+					30"	25"		4'			3+				102	101	101
" 22 "	1/8	E		S	35"	3'		4'30"		100	124	120	120	114						112	26	34	44	36	32					32	1+	2-	3+	3+																102	102	102

Dog No. 14	units curare per pound	anesthetic used	amount anesthetic used	plane of anesthesia	time for head drop	time full induction	duration of action	time of attempt to rise	complete return to normal	pulse before anesthetic or curare	pulse after anesthetic before curare	pulse 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb. 10, 1948	1/4									120		112	102	108	110	110	124	124	124	120
" 11 "	1/2				35"	45"	6'	7'	9'	132		112	66	58	58	76	84	92	112	136
" 12 "	3/4				40"	40"	28'	22'	25'	88		96	76	76	60	60	80	84	112	84
" 20 "	1/4	N	3/4	L		30"	15'		20'	72	152	176	132	120	112	104	112	112		88
" 21 "	3/8	N	3/4	L		15"	20'		30'	72	132	132	112	120	112	108	108	120	108	85
" 24 "	1/2	N	3/4	L		15"	15'		21'	88	144	120	136	132	128	128	124	112	100	84
" 27 "	1/4	N	1	S		36"	38'		36'	120	160	140	136	128	120	120	124	118	112	112
March 3 "	3/8	N	1	S		20"	60'		70'	128	190	210	164	160	160	156	136	130	128	120
" 4 "	1/2	N	1	S		25"	40'		50'	120	148	164	144	140	138	128	126	116	120	148
" 9 "	1/4	PS		L		12"	6'		9'	116	172	156	144	138	132					120
" 11 "	3/8	PS		L		12"	12'		15'	116	168	160	160	144	160	160	148			132
" 13 "	1/2	PS		L		20"				108	138									
Dog No. 29																				
March 18, 1948	1/4	PS		S		36"	9'		15'	92	108	122	136	108	100	98	104	102		104
April 9	3/8	PS		S		24"	15'		20'	84	100	86	74	74	70	62	84			116
10	1/2	PS		S		25"	20'		26'	94	126	128	124	104	92	80	78	68	74	74
15	1/4	E		L		120"	4'		6'	102	120	131	134	134						120
21	1/4	E		S		130"	5'		9'	134	112	130	136	124						136
23	1/8	E		L		110"	6'		8'	126	124	140	126	124						126
24	1/8	E		S		130"	6'		9'	126	108	130	124	118						124

Dog No. 14	respiration before anesthetic or curare	respiration after anesthetic before curare	respiration 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	" 1 hour "
Feb. 10, 1948	48		36	34	34	38	40	40	40	36	60
" 11 "	54		48	32	32	28	28	30	34	26	48
" 12 "	40		40	40	60	66	0	36	40	40	48
" 20 "	24	36	36	48	36	32	28	32	28		32
" 21 "	24	40	16	12	12	12	18	12	16	10	20
" 24 "	16	28	20	18	16	16	14	14	12	12	24
" 27 "	16	8	10	10	8	8	6	6	6	8	12
March 3 "	24	28	24	16	12	12	12	12	12	8	8
" 4 "	32	40	32	28	28	20	22	19	16	12	24
" 9 "	22	40	30	24	24	24					30
" 11 "	24	44	52	36	28	44	32	32			28
" 13 "	32	30									
Dog No. 29											
March 18, 1948	18	22	22	26	16	16	20	16	20		20
April 9	20	26	18	16	16	12	12	24			26
10	24	30	22	18	20	20	16	16	20	22	18
15	21	40	0	40	42						26
21	22	44	0	36	30						34
23	22	40	20	0	44						32
24	24	28	0	42	38						30

Dog No. 14	abdominal tension after anesthetic before curare	abdominal tension 3 min after curare	" 6 "	" 9 "	" 12 "	" 15 "	" 20 "	" 25 "	" 30 "	minutes and degree of cyanosis	time artificial respiration	time 1st dose prostigmine	" 2nd "	" autorespiratory start	" administration metrazol	" " amphetamine	time death	micturition	defecation	salivation	muscular tremors	temperature before anesthetic or curare	temperature at end of duration	temperature 1 hour after administration
Feb. 10, 1948		3+	3+	3+	3+	3+																104^{2}	104^{6}	104^{8}
" 11 "		3-	3-	3+	3+	3+				4'3+												103^{8}	103	102^{6}
" 12 "		3-	3-	3-	3-	3-	3-	3+	3+	1'3+	14'50"	16'		17'				+		3+		103	103	102
" 20 "	3+	3-	3-	3-	3-	3-	1-	3+														101^{8}	100^{6}	100^{6}
" 21 "	3+	3-	3-	3-	3-	3-	1-	1+	2+													102^{4}	100	98^{8}
" 24 "	3+	3-	3-	3-	3-	3-	3+	3+	3+													102	102	101^{4}
" 27 "	1-	3-	3-	3-	3-	3-	3-	3-	1-													102^{6}	100^{4}	97^{3}
March 3 "	1-	3-	3-	3-	3-	3-	3-	3-	3-													102^{4}	99^{8}	100
" 4 "	1+	3-	3-	3-	3-	3-	3-	3-	3-													102^{8}	101^{8}	100
" 9 "	1+	2-	2-	3+	3+																	102^{2}	100^{2}	101^{6}
" 11 "	3+	3-	3-	3-	3-	3+	3+															102^{4}	103	101^{7}
" 13 "	1+																2'30"					102^{8}		
Dog No. 29																								
March 18, 1948	1+	3-	3-	3-	1+	1+	3+	3+														101	100	102^{8}
April 9	2+	3-	3-	3-	3-	2-	3+															100^{8}	101^{8}	102^{8}
10	1+	3-	3-	3-	3-	3-	3-	3+	3+													100^{8}	100^{4}	101^{4}
15	3+	3-	1+	3+						3'3+	2'10"	2'40"		4'20"						2+		101^{8}	100	97^{7}
21	3+	3-	1+	3+						3'1+	2'40"			4'20"						3+		100^{4}	100^{8}	100^{4}
23	1+	3-	3-	3+						2'2+	5'10"	6'10"		7'						3+		101	100^{8}	100
24	1+	3-	3-	3+						3'3+	1'45"	2'35"		4'						3+		102	101^{4}	100^{8}

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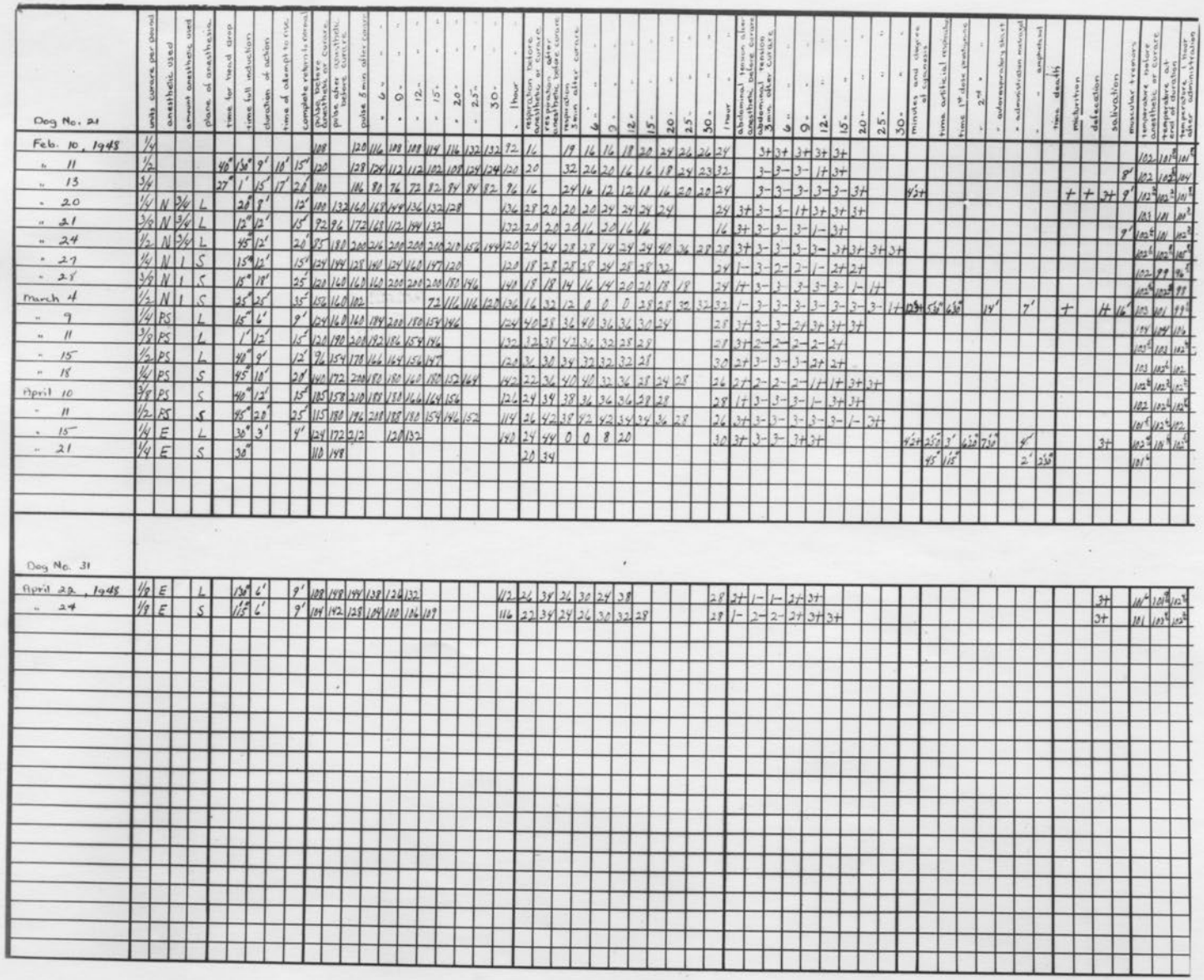
Dog No. 21
Feb. 10, 1948
" 11
" 13
" 20
" 21
" 24
" 27
" 28
March 4
" 9
" 11
" 15
" 18
April 10
" 11
" 15
" 21
Dog No. 31
April 22, 1948
" 24

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