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Glycerol for Intravenous Alimentation: An Experimental Investigation of Its Potentials Utilizing Laboratory Animals

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GLYCEROL FOR INTRAVENOUS ALIMENTATION: AN EXPERIMENTAL INVESTIGATION OF ITS POTENTIALS UTILIZING LABORATORY ANIMALS

by

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A Thesis submitted to the Faculty of the Graduate School of the University of Colorado in partial fulfillment of the requirements for the Degree Master of Science Department of Nursing

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Glycerol for Intravenous Alimentation: An Experimental Investigation of Its Potentials Utilizing Laboratory Animals

Thesis directed by Associate Professor Frances Urton

This study was done to evaluate the potentials of the utilization of glycerol for intravenous alimentation. A solution of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer was administered to New Zealand White rabbits and adult mongrel dogs.

Three rabbits received thirty consecutive daily glycerol infusions. Daily food and water intakes and urine volumes were recorded. Rectal temperatures were taken preinfusion and hourly postinfusion for six hours. A control group of three rabbits received Ringer's lactate with Sorensen's phosphate buffer. Weekly blood samples were obtained via cardiac puncture. At the completion of the study the rabbits were sacrificed and tissues obtained for histopathological studies.

Three experiments were done using adult male mongrel dogs. Each dog received a single intravenous injection of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer. The rate of infusion and volume of solution administered varied in the different studies. Blood and urine specimens were studied at thirty minute intervals to determine any changes caused by the glycerol injection.

This abstract of about 167 words is approved as to form and content. I recommend its publication.

Instructor in charge of thesis
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This research was conducted at the United States Army Medical Research and Nutrition Laboratory, Fitzsimons General Hospital, Denver, Colorado. The writer wishes to express her sincere thanks to Lieutenant Colonel Marion McDowell, Commanding Officer of the laboratory for financial and fiscal support for the study.
# TABLE OF CONTENTS

<p>| I. INTRODUCTION | 1 |
| II. METHODS     | 2 |
| III. RESULTS    | 8 |
| IV. DISCUSSION  | 15|
| V. SUMMARY AND CONCLUSIONS | 17|
| VI. REFERENCES  | 20|</p>
<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Front view of adjustable dog stanchion for intravenous glycerol infusions</td>
<td>6</td>
</tr>
<tr>
<td>2. Side view of adjustable dog stanchion used to restrain dogs for intravenous glycerol infusions</td>
<td>7</td>
</tr>
</tbody>
</table>
I. INTRODUCTION

This study was designed to investigate the potentials of the utilization of glycerol in intravenous alimentation. According to Goodman and Gilman, glycerol is conceded to be toxic in humans and animals when administered in high concentrations over long periods of time. Although glycerol is one of the most widely used pharmaceutical products, very little work has been done to ascertain the fate of intravenously administered glycerol solutions. Perhaps this is due to the fact that early investigators found intravenous glycerol solutions penetrated the red blood cell membrane and caused in vivo hemolysis. Deichmann and Miner and Dalton have reviewed the toxicity of glycerol solutions and state that glycerol given intravenously produces less hemolysis when administered in isotonic saline.

The purpose of this study was to attempt to devise a method for the preparation and administration of a concentrated glycerol solution to laboratory animals without producing the toxic effects reported by previous investigators.

Glycerol is a part of the neutral triglyceride molecule and is, therefore, a substance which animals and humans normally metabolize. According to Parks and co-workers intravenous glycerol is readily absorbed and metabolized, and when oxidized to carbon dioxide and water yields 4.32 kg. calories per gram, slightly more than the 3.74 kg. calories obtained from the same weight of glucose or the 4.18 kg. calories obtained from starch. It is also known that glycerol is
converted to glycogen by the liver.  

II. METHODS

Hemolysis of the red blood cells of animals which have received intravenous glycerol was reported frequently by previous investigators. Therefore, cell fragility tests were conducted to evaluate the effects glycerol has upon rabbit red blood cells in vitro. Glycerol (analytical reagent grade) solutions of different strengths, five, ten, fifteen, and twenty per cent (weight to volume), were prepared with the following diluents which are commercially available for intravenous alimentation: (1) Distilled Water, (2) 0.6/M Sodium Lactate prepared by Abbott Laboratories of North Chicago, Illinois; (3) Hemolyte 75 in five per cent Dextrose, (4) Hemolyte 75 in five per cent Levugen, supplied by Mead Johnson of Evansville, Indiana, and (5) Ringer's Solution, lactated, prepared by Cutter's Laboratories, Berkeley, California. These glycerol solutions were tested to determine if the concentration of glycerol or variances in the electrolytes of the diluents produced hemolysis of the erythrocytes, and if so at what concentrations. The cell fragility tests were performed according to the method described by Thompson, for the micro titration of antigen for hemolytic activity prior to its use in micro complement fixation tests, with the exception that glycerol solutions were substituted for antigen and complement. A mixture of two-tenths ml. (0.2) washed rabbit red blood cells and five-tenths ml. (0.5) of the glycerol solution, prepared as described above, was incubated at thirty-seven degrees Centigrade in a thermatically controlled electric incubator. After three incubation periods, one at thirty minutes, one at five hours, and again at forty-eight hours, the
mixture was centrifuged at one hundred gravities and the degree of
hemolysis, determined by visual subjective evaluation, was recorded in
a range from zero to four according to the scale proposed by Thompson. A zero indicated no hemolysis, a one indicated slight hemolysis, a two
indicated moderate hemolysis, a three indicated considerable hemolysis
and a four complete hemolysis.

Long-term intravenous glycerol study. A group of three New
Zealand White rabbits each weighing approximately 2500 gm. was used for
this study. The rabbits were maintained on "Purina Rabbit Chow Checkers"
guaranteed analysis: not less than fifteen per cent crude protein,
two per cent crude fat, forty-six per cent nitrogen free extract, and
not more than eighteen per cent crude fiber) manufactured by Ralston
Purina Company, St. Louis, Missouri. The glycerol solution tested was
a twenty per cent glycerol, weight to volume, in Ringer's Lactate with
seventy-six ml. Sorensen's phosphate buffer per liter of solution.
The Sorensen's phosphate buffer was made by the method described by
Hepler. This solution pH 7.4 was selected for the study because it
produced no hemolysis of the rabbit red blood cells in vitro within
forty-eight hours as ascertained by the cell fragility test. Each
rabbit was given a daily infusion of fifteen ml. per kg. body weight
for thirty consecutive days. The duration of each infusion was ninety
minutes. The volume and rate of infusion was determined from the
results previous investigators had reported for intravenous alimenta-
tion of rabbits. To detect febrile reactions rectal temperatures
were recorded preinfusion, immediately postinfusion and hourly there-
after for six hours. A control blood sample was analyzed prior to the
onset of the first infusion and weekly thereafter for the duration of
the study to evaluate any changes in blood chemistry or hematology following the glycerol infusions. Blood true glucoses were determined by the Nelson and Somogyi Method.\(^2\) An International Microcapillary Hematocrit Centrifuge and Reader was used for determining microhematocrits. Serum hemoglobins were determined by a color developmental test using a Coleman Junior Spectrophotometer. All urine voided was collected and analyzed daily through one week following the completion of the thirtieth infusion. The urine pH was tested with a Beckman Zeromatic pH meter. Sugar determinations were made on the urine by the Benedict's Test.\(^{28}\) The Benzidine Test\(^{28}\) was used to determine the presence of urine hemoglobin. Robert's Test\(^{63}\) was used to detect the presence of albumin in the urine. Lange's Test\(^{63}\) was employed for determining the presence of acetone in the urine. To ascertain minimal tissue damage one week following the last infusion the rabbits were electrocuted and necropsied. Tissues were obtained and fixed in buffered ten per cent formalin. Duplicate blocks of tissue were fixed in absolute alcohol. The tissues were paraffin-embedded, microscopic sections were cut and stained with Hemotoxylin and Eosin. Duplicate sections were stained by the Gomori iron reaction for the demonstration of hemosiderin pigment. The slides were read by Lieutenant Colonel Samuel W. Thompson II, Chief, Pathology Division, United States Army Medical Research and Nutrition Laboratory, Fitzsimons General Hospital, Denver, Colorado, who in turn submitted a written report and a set of slides to the investigator.

A control group of three New Zealand White rabbits were administered Ringer's lactate with Sorensen's phosphate buffer in the same manner as the group which received the glycerol solution. The
laboratory tests and histopathological studies were the same as described for the experimental group of rabbits.

**Single intravenous glycerol infusion studies.** On the basis of the results obtained in the long term rabbit single intravenous glycerol infusions were administered to dogs since it was deemed more extensive clinical data could be obtained than was possible with rabbits. The dogs used in this study were adult, male, mongrel dogs weighing nine to sixteen kg. which had been maintained on a diet of "Ken. L. Briskit" (guaranteed analysis: not less than twenty-three per cent crude protein, four per cent crude fat, three per cent crude fiber, forty-five per cent nitrogen free extract, eight per cent ash, one per cent calcium, one per cent phosphorus, and not more than one per cent salt) manufactured by Quaker Oats Company, Chicago, Illinois and canned horse meat (content analysis: fifteen per cent crude protein, ten per cent crude fat, two per cent crude fiber and seventy-four per cent moisture) packed by Central Packing Company, North Platte, Nebraska. The daily diet consisted of one pound of "Ken. L. Briskit" and one half pound of horse meat. However, all dogs were fasted twenty-four hours before they were used in any of the following experiments. In the first study a group of five dogs was used. Each dog was given a single intravenous infusion of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer. The volume administered was fifteen ml. per kg. Based upon the report of Zilversmit an infusion time of ninety minutes was selected. A stanchion as depicted in Figures 1 and 2, pages 6 and 7, was used to restrain the dogs for the infusions. The infusions were administered via polyethylene intravenous catheter placement units to facilitate the collection of blood samples at specific times. The
Figure 1. Front view of adjustable dog stanchion for intravenous glycerol infusions.
Figure 2. Side view of adjustable dog stanchion used to restrain dogs for intravenous glycerol infusions. Size: 54 inches long, 24 inches wide and 58 inches high.
urinary bladder was evacuated by a polyethylene urinary catheter which was inserted before starting the infusion. Control blood and urine specimens were collected prior to the onset of the infusion, at midinfusion and at thirty minute intervals for two and one-half hours postinfusion. Blood and urine glycerol levels were determined by the Lambert and Neish Method. Both blood and urine values were corrected for formaldehydegenic material present in preinjection samples. All other clinical laboratory measurements were the same as those reported in the rabbit study. Since these were single infusion studies the dogs were not killed for histopathological studies.

In the second and third experiments in which dogs were employed the same methods were used as in the first dog experiment with the exception that in the second experiment the dosage of the glycerol solution was increased to thirty ml. per kg. body weight. In the third experiment the dosage was the same as in the second experiment but the infusion time was extended to three hours.

III. RESULTS

The cell fragility tests showed no hemolysis of the rabbit blood cells in vitro within forty-eight hours with five, ten, fifteen and twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer per liter. All of the other diluents tested produced hemolysis of the red blood cells within forty-eight hours, regardless of the concentration of glycerol in the solution.

In the first experiment using the three control New Zealand White rabbits, which were given daily intravenous infusions of Ringer's lactate with Sorensen's phosphate buffer, there were no febrile reactions
following the infusions. The daily average rabbit chow intake was 118 gm. The average thirty day weight gain for the group was 438 gm. The daily average water intake was 314 ml. The average twenty-four hour urine output was 178 ml. In this group of rabbits the blood true glucose did not increase during the course of infusions and there were no significant changes in the serum heoglobins or microhematocrits. The pH of the urine was between 8.7 and 9.2 throughout the entire study. One of the rabbits had occasional traces of sugar in the urine. This was not considered significant as a trace of sugar appeared in the urine once during the preinfusion control week. Occasional faint traces of albumin appeared in the urine of these rabbits during both the preinfusion week and the infusion period. No hemoglobinuria or acetone was detected in the urine of this group of rabbits during the experiment.

The three experimental rabbits, which were given daily intravenous infusions of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer, had no febrile reactions prior to the twenty-first infusion. During the last ten infusion days the temperatures were frequently elevated two or three degrees Fahrenheit following the infusion. The peak of the febrile reactions occurred immediately following the infusion or within three hours postinfusion. In all incidences the temperatures were down to normal by the end of six hours postinfusion. The daily average rabbit chow intake was 138 gm. plus approximately thirty-five calories from the glycerol solution. The average thirty day weight gain was 262 gm. The daily average water intake was 345 ml. with an average twenty-four hour urine output of 166 ml. In this group of rabbits a sharp rise in true glucose values over the normal range of 67 to 107 mg per cent occurred. During the
thirty day test period the true glucose values were between 136 and 300 mg per cent. The serum hemoglobins remained within the normal range of zero to one hundred mg per cent.\(^1\) The microhematocrits never fell below the normal range of 33 to 44 per cent.\(^1\) The pH of the urine during the infusion period did not change from the preinfusion values of pH 8.5 to 9.0. The quantity of sugar excreted in the urine varied with each rabbit in the group. One rabbit did not excrete any sugar during the entire test period, while the second rabbit had occasional traces of glycosuria. The third rabbit had a three plus sugar excretion in the first few days of the experiment. During the last part of the experiment the sugar excreted by this rabbit fluctuated from negative to three plus. The degree of glycosuria varied with the increase or decrease in the blood true glucose. The urine contained no hemoglobin until after the twenty first injection. Hemoglobinuria occurred in all three rabbits during the final ten days of the study. All three rabbits had traces of albumin in the urine during the first three weeks of infusions. During the last week of the study the amount of albumin increased to a three or four plus on occasions. There was no acetone in the urine of this group of rabbits throughout the infusion period.

In comparing the results of the experimental rabbits with the results of the control group it was evident that multiple intravenous infusions of a concentrated glycerol solution produced febrile reactions. The temperature elevations were of short duration and occurred either immediately postinfusion or within three hours after the infusion was completed. In all incidences the temperatures were back to normal by six hours postinfusion.

It was noted that although the average daily rabbit chow intake
for the experimental group of rabbits was twenty gm. more than for the control group. The experimental rabbits gained only an average of 262 gm. while the control rabbits gained an average of 438 gm. This difference in weight gain could not be explained as no measurement of urinary glycerol excretion were carried out in this study. The water intake and urine output of the two groups of rabbits in the study did not vary significantly.

Since the true glucose values for the control rabbits did not vary during the study, the increase in blood true glucose of the experimental rabbits was attributed to the glycerol administered. No hemolysis of the red blood cells occurred in either group of rabbits during the study.

Apparently glycerol given intravenously does not affect the urine pH since the pH of the urine did not change in either group. Since the control group of rabbits did not have an appreciable degree of glycosuria and two of the experimental rabbits did, it was apparent that the glycerol produced the glycosuria in the experimental rabbits. The hemoglobinuria which occurred only in the experimental group was attributed to the glycerol. Since the control rabbits had only an occasional faint trace of albumin in the urine and the experimental rabbits had traces of albumin in the urine early in the study and a three or four plus albumin later in the study, the albuminuria was considered to be related to the glycerol infusions.

When the study was terminated both the control and experimental group of rabbits were electrocuted and necropsied. Histopathological studies were performed as described under methods. Upon microscopic examination of tissue sections from the spleens of the experimental
group of rabbits the pathologist, Lieutenant Colonel Samuel W. Thompson II, reported that the cytoplasm of the reticuloendothelial cells with the Malpighian corpuscles was frequently vacuolated. Within the red pulp there were numerous accumulations of eosinophils and quantities of hemosiderin pigment. The pathologist reported that no significant lesion was noted in microscopic tissue sections prepared from tissues of the control rabbits. In the liver of one experimental rabbit portal cirrhosis was noted. No significant lesion was observed in the livers of the remaining two experimental rabbits and three control rabbits. Microscopic examination of tissue sections from the kidneys of all experimental rabbits revealed focal areas within the renal cortex in which the cytoplasm of the renal tubules was vacuolated. Vacuolation of the cytoplasm of the epithelial cells of the renal pelvis was also noted. These lesions were interpreted by the pathologist as evidence of peracute toxic nephrosis related to the intravenous administration of glycerol. In one experimental rabbit they were superimposed upon preexistent lesions of focal chronic interstitial nephritis of undetermined cause. No lesion was observed in the kidneys of the control rabbits. Microscopic examination of tissues from all other organs of the experimental and control rabbits was performed and no significant lesion was noted. In the opinion of Lieutenant Colonel Samuel W. Thompson II, the above lesions were not irreversible.

The first group of five dogs in the study weighed 9.5 - 12.4 kg. The volume of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer administered varied from 142.5 - 185.0 ml. depending upon the weight of the individual dog (fifteen ml. per kg. of body weight). In a similar fashion the caloric value of the solution
which the dogs received varied from 123 - 160 calories. The disappearance of the glycerol from the blood stream and its appearance in the urine was measured. The blood glycerol level dropped rapidly and some of the glycerol appeared in the urine at the end of the infusion. Four to five times as much urine was excreted during the twenty-four hours following the termination of the infusion as was recorded during the twenty-four hour preinfusion period. The five dogs excreted in the urine 39.2, 28.3, 31.9, 32.9 and 22.2 per cent of the administered glycerol, respectively. No febrile reactions occurred during the infusion time or within twenty-four hours postinfusion. The plasma hemoglobins did not go above the preinfusion values, indicating there was no hemolysis (in vivo) of the red blood cells. There was only a slight increase in blood true glucose levels at the completion of the infusions. The glycerol solution did not alter the urine pH of any of the dogs. No glycosuria was detected following the glycerol infusions. Two of the five dogs had traces of hemoglobin in the urine postinfusion. The dogs seemed to tolerate the glycerol infusions well and no change in the dogs behavior was noted.

In the second experiment a group of three dogs weighing 12.2 - 13.6 kg. was used. The volume of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer administered varied from 366 - 408 ml. depending upon the weight of the individual dog (thirty ml. per kg.). In a similar fashion the caloric value of the solution which the dogs received varied from 318 - 352 calories. The disappearance of the glycerol from the blood stream and its appearance in the urine was measured. The blood glycerol level dropped rapidly and some of the glycerol appeared in the urine at the end of the infusion. During the twenty-four hour postinfusion period the urine output increased three
to five times in volume over the twenty-four hour preinfusion control period. The three dogs excreted in the urine 40.0, 39.7 and 31.3 per cent of the administered glycerol, respectively. No febrile reactions occurred during the infusion or within twenty-four hours postinfusion. No hemoglobinuria or glycosuria occurred in any of the dogs following the glycerol injections. One dog had faint traces of albumin in the urine postinfusion. At the completion of the infusion this dog had slight convulsive twitchings of the head and face. The dog's blood glycerol at this time was 561 mg. per cent. The blood glycerol level of all three dogs dropped rapidly postinfusion and was back to preinfusion level within twenty-four hours. There was no significant rise in blood sugars following the infusions.

In the last experiment the glycerol dose remained the same as in the second experiment; however, the infusion time was extended to three hours. A group of three dogs weighing 10.9 - 13.6 kg. was used in this experiment. The volume of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer administered varied from 327 - 408 ml. depending upon the weight of the individual dog (thirty ml. per kg.). In a similar fashion the caloric value of the solution which the dogs received varied from 281 - 351 calories. Following the infusion the blood glycerol dropped rapidly and some of the glycerol appeared in the urine at the end of the infusion. The three dogs excreted in the urine 37.4, 39.9 and 47.2 per cent of the administered glycerol, respectively. During the twenty-four hour postinfusion period the urine excreted increased six to eight times in volume over the twenty-four hour preinfusion control period. The dogs were extremely thirsty during and following the infusion and drank large quantities of water when the infusion
was completed. No hemoglobinuria or glycosuria occurred in any of the dogs following the glycerol injections. Two dogs had faint traces of albumin in the urine postinfusion. The blood sugar did not rise significantly following the infusions. The blood glycerol dropped rapidly postinfusion and returned to preinfusion level within twenty-four hours.

IV. DISCUSSION

In reviewing the results of the long term rabbit study it was interesting to note that the rabbits tolerated a solution of twenty percent glycerol in Ringer's lactate and Sorensen's phosphate buffer for twenty-one days before any adverse clinical symptoms were noted. All of the experimental rabbits showed a definite febrile response following twenty-one glycerol infusions. No febrile reactions occurred in the rabbits that received a control solution of Ringer's lactate with Sorensen's phosphate buffer, therefore the increase in bodily temperatures was attributed to the glycerol. Johnson, Carlson and Johnson and Deichmann also reported that febrile reactions occur frequently when concentrated glycerol solutions are given intravenously to rats and rabbits.

Previous investigators have reported that the intravenous administration of concentrated glycerol solutions causes increased water intake and diuresis. Excessive water intake or diuresis was not noted in the rabbit study, although both were evident in the dog studies. Schubel has reported that the administration of large doses of intravenous glycerol leads to urinary excretion of from forty to fifty percent of the glycerol dose. The urinary excretion of the glycerol infused in the rabbits was not measured. The dogs which were given a
a single infusion of twenty per cent glycerol excreted twenty-two to forty-seven per cent of the infused glycerol within twenty-four hours postinfusion. The urinary glycerol excretion was not affected regardless of the dose given or the rate of infusion.

The rise in the blood true glucose of the rabbits agreed with the findings of Voegtlin, Thompson and Dunn who reported that intravenous glycerol, when administered to fasting rabbits, causes extensive and prolonged hyperglycemia. However, it does not agree with Noble and MacLeod who reported that glycerol had no effect on the symptoms of hypoglycemic shock. Following the single infusion of twenty per cent glycerol the dogs used in this study did not exhibit an elevation in blood true glucose. Whether or not an animal is fasted prior to infusion may have some bearing upon the blood true glucose following the glycerol infusion since the blood true glucose was elevated in the rabbits, which were not fasted, and was not elevated in the dogs, which were fasted.

Although other investigators reported that hemolysis of the red blood cells occurs, following the injection of concentrated glycerol solutions, the serum hemoglobins of both the control and experimental rabbits remained within the normal range of zero to one hundred mg. per cent. There was no increase in the serum hemoglobins of the dogs following a single glycerol injection. These results suggest that administration of multiple infusions of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer does not produce hemoglobinemia. Johnson, Carlson and Johnson pointed out that while an aqueous solution of glycerol causes hemolysis, the same as distilled water, a solution of glycerol in isotonic saline is not hemolytic.

Analysis of the daily urine specimens of all experimental and
control rabbits gave some insight into the effects of glycerol upon the kidney. Two of the three experimental rabbits occasionally excreted sugar in the urine following the glycerol infusions. Glycosuria was not noted in control rabbits. The amount of sugar excreted by the experimental rabbits varied with the increase or decrease of blood true glucose. The albuminuria that followed the injection of the glycerol solution, during the latter stage of the experiment, was attributed to the glycerol. Albuminuria following the parenteral injection of glycerol solutions has been reported by other investigators. \( ^{13,32} \) The hemoglobinuria which occurred in the rabbits after twenty-one daily glycerol infusions was not accompanied by evidence of hemoglobinemia. Microscopic examination of tissue sections from the kidneys of all experimental rabbits revealed focal areas, within the renal cortex, in which the cytoplasm of the renal tubules was vacuolated and which the pathologist interpreted as evidence of peracute toxic nephrosis. It is probable that the glycosuria, albuminuria and hemoglobinuria are all related to altered permeability of the renal tubular epithelial cells resulting from the toxic nephrosis caused by the intravenous administration of glycerol.

V. SUMMARY AND CONCLUSIONS

A solution of twenty per cent glycerol in Ringer's lactate with Sorensen's phosphate buffer was given intravenously to New Zealand White rabbits for thirty consecutive days. The dose was fifteen ml. per kg. body weight and was administered in ninety minutes. No adverse clinical symptoms were noted before the twenty-first infusion, at which time febrile reactions, hemoglobinuria and glycosuria occurred. To these
adverse findings may be added peracute toxic nephrosis which was diagnosed by a pathologist upon microscopic examination of tissue specimens obtained at necropsy. In view of the fact that rabbits tolerated the twenty per cent glycerol solution for twenty-one days before toxic effects were manifested, it is possible that a ten per cent glycerol in Ringer’s lactate with Sorensen’s phosphate buffer could be safely administered for a longer period of time.

Adult male mongrel dogs were given a single intravenous infusion of twenty per cent glycerol in Ringer’s lactate with Sorensen’s phosphate buffer. Three groups of dogs were employed to determine the toxicity produced by various doses and rates of infusion of the same glycerol solution that was administered to rabbits. Although the dogs tolerated the glycerol solution fairly well the following adverse clinical symptoms were noted; excessive thirst, diuresis, hemoglobinuria and convulsive twitching of the head and face of one dog.

A review of the results of this study suggest that further studies, using a ten per cent glycerol solution, might provide more data of academic interest. A lesser concentration of glycerol may eliminate the diuresis and glycosuria and reduce the amount of glycerol excreted in the urine. It was evident that, in view of the rapid excretion of approximately thirty-five per cent of the glycerol in the urine of dogs which received the twenty per cent solution, only about sixty-five per cent was retained by the animal. It was presumed that, in view of the negative blood glycerol levels at twenty-four hours postinfusion, the glycerol retained by the animal was metabolized. However, even if the retained glycerol was completely metabolized it would not compare favorably with a twenty per cent dextrose solution. The latter solution
will yield approximately the same number of calories per gram as glyce-
rol. Approximately ninety-five per cent of the dextrose, administered
at the same rate and concentration as employed for the glycerol solution
used in this study, is normally retained by dogs. This has been repeat-
edly demonstrated by the Toxicology Branch, Pathology Division, United
States Army Medical Research and Nutrition Laboratory, Fitzsimons General
Hospital, Denver, Colorado in their control animals used in routine assay
of the toxicity of preparations intended for intravenous alimentation.
Therefore, the investigator is of the opinion that glycerol has little
value in intravenous nutrition.


