A STUDY OF THE EFFECTS OF DEHYDRATION ON BLOOD UREA NITROGEN IN THE CANINE

by

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INTRODUCTION

Blood urea nitrogen (B.U.N.) is an indirect way of expressing the amount of blood urea (B.U.) present in the blood, or more aptly blood urea nitrogen is the quantity of nitrogen present in the blood urea and it is expressed in milligrams per 100 ml. of blood. Since the molecular weight of urea is 60 and the nitrogen part of it is 28, the blood urea nitrogen is 28/60 of blood urea or the B.U. is 2.14 times that of B.U.N.

Urea is widely distributed in nature and is a constituent of the lowest and highest forms of animal life. It is the diamide of carbonic acid which when hydrolyzed by acids, alkalies or the enzyme urease, yields ammonia and carbon dioxide. Its high nitrogen content (46.6%), its non-toxic character and its ready diffusibility peculiarly adapt it to serve as an agent for the excretion of waste nitrogen. It is eliminated primarily in the urine although some is excreted through the skin particularly if perspiration occurs (38). Urea appears to traverse without apparent resistance almost all membranes within the body. It is the principal end product of protein catabolism and is the main substance excreted by the kidney. In the process of elimination it acts as a natural diuretic and thus is one of the factors controlling the volume of urine flow (38).

The kidney by its remarkable functions of filtration, selective resorption and excretion holds an important position in maintaining the 'milieu interieur' of the body. Urea is completely filterable at the glomeruli, but its percent clearance is always less than that of inulin, indicating reabsorption at the tubular cells. The amount of urea reabsorbed by the tubules is directly proportional to the plasma concentration and because of the direct relationship of clearance to rate of urine flow, it is thought that

urea is largely reabsorbed by a passive process of diffusion distinct from mechanisms which actively reabsorb glucose, amino acids, and ascorbic acid (42). The tubular reabsorption of urea is more limited than that of water and hence the amount of urea is always greater in urine than in serum. The quantity of water required for the elimination of urea depends upon the amount of urea in the glomerular filtrate which in turn is determined by the rate of protein catabolism. As water becomes more and more limited, less and less is available for each increment of urea until a maximal concentration is reached. This is seen in dehydration where urea clearance falls and the concentration of N.P.N. in body fluids rise (21).

Since kidneys are the principal excretory organs for urea, it follows that any derangement in the excretory mechanism of kidney function adversely affects the proper excretion of urea and the urea is consequently retained in the blood. Besides the renal factor, increased nitrogen retention (azotemia) may arise from extra renal factors also. Conditions such as severe vomiting, diarrhea, intestinal obstructions, and hemorrhage into gastro-intestinal tract bring about a state of dehydration with an imbalance between the water and the electrolyte systems of the body. These extra renal factors influence the nitrogen retention in the body and may be reflected by an elevated B.U.N.

Dehydration is a common occurrence in small animal practice. Water is the single largest constituent of living organisms and constitutes the universal medium in which all the complex processes of life take place. When water elimination exceeds water intake the interstitial fluid yields water as long as possible but eventually cellular dehydration occurs. During the preliminary stages of negative water balance, tissues such as skin and

muscles account for the major loss of water, thus maintaining the fluid balance in the more vital organs. Eventually hemoconcentration occurs and is characterized by increased viscosity of blood, high cell and plasma ratio, and by increased specific gravity and protein content of the plasma (42).

Deprivation of food and water through carelessness can occur. Excessive elimination of water through copious sweating, prolonged vomiting, severe diarrhea and marked diuresis are common occurrences in many of the dogs presented for veterinary care. Failure of water absorption from the alimentary tract as in pyloric stenosis or high intestinal obstruction is encountered fairly frequently. Neglected or unconscious patients and mentally disturbed animals which refuse fluids suffer more often from dehydration than presently estimated.

Though the literal interpretation of the word dehydration is depletion of water, the term is misleading because in most instances clinical dehydration includes deficits of sodium salts as well as water and may also be complicated by other deficits and abnormalities such as potassium loss and alteration in acid base balance. Dehydration does imply a contraction of the extracellular volume which is usually shared by both the plasma and interstitial compartments.

Elevations of B.U.N. levels have been encountered in conditions such as renal insufficiency, infectious disease, gastrointestinal derangement, gastrointestinal obstruction, severe hemorrhage, burns, shock, prostatic obstruction, dehydration and electrolyte imbalance in the body fluids. Many disease states which are otherwise unrelated have certain features in common such as starvation, dehydration, vomiting, diarrhea, sweating and renal dysfunction. Dehydration sets in motion transfer of fluids from cells to

extracellular compartments so that the water deficit is shared by all phases of the body fluids. It is evident that in all these varied manifestations, the elevated B.U.N. is either due to renal damage or to dehydration in some form or other which is attended with oliguria or anuria. It has been a common experience of most clinicians to encounter elevations of B.U.N. where no nephritic syndromes are detected. In the majority of these cases the imbalance of the body fluids and electrolytes, producing the condition of dehydration, should be looked upon as the principal culprits.

The state of dehydration brings in its train the resultant hemoconcentration, oliguria or anuria and consequent decrease in urea clearance. These factors which are a predominant corollary of various disease manifestations can be gauged by the estimation of B.U.N. The normal B.U.N. value in dogs varies from 10 to 20 mg. per 100 ml. of blood and any appreciable increase over this is significant and should be interpreted along with the history and condition.

It has been stressed in veterinary literature that the elevated B.U.N. in dogs is due primarily to renal damage and consequently in practice the clinical determination of B.U.N. is predominantly made use of for evaluating the kidney function. It is suggested that the rise in B.U.N. occurring in leptospirosis and other infectious diseases is due to dysfunction of the kidney or to increased tissue destruction. For the most part published material on blood urea nitrogen levels in the dog disregards the syndrome of dehydration and its effect on the B.U.N. readings. The purpose of this study is to assess the significance of blood urea nitrogen in dogs suffering from various forms of dehydrations and to see to what extent this estimation could be helpful as a diagnostic aid in canine diseases.

REVIEW OF LITERATURE

The nature of the non-protein nitrogenous substances (N.P.N.) is described by Peters and Van Slyke. N.P.N. refers to the nitrogen of blood, tissues, urine or exudates which are not precipitated by the usual protein precipitating reagents. It comprises of a mixture of compounds including urea, ammonia, amino acids, creatine, creatinine, uric acid, and other nitrogenous substances spoken of as undetermined nitrogen. They represent intermediary products of protein metabolism in the process of transportation or end products of metabolism on their way to the excretory organs (38). In both health and disease the degree of nitrogen accumulation depends on the functional activity of the kidneys, rate of protein catabolism and the disturbances in the body fluids. For practical laboratory diagnosis it is necessary to determine only the N.P.N. or the urea nitrogen. In practice the estimation of urea nitrogen is preferred as it is a single value, its determination is less difficult and it has a greater variation in disease than the other N.P.N. substances (9).

Although the N.P.N. normally constitutes only one percent of the total nitrogen of the blood Myers attaches greater importance to variations in the substances which form the non-protein than the protein nitrogen. This is due largely to the fact that these variations in the non-protein constituents give us an insight into some of the processes of anabolism and catabolism (37).

The concentration of N.P.N. of the blood is chiefly determined by the balance between the rate of protein catabolism and the urinary output. The excretion of nitrogen in feces and sweat is almost negligible except when

the sweating becomes profuse. The kidney is considered as the main channel for nitrogen excretion. If the fluid available for urine formation is small in comparison with waste nitrogen requiring elimination, the concentration of N.P.N. in the blood will rise. Azotemia or elevations of the N.P.N. substances in the blood may occur in many situations. The variations of these agents in health and disease are clearly indicated by determining the urea nitrogen level of the blood (38).

Creatine is a constituent of most tissues but is rather unevenly distributed in the body. Its high concentration is seen in striated muscles, testes, liver and kidneys and to a lesser degree in brain. In blood it is seen in low concentrations. A large part of creatine in muscle exists in combination with phosphoric acid as phosphocreatine. It plays some role in the activity of muscle and carbohydrate metabolism (38).

Creatine and creatinine are also formed in the liver though the initial step in their formation takes place in the kidney, where arginine and glycine react through a process called transamidination to form the compound guanidino acetic acid. This compound is carried to liver where it is transmethylated from methionine to creatine. Before creatine is excreted it is converted to its cyclic anhydride creatinine. High protein diet, starvation, carbohydrate deprivation, diabetes, wasting diseases, fevers, exophthalmic goitre and certain muscular dystrophies show increased creatinuria. Unlike the excretion of urea which is derived largely from exogenous sources, the creatinine output is practically independent of the protein level of the food. Creatinine excretion is therefore considered to be an index of the magnitude of the metabolism of the tissues, especially of the muscles.

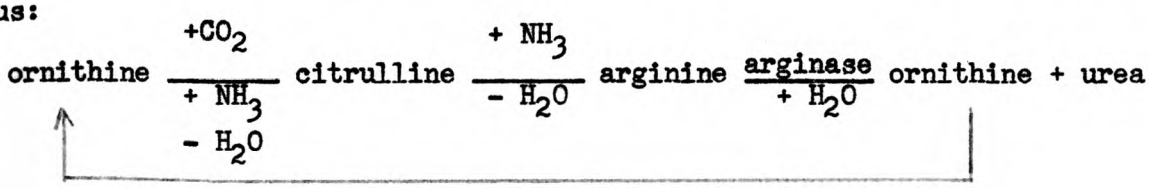
Urea as such is distributed throughout nature and is a constituent of body fluids in the lowest and the highest forms of animal life. Being

readily diffusible it is found in about the same concentration in the various tissues and body fluids such as lymph, bile, cerebrospinal fluid and pancreatic juice as in blood (5).

The formation of urea appears to be a function of the liver exclusively. This has been demonstrated by experiments in which there was complete cessation of urea formation after the liver had been removed. Moreover, experiments with isolated tissues, incubated in thin slices under physiological conditions have also shown that only liver tissue is capable of synthesizing urea (26).

This function of ureogenesis of liver has been proved by the experiments of Mann and his associates in hepatectomized dogs. They have shown that, after the injection of glycine or alanine, the injected amino acid rose in the blood and urine with no evidence of urea production (5).

It has been clearly shown that in dogs urea formation or ureogenesis is exclusively a hepatic function. The absorbed amino acids undergo deamination with the formation of ammonia which is then converted by the liver into urea. Studies with the isolated tissues incubated in thin slices, substantiate the observation that only liver tissue is capable of synthesizing urea. The conversion of arginine to ornithine and urea by the liver enzyme arginase is the reaction that is limited to this organ. Ornithine thus liberated by the decomposition of arginine is used over and over again to facilitate urea production. In the process, orinthine gives rise to citrulline which finally forms arginine to continue the cycle. The whole scheme may be represented thus:



The fact that there is a higher concentration of urea in the blood coming from the liver and a lower concentration in the venous blood leaving the kidneys than there is in the systemic blood clearly shows that urea is formed in the liver and is eliminated by the kidneys (38). Since the quantity formed by the liver appears to be determined by the efficiency of deamination of amino acids, a decreased formation of urea may occur in such diseases of the liver as marked cirrhosis, toxic hepatitis, carcinoma and acute yellow atrophy of liver (30).

Urea is the principal end product of the metabolism of protein substances in mammals. Its source is considered to be endogenous when it is derived from tissue proteins and exogenous when it is metabolized from food proteins.

Nielsen (10) in studying urea excretion in mammals revealed further information on the effect of food on urea formation and elimination. He observed that in all mammals investigated, the urea clearance was found to vary with the protein content of the diet. When nitrogen intake was reduced, the urea clearance decreased, sometimes considerably, and when the intake was increased the urea clearance was increased to some extent. He further observed that in the dog the variations in the protein intake had a greater effect upon the renal hemodynamics than in man. Intake of meat in an animal that had been starved for 16 or more hours produced an acute increase in renal plasma flow, glomerular filtration rate and urea clearance. This increase which reached a maximum value three to four hours after the protein intake depended to a certain extent upon the quantity of meat given. If more than 60 gms. of meat per Kgm. of body weight was given in one feeding no further increase in renal function could be produced.

Widdowson et al. (41) studied the excretion of urea, ammonia and purine end products by the new born animal. Their observations are pertinent with regard to the protein metabolism and urea excretion. They found that the percentage of the total nitrogen excreted as urea by new born babies, pigs and pups when compared with the values of adults were lower and they attributed this to the utilization of amino acids toward anabolism at this age.

In discussing the excretion of urea by the kidneys Grollman (24) points out that the urea is excreted by filtration. Not all of the filtered urea is excreted since back diffusion may occur. The proportion reabsorbed by this latter process varies to some extent depending on the quantity of urine formed but averages approximately 50 percent of the filtered urea. The concentration of urea in the blood, therefore, varies with the rate of catabolism of protein, the rate of excretion of urine and the efficiency of the kidneys as measured by glomerular filtration.

He further states that the B.U.N. may be considerably increased as a result of injury, infection or other destructive causes when the catabolism of protein is excessive and the excretory demands on the kidneys are high. Insufficient intake of fluid or abnormal output of fluids, as in sweat, vomition, diarrhea, fistulous discharges or diversion of fluids to extracellular compartments as in edema and ascitis, produces inadequate urine. This is due to the lack of fluid for renal excretion and the B.U.N. accumulates. Advanced renal insufficiency increases B.U.N. due to failure of proper filtration (24).

It has been established that the variation of the normal blood urea nitrogen in dogs is considerable and depends mainly upon the nature of food offered. According to Bollman and Adler (3) the normal value of B.U.N. of

dogs lies between 8 and 20 mg. per 100 ml. of blood. Kingma and Catcott (29) report a normal range of 12 to 17 mg. urea nitrogen per 100 ml. of blood. Allison et al. (1) working on 20 normal dogs, well bred, from good homes and free from all abnormalities, report that the B.U.N. varied from 10 to 22.6 mg. percent with an average of 15.5 mg. percent and a mean deviation of 2.4 mg. per 100 ml. of blood. Creatinine varied from 1 mg. to 1.7 mg. per 100 ml. of blood with an average of 1.36 and a mean deviation of 0.13 mg. percent. They further state that determinations reported in a number of literatures for B.U.N. and creatinine compare favorably with their findings and that these determinations were made on laked blood and the hemolysis did not change the concentration of B.U.N. or creatinine significantly (1). Crandall (14) surveyed the blood urea (B.U.) levels of hospitalized dogs and found that normal blood urea of healthy hospitalized dogs ranged between 20 and 40 mg. (i.e., 9 to 18 mg. of B.U.N.) per 100 ml. of blood.

Estimations of blood urea and blood urea nitrogen have been reported in various conditions. Levinson and MacFate (31) listed several conditions which showed the increased non-protein nitrogen such as nephritis, uremia, peritonitis, renal obstruction, malignancy, pneumonia, intestinal obstruction, prostatic obstruction, metallic poisoning, and cardiac failure. Decreased values were seen in acute liver destruction and eclampsia. Kolmer (30) in his treatise on clinical diagnosis by laboratory examination gave a wide list of the conditions in which urea nitrogen and creatinine were increased. Elevations were noted in reduced glomerular filtration due to subacute or chronic nephritis. Conditions, associated with marked oliguria or anuria, such as acute glomerular nephritis, toxic nephrosis, obstructing ureteral calculi, post operative urinary suppression caused retention of

urea nitrogen. Damage to kidney parenchyma due to tuberculosis, pyonephrosis, hydro-nephrosis, renal cortical necrosis or congenital polycystic disease of kidneys also produced retention, Prostatic obstruction commonly showed increased B.U.N. The excessive endogenous protein metabolism due to fever of acute infections raised the level of B.U.N. The list included dehydration caused by severe hemorrhage, pyloric spasm, acute intestinal obstruction, gastric tetany, vomiting, diarrhea and the loss of extracellular fluids in profuse sweating. Surgical procedures due to limitations of fluid intake, loss of fluid and chloride in extensive burns, histamine shock and adrenal insufficiency were also mentioned as factors causing elevations of B.U.N. Other conditions listed included congenital hypoplasia of the kidney, renal amyloidosis and hemoglobinuria.

Renal insufficiency is one of the important conditions where elevated B.U.N. is observed. Bloom (8) states that urinary changes due to chronic interstitial nephritis are characteristic of impaired renal function. The kidney is unable to concentrate the urine and the specific gravity of the urine approaches that of the deproteinized blood. There is said to be a "fixation" of the specific gravity of the urine between 1.008 to 1.012. The analysis of blood may give some indication as to the severity of the renal damage. The amount of N.P.N. retained in the blood is of diagnostic and prognostic importance. If the B.U.N. is above 50 mg. per 100 ml. then a uremic condition is said to prevail.

Coffin (13) discussing the significance of azotemia indicates that B.U.N., N.P.N., and creatinine may be used as a measure of kidney efficiency. In the dog rather high normal values, B.U.N. up to 40 mg. percent may be expected in well nourished meat eaters. Values of 80 to 400 mg. percent

urea nitrogen may be expected in renal insufficiency in dogs with somewhat lower values in herbivorous animals.

Bell (4) in analysing the B.U.N. findings in renal diseases of man observed that an elevation of B.U.N. is not found until 50 percent of the nephrons have been destroyed and hence it is of little value in diagnosis of nephritis in its early stages. Very high levels of 200 mg. percent or more are seldom reached before the onset of clinical uremia. Bell suggests that the urea clearance test may be of great value in the diagnosis of the early stages of nephritis.

Allison et al. (2) studied the effects of kidney damage upon the nitrogenous constituents of dog's blood and upon the specific gravity of urine. They have revealed that in most cases of kidney damage the ability to concentrate the urine decreases and that urea nitrogen retention in the blood is a better measure of renal impairment than other forms of N.P.N. Their data suggests that after a period of limited fluid intake a low specific gravity of urine correlated with higher than normal blood urea is of clinical significance in detecting renal impairment (2). Middleton (34) cautions in assessing renal insufficiency by the degree of azotemia. He points out that hemoconcentration not only vitiates the determinations of blood constituents but also materially increases the toxemia of renal insufficiency. Azotemia is profoundly influenced by dehydration and parenteral fluids are indicated in such instances.

Bloom (8) describes the symptoms of uremia and its relation to high blood urea nitrogen. Uremia is the symptom complex resulting from renal insufficiency and is characterized by the retention of nitrogenous constituents in the blood. Though the exact mechanism of uremia is not known,

factors such as toxic urinary substances, changes in osmotic pressure of blood, hyperkalemia and the retention of products of intestinal putrefaction, (indican and phenols) have all been incriminated as causes. He interprets uremia as a complex auto-intoxication resulting from a combination of biochemical disturbances of diverse types each of which singly is probably not predominant or necessarily causative (8).

Bright and Christison (38) agreed that urea, the chief end product of protein metabolism, was the most abundant urinary excretory substance which accumulated in the blood in nephritis. Though it has been incriminated as the toxic compound responsible for the symptoms of uremia it is actually a peculiarly bland substance. They opine that the misconception arose due to the failure to recognize the dehydrating effect of the diuretic action of urea. The authors are of the opinion that the uremic symptoms seen by high feeding of urea or intravenous injections of urea are in reality due to the loss of fluid resulting from the efforts to eliminate the urea from the body.

Coffin (13) also thinks that there is no direct relationship between high values of B.U.N. and uremia. He states that there is apparently no direct proportion between the height of these findings and the prognosis of any individual case. Normally, high values indicate a grave prognosis but one often sees animals with astronomical figures for blood urea nitrogen which are in better clinical state than animals with much lower values. The author thinks that the toxicity in uremia is not due to the substances measured but to other substances for which no chemical tests are commonly employed.

According to Milks (35) many fatal cases of uremia have been diagnosed as some form of gastrointestinal inflammation and this in turn attributed to ptomaine poisoning, putrid and decomposed meat or food, auto-intoxication,

poisoning and infections. He quotes Boyd as stating that the symptoms may be cerebral with excitement, apathy, muscular twitching, convulsions and coma; gastrointestinal with vomiting or diarrhea; or pulmonary with dyspnea due to acidosis. It is a toxemia of uncertain nature always associated with urea in the blood. The author is certain that the urea circulating in the blood is not the primary cause, because dogs given high doses of urea intravenously have withstood the uremic tendency. He thinks that different toxic products may occur in different cases.

Many of the acute infectious diseases produce an elevated B.U.N. Peters and Van Slyke (38) in discussing the azotemia of infectious disease observe that severe infectious diseases show an increased N.P.N. substances in the blood. A moderate increase of B.U.N. up to 25 to 30 mg. percent were mostly due to the destruction of tissue proteins. The high nitrogen catabolism and the scanty urine seen in these conditions favor the accumulation of nitrogen in the blood and tissues. Prevention of dehydration and providing plenty of fluid to promote adequate urine flow usually eliminate such accumulation.

Bild (6) believes that the best use of the determination of the blood urea is in the diagnosis of leptospirosis. When the clinical symptoms are suggestive the blood urea invariably goes up and this rise is not seen in infectious hepatitis or distemper and thus it is to him a worthwhile signpost of diagnostic and prognostic value in leptospirosis (7). Mosier (36) reporting on leptospirosis in pet animals points out that in chronic type of leptospirosis evidence of an elevated B.U.N. is a very useful diagnostic aid. Again reporting on the laboratory findings in acute hemorrhagic and icteric types where hemoconcentration was marked, leucocytosis and increased sedimentation rates were noticed. He adds that in toxic

uremic stages the B.U.N. readings would rise extremely high and in one instance it reached 480 mg. percent. The electrolyte abnormalities included an increased phosphate and decreased chloride level. McIlnay (33) also found that blood urea was decidedly higher in positive cases of leptospirosis. His findings ranged from 60 to 180 mg. percent. He had also noted an increased sedimentation rate associated with elevated blood urea.

Kingma and Catcott (29) studied the effects of foreign bodies in the canine alimentary tract. They considered that the two usual sites of most obstructions in the alimentary tract are the areas of the pylorus and the terminal part of the ileum. They studied the B.U.N. variations in dogs in which foreign bodies were forcefully introduced into the stomach, in dogs whose pylorus and ileum were partially obstructed, and also in dogs whose pylorus and ileum were completely ligated. Their results demonstrated no significant changes of B.U.N. in the dogs in which gastric foreign bodies were placed. In dogs with intestinal foreign bodies there was a significant increase in each trial. Animals which succeeded in moving the foreign object down the intestinal tract had a fluctuating B.U.N. In one dog which died within 72 hours of a duodenal occlusion the B.U.N. reached 126 mg. per 100 ml. 48 hours following surgery. The dog in which a foreign object was placed in the ileum showed B.U.N. levels varying from 29 to 47 mg. percent. Only two dogs were utilized in the study of the effects of complete intestinal obstructions.

Haden and Orr (25) in their experiments showed that the first chemical changes taking place during intoxication incident to obstruction of the upper intestinal tract were a fall in blood chlorides and a rise in carbon dioxide combining power of the plasma. The rise in N.P.N. did not occur

until there was a marked depletion of chlorides. Changes in the chloride metabolism was the most striking feature of the intoxication due to high obstruction. Depletion of chlorides may have been related to the increased protein destruction. They stated that the most obvious explanation for the disappearance of the chlorides was a loss by vomiting. However, these authors have observed a chloride loss in dogs in which vomiting had not occurred and in rabbits which cannot vomit. They opine that the chlorides may be used up in the course of increased tissue destruction. They further demonstrated that ligation of the duodenum, ligation of the duodenum with gastroenterostomy, and ligation of the upper half of the ileum, resulted in a fall in chlorides, a rise in N.P.N. and B.U.N., and an increase in the carbon dioxide combining power of the plasma. The fundamental change was a fall in chlorides followed by an alkalosis. The fall in chlorides was attributed to the utilization of the chlorine ion in the course of the intoxication. Ligation of the ileum at the ileocecal valve was followed by little increase in nitrogen and no change in the chloride content or carbon dioxide combining power of plasma.

De Wardener (15) points out that gastric juice consists of water containing 145 mEq/L of chlorides, 83 mEq/L hydrogen ions, 50 mEq/L of sodium and 12 mEq/L of potassium. Following persistant vomiting associated with pyloric obstruction an acute depletion of water, hydrogen ion, chlorides, sodium and potassium occurs. Each of these give rise to its own sequence of disturbances in body fluids. This continuous loss of water with sodium and chlorides reduces the volume of all fluid compartments including the blood volume which in turn brings about renal vaso constriction with the resultant diminution of glomerular filtration rate and a rise in B.U.N.

Gamble and Ross (22) studied the factors in the dehydration following pyloric obstruction. They found that there was a reduction of plasma chlorides due to a withdrawal of Cl' from the body as a result of the continued vomiting of gastric secretions. The fall in the plasma chloride was accompanied by a rise in bicarbonate. Another important change noted was a rapid and extensive dehydration of the plasma indicated by a progressive increase in the concentration of the protein. They were of the opinion that a moderate impairment of renal function shown by a rise in the urea content of the plasma may reasonably be attributed to the lack of water intake, there being practically no absorption of the water taken in the stomach. These authors also support the view and concur with the results of the experiments of Haden and Orr. They tested the therapeutic efficacy of the administration by clysis of a number of salts such as potassium chloride, ammonium chloride and calcium chloride and found all of these to be not only of no benefit but harmful. They have quite thoroughly demonstrated that the injection of sodium chloride solution tends to restore normal plasma values and greatly prolong the life of the animal.

The metabolic alkalosis which occurs in pyloric obstructions is due to the increase of the bicarbonate fraction (26). This type of alkalosis occurs much more commonly as a consequence of high intestinal obstruction, after prolonged vomiting or after the excessive removal of gastric secretions containing hydrochloric acid. The elevated blood pH of an uncompensated alkalosis may lead to tetany by inducing a decrease in ionized serum calcium. This is referred to as gastric tetany, although its relation to the stomach is incidental. The chloride deficit caused by the removal of gastric secretion is replaced by bicarbonate. This type of metabolic alkalosis is aptly

termed "hypochloremic alkalosis". Studies on alkalosis by Burnett et al. (11) showed severe alkalosis and renal failure in man as a result of the loss of gastric contents following pyloric obstruction. The evidence suggested that although the normal kidney may suffer considerable functional impairment as a result of alkalosis this impairment of function is reversible.

Markowitz (32) notes that the nearer the obstruction is to the pylorus, the greater is the urgency for surgical correction. When the obstruction is close to the pylorus, vomition is more frequent and the loss of fluid and sodium chloride is greatly increased. The loss of Cl ion results in alkalosis and dehydration. He further observed that the obstructed segment would elicit toxins which when absorbed might produce the quicker lethal effect.

Wangensteen and Leven (40) experimented with intestinal obstructions at various levels. They concluded that the early death occurred as a result of dechloridization, dehydration and toxemia together or singly. They state that in complete obstruction of the upper part of the intestine of the dog the life of the animal may be prolonged three or four weeks by the subcutaneous injection of saline. If saline is not administered and if the vomiting continues, death usually occurs within three or four days. Hypochloremia, a rise in blood urea and increased carbon dioxide combining power result from the loss of essential fluids due to vomiting. When the obstruction was established in the lower part of ileum the dogs survived for a longer period and the incidence of vomiting greatly decreased.

Dragstedt (16) maintains that death in upper intestinal obstruction was associated with failure of reabsorption of gastric and pancreatic juices since the jejunum had but little absorptive power. The slower retrograde

process in lower obstructions results from the fact that a considerable length of absorbing intestine may lie between the stomach and the site of obstruction.

Wiggers (42) described the mechanism of dehydration in the body. When water elimination exceeds water intake the interstitial compartment yields water to a certain extent till actually the cells get dessiccated or dehydrated. He points out that in the preliminary stages of this kind of negative water balance tissues such as the skin and muscles give out considerable quantities so that the more important organs may not suffer. In this stage the blood also becomes anhydremic and consequently becomes more viscous and increased in its specific gravity, protein content and other dissolved constituents.

The author also describes the general symptoms attributed to dehydration. The loss of fluid gives rise to a characteristic shrunken appearance of the body and face. The skin losses its elasticity, becomes hard and leathery, and the body loses weight. When the depletion reaches an advanced stage, the heat regulatory mechanism of the water is deranged and fever may result. The author states that this kind of fever is seen as a symptom of desert thirst and in infants when dehydration is marked. Further, the anhydremia leads to diminished urinary excretion which in turn causes retention of acid radicals causing acidosis. In far advanced cases circulatory failure or cerebral disturbances may result.

Elkinton and Max (20) subjected four dogs to a prolonged water deprivation experiment in order that they might study the N.P.N. and electrolyte distribution. They found that the concentration of sodium in the serum rose showing hypertonicity of body fluids. There was a considerable amount of

water loss in the body but this was more evident in the intracellular than the extracellular compartment. N.P.N. of the blood did not rise until the terminal stages and the specific gravity of the uring remained high.

The relationship between food and water ingestion in dog has been studied by Cizek (12). He states that the amount of fluid and the interval of ingestion definitely bears a relationship to the amount of food ingested. A highly watered diet may not be immediately followed by any fluid intake whereas the same food given dry induces drinking of water in direct proportion to the amount that has been given and with such accuracy that the total intake bears a fixed ratio to the food. When the water content of the food is changed, intake of fluid is accurately readjusted so that the total intake for a given amount of food remains constant.

Elkinton suggests that the weight loss in starvation is due primarily to a loss of carbohydrates, protein and fats, which provide energy for metabolic needs. In protracted starvation, the body relies chiefly upon fat and tissue protein and it is the combustion of tissue protein that releases a certain amount of cell potassium. In addition, nitrogen products, chiefly urea, accumulate from the degradation of the protein molecule and acetone bodies accumulate when fatty acids are used in excess of the capacity of the excretory organs to excrete. Hence, the net effect of acute food deprivation is a destruction of body tissues and a loss of some of the body potassium in the urine.

Vomiting is accompanied by all of the changes seen in dehydration and starvation. Such patients also develop negative balances of body constituents as a result of losses in the vomitus. Gastric secretion contains considerable amounts of sodium and of potassium in addition to its high

content of hydrochloric acid. The loss of chloride ion resulted in hypochloremia and metabolic alkalosis.

Elkinton and Danowski (19) state that diarrhea produces varying degrees of dehydration and starvation. More specific deficits of body constituents through losses of gastro-intestinal secretions may occur. They found that in contrast to gastric juice, the intestinal fluids contained bicarbonate rather than chloride as the predominant anion. Sodium and the potassium were again the chief cations. Analysis of diarrheal stools revealed a much higher content of water, sodium, potassium, chlorides and nitrogen than that present in formed stools. The electrolytes which were lost were those of ingested or endogenous material or both. They state that with more severe and protracted diarrhea a greater dehydration results, which raises the concentration of extra-cellular electrolytes even though actual deficits exist. This explained the marked hyperchloremia, hypernatremia and hyperkalemia. The accompanying metabolic acidosis is due to losses in bicarbonate in the stool, to starvation with accumulation of ketone bodies and to renal failure with hyperchloremia.

The literatures reviewed, generally indicate an elevation of the N.P.N. substances in dehydrations and intestinal obstructions. The investigators have laid more stress and importance on the body fluid and electrolyte aspects, rather than the blood urea level or its significance. It has been widely accepted that in all the dehydrations and starvations an acidosis is the rule except in the dehydration accompanied by vomiting where alkalosis supervenes. It has also been established that the cause of death in extreme cases of uremia is not due to the toxic character of the blood urea present in the system but due to other toxic products of metabolism, the nature of which is still uncertain.

MATERIALS AND METHODS

For this study a total of 30 dogs, 12 males and 18 females of mixed breeding were used. The dogs varied from one to three years in age and ranged from 10 to 23 pounds in weight. The state of health was determined by physical examination and clinical observation for a period of 48 hours prior to the commencement of the experiment. All dogs utilized were considered to be clinically healthy. Only dogs in which B.U.N. was within the normal range of 10 and 20 mg. percent were selected. The dogs were picked at random, numbered from 1 to 30 and placed in one of the six groups for this study. In each instance the weight of the dog was recorded and the B.U.N. level determined before the experiment was started.

The method and the principle of B.U.N. determination used in these series was the one recommended by Karr (28) using the Klett-Summerson photoelectric colorimeter. Protein-free filtrate obtained from the sample of blood is treated with phosphate buffer solution and the enzyme urease. Upon incubation, the urease decomposes the urea and liberates ammonia which forms ammonium carbonate. Gum ghatti is then added to form a protective colloid and keep the solution from becoming cloudy. When Nessler's solution, which is an alkaline solution of the double iodide of mercury and potassium, is added, it reacts with ammonium carbonate to form an orange-yellow dimercuric ammonium iodide. The depth of color is measured in the Klett-Summerson colorimeter as compared with a standard urea solution.

About three ml. of blood was drawn from the cephalic vein with a syringe and 20 gauge needle rinsed with 10 percent sodium citrate solution as the anticoagulant and put in a five ml. dry test tube. Two ml. of this well mixed blood was pipetted into a 50 ml. dry Erlenmeyer flask. Sixteen ml. of N/12 sulphuric acid was passed through a pipet into the flask and mixed well

to lake the blood. Two ml. of 10 percent sodium tungstate solution was slowly added to the laked blood, drop by drop and with constant shaking. The tungstic acid formed precipitated the protein to a pinkish coagulum which with vigorous shaking developed a brown color. The flask was allowed to stand for five minutes and the contents were filtered through a funnel with nine cm. No. 40 Whatman filter paper into a 10 ml. dry test tube. The protein-free blood filtrate thus obtained was water clear. Five ml. of this filtrate was transferred to a blood urea tube graduated into 25 and 50 ml. One drop each of phosphate buffer and glycerol urease was added to this and contents were placed in a constant temperature water bath at 50 degrees centigrade for 15 minutes. At the end of the period the mixture was diluted to 25 ml. mark with distilled water and mixed well. Ten ml. of the diluted solution was pipeted into Klett-Summerson colorimeter tube to which two drops of gum ghatti solution had been previously added. To this one ml. of Kock-McMeekin Nessler's solution was added when a clear yellowish orange color developed. After allowing the mixture to stand for 10 minutes the intensity of color was read in the colorimeter. To correct for the possible ammonia in the reagents, especially in the urease solution, a blank was prepared, using five ml. of distilled water instead of the protein-free blood filtrate and repeating the complete procedure as described above. The reading of this blank was deducted from the reading of the unknown to arrive at the true reading of the unknown. Similarly the reading was taken for a standard urea solution containing an equivalent of 45 mg. percent of urea nitrogen with 1 in 10 filtrate. Blood urea nitrogen was calculated against the standard solution of urea by the following formula:

$$\frac{45}{\text{reading of standard minus blank}} \times \text{reading of unknown minus blank} = \text{milligrams percent of B.U.N.}$$

Group I, consisting of four dogs, Nos. 1 to 4, were used for the study of the effects of starvation on B.U.N. levels. Food and water were withheld from three of these animals, Nos. 2 to 4, and 24 hour changes in B.U.N. and weight were recorded for a period of five days. These results were compared with that of the control dog No. 1.

Group II consisting of four dogs, Nos. 5 to 8, were used for the study of the effect of dehydration on B.U.N. levels. Three dogs, Nos. 6 to 8 were allowed dry Gaines food but water was completely withheld. The changes in B.U.N. and weight were recorded at 24 hour intervals for five days and compared with that of the control animal No. 5 which received the normal food and water.

In Group III, four dogs were used, Nos. 9 to 12, for the study of the effect of dehydration through induced diarrhea. Three of the dogs, Nos. 10 to 12, were rapidly dehydrated by daily dosing with one ounce of magnesium sulphate in three ounces of water either orally or for intractable dogs by the use of stomach tube. Food and water were withheld and daily variations in B.U.N. and weight were recorded at 24 hour intervals and compared with the control dog No. 9 in the series.

Group IV consisted of four dogs, Nos. 13 to 16. Three of these, Nos. 14 to 16 were given one ounce of castor oil at 24 hour intervals. The effects of purgation on B.U.N. and weight were noted at 24 hour intervals for a period of five days and compared with that of the control animal No. 13.

Group V consisted of seven dogs, Nos. 17 to 23, from which food was withheld for 18 hours prior to the surgery. Anesthesia was induced by intravenous injection of nembutal at the rate of one ml. for every five pound body weight. The dogs were secured in the dorso recumbent position, the

area prepared and draped for an aseptic surgery. The abdomen was opened just posterior to the xiphoid cartilage with the incision extending posteriorly along the linea alba for a distance of 6 cm. The stomach and duodenum lying slightly to the left of the median line were located and lifted through the incision. The pylorus was ligated using a double strand of No. 3 twisted silk. Care was taken to see that the ligation was tight enough to prevent the passage of food and at the same time not too tight to cut through the tissues. The stomach and the duodenum were carefully replaced and the incision closed by suturing the peritoneum and rectus abdominus muscles in the first row of sutures and the external fascia of the rectus muscles with a second row of continuous suture using No. 0 chromic catgut. The skin was closed with interrupted suture of No. 30 silk. Control dog No. 17 was subjected to the same procedure of surgery and manipulation of stomach and duodenum but the pylorus was not ligated. The weight, temperature, symptomatology and the B.U.N. were recorded at 12 hour intervals in each dog until the time of death. Water and food were available to the animals throughout the postoperative period.

Group VI consisted of seven dogs, Nos. 24 to 30, used for the study of ileac obstruction and its effect on B.U.N. Six dogs, Nos. 25 to 30, were subjected to the same procedures of preparation, anesthesia and draping as in Group V. An incision about four cm. long was made through the linea alba and the abdominal cavity exposed. The omentum was carefully pushed to one side and the ileum at the ileocecal junction was lifted through the incision. A double strand of No. 3 twisted silk was used to tie off the portion of the ileum just anterior to the ileocecal junction. Care was exercised to see that the ligation was not too tight to cut through the intestinal wall nor

too loose to be displaced or to allow food to pass through. The intestinal loops were then carefully returned to their position and the peritoneum and the rectus muscles sutured with No. 0 chromic catgut with two rows of sutures. The skin was closed with interrupted sutures using No. 30 silk. The control dog No. 24 underwent the same surgery and manipulation of the intestines without the ligation. The changes in B.U.N. and other symptomatology were recorded at 24 hour intervals for a period of five days.

In dogs Nos. 9 to 20 of Groups III, IV, and V a hematocrit was run along with the B.U.N. to see to what extent the dehydration could be assessed by the use of hematocrit. The heparinized microcapillary tubes were used for the hematocrit determinations. The blood was drawn by capillary action to about three fourths of the microcapillary tube and one end of the tube was sealed by gas flame and the tubes centrifuged in the hematocrit electrofuge for three minutes at 30,000 revolutions per minute. The hematocrit was read against the plastic "hematocrit reading chart". The results are tabulated in Tables III, IV, and V.

The B.U. level of the dogs, Nos. 9 to 20,were also determined by the Lamotte Kit which is a field kit that can be conveniently operated by any practicing veterinarian. These estimations were determined to see to what extent the Lamotte Kit findings agreed with the photoelectric colorimeter. Five ml. of the citrated blood was added drop by drop, to an equal volume (5 ml.) of 10 percent trichloroacetic acid in a heavy walled centrifuge tube. After thorough mixing the centrifuge tubes containing the mixture were centrifuged for five minutes at 3,000 revolutions per minute. The clear supernatant protein-free solution was carefully transferred to a 50 ml. beaker. The buret supplied with the kit was filled with five percent

mercuric chloride solution up to the 0 mark. Calibrations in this buret are marked from 0 at the top to 00 down the line allowing 1.5 ml. and thereafter it is calibrated as milligrams blood urea. The first 1.5 ml. of mercuric chloride was run from the 0 to the 00 mark into the beaker containing the protein-free solution and mercuric chloride was then added drop by drop and mixed with a long medicine dropper. The mercuric chloride from the buret was added until a test drop of the mixture produced a reddish brown precipitate within three seconds when added to a drop of saturated solution of sodium carbonate in the spot plate. When this end point was reached the buret reading gave the milligrams percent of blood urea. This figure divided by the constant 2.14 gave the estimated B.U.N.

OBSERVATIONS

Group I Effect of Withholding Food and Water on the B.U.N. of Dogs.

The four dogs in this group showed a range of B.U.N. level between 9.12 mg. percent to 11.21 mg. percent at the beginning of the experiment. These were well within the normal levels as established by various workers (3, 1, 14). Dog No. 2 had an initial B.U.N. reading of 10.28 mg. This increased to 20.64 mg. percent in five days when food and water were completely withheld. The rise was gradual averaging 1 mg. to 4 mg. per day. The findings in dog No. 3 were very similar to those in dog No. 2, with the B.U.N. level reaching slightly more than twice its original level. In dog No. 4 the readings were slightly higher. Within 48 hours the B.U.N. was almost twice its original reading although in the following three days it did not show such a rise. The overall rise was from 9.60 mg. to 23.82 mg. percent. It may be seen in Table I that the peak elevation of B.U.N. in these animals

Table 1. Effect of withholding food and water on the B.U.N. of dogs.

	Group I									
	Control Dog No. 1 Male		Dog No. 2 Female		Dog No. 3 Male		Dog No. 4 Female		Dogs Nos. 2 to 4 Average B.U.N.	
Days	Weight lbs.	B.U.N. mg. %	Weight lbs.	B.U.N. mg. %	Weight lbs.	B.U.N. mg. %	Weight lbs.	B.U.N. mg. %	B.U.N. mg. %	Percentage increase
0	10	9.12	13	10.28	12	11.21	18	9.60	10.36	
1	10	10.14	13	11.42	12	16.73	18	13.84	13.99	35.1
2	10	10.24	12.5	15.60	11.5	17.46	17.5	18.34	17.13	65.3
3	10	9.20	12.5	18.20	11	20.24	17	19.62	19.35	86.9
4	10	10.12	12	20.22	11	22.62	17	21.56	21.46	107.1
5	10	10.00	11.5	20.64	10.5	24.82	16.5	23.82	23.09	122.8
Weight loss	-	-	1.5	-	1.5	-	1.5	-	-	-

was only slightly above the upper limits of normal ranges. However, the rise was significant being more than twice the original level in the period of five days. Elkinton and Max (20) studied prolonged water deprivation in four dogs extending over a period of 11 to 20 days. They reported a marked increase in two dogs which exhibited uremic syndromes, and succumbed with 270 mg. and 152 mg. of N.P.N. percent on the 11th and 15th day, respectively. The two other dogs did not show any appreciable increase. However, in this series the increase is much more marked and sufficiently significant to deduce definite conclusions of slight hemoconcentration. The control dog, No. 1 showed a variation of only 1.12 mg. percent during the course of the experiment. The three dogs lost an average of 1.5 pounds in weight during five days.

Group II Effect of Withholding Water on the B.U.N. of Dogs.

In this series, three dogs, Nos. 6 to 8 were subjected to water deprivation but were allowed dry food. The increase in B.U.N. levels were more appreciable and quicker in onset. In dog No. 6 the B.U.N. level rose from 10.56 mg. to 20.56 mg. percent in two days and at the end of the fifth day the level was 28 mg. percent. Dog No. 7 showed a rise from 13.38 mg. to 25.12 mg. percent in two days and thereafter there was no rise and the level remained stationary. Dog No. 8 with original reading of 10.36 mg. rose to 25.76 mg. percent in the first two days and showed a steady increase similar to dog No. 6 till it reached 31 mg. percent. It may be observed that in this series the rise of B.U.N. level occurred more quickly and was higher than in Group I where food was withheld in addition to water. The control dog No. 5 showed a variation of only 1.90 mg. percent during the course of five days. The three dogs under trial lost an average of two pounds each in weight during the period.

Table 2. Effect of withholding water and allowing dry food on the B.U.N. of dogs.

	Group II									
	Control		Dog No. 6		Dog No. 7		Dog No. 8		Dogs Nos. 6, 7, & 8	
	Dog No. 5 Female		Male		Female		Female		Average B.U.N.	
Days	Weight lbs.	B.U.N. mg. %	Weight lbs.	B.U.N. mg. %	Weight lbs.	B.U.N. mg. %	Weight lbs.	B.U.N. mg. %	B.U.N. mg. %	Percentage increase
0	15	11.52	18	10.56	12	13.38	13	10.34	11.42	
1	15	10.50	17.5	16.82	12	20.38	13	13.80	17.00	49.7
2	15	12.42	17	20.56	11	25.12	12	25.76	23.81	108.5
3	15	11.34	16	26.38	11	23.32	11.5	29.94	26.54	131.5
4	15	13.42	16	27.12	10.5	24.13	11	32.64	27.96	144.8
5	15	13.00	16	28.00	10	25.32	11	31.00	28.10	146.0
Weight loss	-	-	2	-	2	-	2	-	-	-

Group III Effect of Catharsis with Magnesium Sulphate on B.U.N. of Dogs.

The four dogs Nos. 9 to 12 in this group had normal B.U.N. levels which were considerably higher than the first two groups and ranged from 14.20 mg. to 18.96 mg. percent. This may have been due to the higher plane of nutrition of these dogs. The three dogs, Nos. 10, 11, and 12, subjected to the effect of purgation with daily doses of magnesium sulphate showed considerable rise in their B.U.N. level. Nos. 10 and 11 showed a steady rise up to 32.68 mg. on the fourth day. Dog No. 12 exhibited a phenomenal rise from 16.59 mg. to 26.07 mg. at the end of the first day, 40.95 mg. at the end of the second day and 50.95 mg. at the end of the third day. Death occurred 20 hours later before the fourth determination of B.U.N. was made.

The hematocrit readings in the four dogs showed a normal range of 43 to 48 ml. percent prior to the experiment. The rise in hematocrit in the trial dogs Nos. 10 to 12 were from 43 to 50, 46 to 52,and 48 to 56 ml. percent, respectively. The hemoconcentration though not marked was appreciable when compared to the original hematocrit for these dogs. The loss in weight during the five day period was from one to two pounds.

Group IV Effect of Castor Oil Purgation on the B.U.N. of Dogs.

In this group of dogs castor oil was substituted for magnesium sulphate as the cathartic agent. The rise of B.U.N. level compared favorably with the results of the effects of magnesium sulphate seen in Group III. The trial dogs, Nos. 14 to 16, showed a rise from 13.05 mg., 13.92 mg., and 12.44 mg. to 35.68 mg.,33.00 mg., and 30.62 mg. percent,respectively at the end of five days. The control dog No. 13 exhibited a fluctuation of $\pm$ 2.30 mg. percent.

Table 3. Effect of dehydration induced by purgation with magnesium sulphate on the B.U.N. and hematocrit of dogs.

	Group III											
	Control Dog No. 9 Female			Dog No. 10 Male			Dog No. 11 Female			Dog No. 12 Male		
Days	Weight lbs.	B.U.N. mg. %	HT ml. %	Weight lbs.	B.U.N. mg. %	HT ml. %	Weight lbs.	B.U. N mg. %	HT ml. %	Weight lbs.	B.U.N. mg. %	HT ml. %
0	11	14.2	44	15	18.96	43	13	15.45	46	12	16.59	48
1	11	12.52	44	15	20.85	48	13	18.96	47	12	26.07	50
2	11	15.20	42	14	25.59	50	12	27.96	50	10	40.95	54
3	11	15.10	44	13.5	30.32	52	12	29.98	50	10	50.95	56
4	11	14.22	43	13.5	32.68	52	11.5	32.68	54			
5	11	13.52	45	13	32.52	50	11	31.52	52			
Weight loss	-	-	-	2	-	-	2	-	-	2	-	-

Dog No. 12 died on the 4th day before the readings were taken.

Table 4. Effect of dehydration induced by purgation with castor oil on the B.U.N. and hematocrit of dogs.

	Group IV													
	Control Dog No. 13 Female			Dog No. 14 Female			Dog No. 15 Female			Dog No. 16 Male			Dogs Nos. 10,11, 12,14,15 & 16. Average B.U.N.	
Days	Wt. lbs.	B.U.N. mg.%	HT ml.%	Wt. lbs.	B.U.N. mg.%	HT ml.%	Wt. lbs.	B.U.N. mg.%	HT ml.%	Wt. lbs.	B.U.N mg.%	HT ml.%	B.U.N mg.%	Percentage increase
0	13	12.12	50	18	13.05	45	17	13.92	42	15	12.44	45	15.06	
1	13	12.62	48	18	16.73	46	17	17.86	46	15	15.48	48	19.32	28.3
2	12.5	10.82	46	17.5	29.00	48	16	22.28	46	14	22.84	50	28.10	86.5
3	12.5	12.00	46	17	33.65	48	16	26.82	48	14	27.44	54	33.19	120.3
4	13	9.82	48	16.5	35.00	50	15.5	31.60	50	13.5	29.62	54	32.31	114.5
5	13	11.12	44	16	35.68	52	15	33.00	54	13.5	30.62	54	32.66	116.8
6*	13	11.25	48	17	18.68	48	16	15.50	50	14	20.52	50	18.20	21.4
Weight loss	-	-	-	2	-	-	2	-	-	1.5	-	-		

*Castor oil stopped on the 5th day and water offered.

The results in this series were higher and more rapid than the results of plain water depletion experiment in Group I and II. At the end of the fifth day the administration of castor oil was stopped and water and food were offered. The blood urea rapidly decreased to the normal range within 24 hours.

Hematocrit readings in the three dogs, Nos. 14, 15, and 16, increased from 45, 42,and 45 ml. percent to 52, 54,and 54 ml. percent, respectively. The loss in weight during the period was 1.5 to 2 pounds.

Group V Effect of Pyloric Ligation on the B.U.N. of Dogs

In this group of seven dogs the preliminary blood urea nitrogen levels ranged from 10.20 mg. to 20 mg. percent. The control dog No. 17 showed a fluctuation of $\pm$ 2.56 mg. percent during the period of the experiment. Dog No. 18 showed a rise from 16.35 mg. to 174.55 mg. percent at the end of 60 hours. In the first 12 and 24 hours there was a drop in the B.U.N. level from 16.35 mg. to 15.28 mg., and 14.69 mg. percent. Thereafter the rise was very marked being 78.45 mg., 119.87 mg., and 174.55 mg. percent at 36, 48, and 60 hours. Dog No. 19 showed the rise from 20.00 mg. to 93.67 mg. percent at the end of 48 hours at which time death occurred. This dog also exhibited a drop in the B.U.N. level at the twelfth and twenty fourth hour from 20.00 mg. to 15.03 mg., and 13.25 mg. percent and the subsequent 12 hourly rises were 52.21 mg. and 93.67 mg. percent. In dog No. 20 the initial reading was 13.26 mg. which dropped in the next 24 hours to 12.36 mg. percent and then began to rise reaching 26.78 mg. in 36 hours, 85.52 mg. in 48 hours and 124.38 mg. percent in 60 hours. Dog No. 21 with its original level of 12.66 mg. showed a decrease of 1.12 mg. percent in the first 24 hours and then the rise was to 30.85 mg., 90.68 mg., and 130.24 mg. percent in the three

Table 5. Effect of pyloric ligation on the B.U.N. and hematocrit of dogs.

	Group V															
	Control Dog No. 17 Male				Dog No. 18 Female				Dog No. 19 Male				Dog No. 20 Female			
Hrs.	Wt. lbs.	B.U.N. mg.%	HT ml.%	Temp.	Wt. lbs.	B.U.N. mg.%	Ht ml.%	Temp.	Wt. lbs.	B.U.N. mg.%	HT ml.%	Temp.	Wt. lbs.	B.U.N. mg.%	HT ml.%	Temp.
0	18	12.12	44	101.6	13	16.35	46	102.2	16	20.00	45	101.8	22	13.26	45	101.8
12	-	14.24	-	101.8	-	15.28	-	102.0	-	15.03	-	102.0	-	13.56	-	102.0
24	18	10.56	46	102.0	13	14.69	46	102.4	16	13.25	44	101.8	22	12.36	46	101.6
36	-	13.86	-	101.8	-	78.45	-	101.8	-	52.21	-	101.6	-	26.78	-	101.2
48	18	10.24	44	102.0	12	119.87	52	101.6	15	93.67	52	101.2	20.5	85.52	52	101.0
60	-	9.56	-	102.0	-	174.55	-	101.6	-	-	-	-	-	124.38	-	101.2
Weight loss	-	-	-	-	1.0	-	-	-	1.0	-	-	-	1.5	-	-	-

Dog No. 19 died between 48 and 60 hours.
Dog No. 18 and 20 died between 62 and 72 hours.

Table 6. Effect of pyloric ligation on the B.U.N. of dogs.

	Group V										
	Dog No. 21 Male			Dog No. 22 Female			Dog No. 23 Female			Dogs Nos. 18 to 23 Average B.U.N.	
Hours	Wt. lbs.	B.U.N. mg. %	Temp.	Wt. lbs.	B.U.N. mg. %	Temp.	Wt. lbs.	B.U.N. mg. %	Temp.	B.U.N. mg. %	Percentage increase
0	22	12.66	102.0	20	10.20	101.6	15	10.58	102.4	13.84	
12	-	13.62	102.4	-	8.28	101.8	-	9.20	102.6	12.49	-9.7
24	22	11.54	102.0	19	8.20	101.4	14.5	9.20	102.2	11.54	-16.6
36	-	30.85	102.4	-	19.32	101.2	-	29.21	101.8	39.47	185.1
48	20.5	90.68	101.8	18.5	46.92	101.0	13.5	52.90	101.2	81.59	487.9
60	-	130.24	101.0	-	100.50	100.2	-	98.90	101.0	125.71	807.5
72	Died			Died			Died				
Weight loss	21.5			19.1			14.3				

All the 3 experimental dogs died between 62 and 72 hours.

succeeding 12 hour intervals. Dog No. 22 from its presurgical level of 10.20 mg. showed a drop of 2 mg. in the first 24 hours and the rise shown thereafter at 12 hour intervals was 19.32 mg., 46.92 mg., and 100.50 mg. percent. Dog No. 23 with its normal B.U.N. level of 10.58 mg. dropped to 9.28 mg. percent in the first 24 hours and then the level reached 29.21 mg., 52.90 mg., and 98.90 mg. percent in the succeeding 12 hour intervals. It is significant to note that all the six dogs with the pyloric ligation showed a slight drop in their B.U.N. level during the first 24 hours and a very rapid and high rise of B.U.N. in the next 36 hours. Except for dog No. 19, which died between the forty eighth and sixtieth hours, the remaining five dogs died between the sixty second and seventy second hours.

Hematocrit readings in dogs 18 to 20 increased from 46, 45, and 45 to 52, 52, and 52 ml. percent, respectively at the end of 48 hours. These readings were taken at 24 hour intervals and the results do reveal the evidence of hemoconcentration. Hematocrit was not checked in the rest of the dogs.

The weight recorded showed a loss of 1 to 1.5 pounds in the 48 hour period in all the dogs. The temperature chart showed only slight fluctuations during the period of observation. Prominent symptoms in the experimental dogs consisted of depression, retching, severe vomiting, staggering, ataxia and prostration. Dog No. 19 showed tetanic convulsions a few hours before death.

Group VI Effect of Ileac Ligation on the B.U.N. of Dogs

The B.U.N. determinations were made at 24 hour intervals in this group of dogs with ileac ligation. The normal range of B.U.N. ranged from 10.80

Table 7. Effect of ileac ligation on the B.U.N. of dogs.

	Group VI											
	Control Dog No. 24 Male			Dog No. 25 Female			Dog No. 26 Male			Dog No. 27 Female		
Days	Wt. lbs.	B.U.N. mg. %	Temp.	Wt. lbs.	B.U.N. mg. %	Temp.	Wt. lbs.	B.U.N. mg. %	Temp.	Wt. lbs.	B.U.N. mg. %	Temp.
0	23	10.80	101.8	18	13.50	102.2	16	10.50	101.2	22	14.50	101.6
1	23	11.25	101.6	18	13.00	102.6	16	12.25	101.8	22	12.38	101.8
2	23	10.24	102.0	18	25.00	102.2	16	12.25	102.0	22	13.56	102.0
3	23	12.06	101.4	17.5	20.50	101.8	15.5	11.88	101.6	21	17.82	101.2
4	23	12.00	102.0	17.5	12.48	101.8	15.5	13.56	102.0	21	16.58	102.0
5	23	11.50	101.6	17.5	11.60	102.0	15.5	14.52	101.2	21	16.32	101.6
Weight loss	0	-	-	0.5	-	-	0.5	-	-	1.0	-	-

Table 8. Effect of ileac ligation on the B.U.N. of dogs.

	Group VI										
	Dog No. 28 Male			Dog No. 29 Female			Dog No. 30 Female			Dogs Nos. 25 to 30 Average B.U.N.	
Days	Wt. lbs.	B.U.N. mg. %	Temp.	Wt. lbs.	B.U.N. mg. %	Temp.	Wt. lbs.	B.U.N. mg. %	Temp.	B.U.N. mg. %	Percentage increase
0	16	15.00	102.2	12	13.56	101.2	13	16.02	102.2	13.84	
1	16	12.50	102.0	12	11.00	101.6	13	15.62	102.0	12.79	-7.3
2	15.5	12.00	101.6	12	11.00	101.8	13	14.52	102.6	14.72	6.4
3	15.5	15.25	102.0	11	13.28	101.4	12	18.56	101.8	16.21	17.0
4	15	22.12	101.8	11	12.58	102.0	12	15.36	102.4	15.44	11.6
5	15	17.28	101.8	11	12.30	101.2	12	14.32	101.6	14.39	3.9
Weight loss	-	-	-	1	-	-	1	-	-	-	-

to 14.50 mg. percent for these seven dogs. Dog No. 25 showed some fluctuation in the B.U.N. level from 13.50 to 25.00 mg. percent at the end of two days, which then dropped to its normal range in the next three days. The remaining five dogs, Nos. 26 to 30, did not show any appreciable rise or fall in the level of blood urea nitrogen. Daily fluctuation in the readings were within normal range. It may be concluded that the B.U.N. is not affected by the ligation of ileum at the level of ileocecal junction. The weight recorded during the period showed a slight fall ranging between one half to one pound in five days. The temperature and the other symptomatology exhibited during the period was not significant. All the dogs in this experiment vomited occasionally but they continued to consume food and water.

Blood Urea Determinations by Lamotte Kit

The blood urea determinations of dogs, Nos. 9 to 20, were also made by Lamotte Kit. The readings were taken at the start of the experiment and again at the end of 48 hours involving a total of 24 readings in the 12 dogs. The conversion of blood urea (B.U.) to blood urea nitrogen (B.U.N.) and the determinations derived from the Klett-Summerson photoelectric colorimeter are all tabulated in the Table 9. The percentage of deviation ranges from 0.2 to 9.6 percent.

DISCUSSION

Normal Range of the B.U.N. in Dogs

The blood urea nitrogen level of the 30 dogs used in this study varied from 9.12 to 20 mg. per 100 ml. of blood. Fourteen of the dogs showed a range between 9 and 13 mg. percent, 11 showed a range between 13 and 16 mg.

Table 9. Table showing the comparative values of B.U.N. as obtained by Klett-Summerson photoelectric colorimeter and Lamotte Kit.

Dog Number	Lamotte Kit Blood urea mg. %	Conversion of B.U. to B.U.N. $\frac{\text{Blood urea } \%}{2.14}$	Klett-Summerson B.U.N. mg. %	Percentage deviation
9	32	14.95	14.20	5.0
9	36	16.82	15.20	9.6
10	42	19.62	18.96	3.4
10	60	28.03	25.59	8.7
11	36	16.82	15.45	8.2
11	60	28.03	27.96	0.2
12	34	15.89	16.59	4.4
12	84	39.25	40.95	4.3
13	26	12.01	12.12	0.9
13	22	10.28	10.82	5.2
14	26	12.01	13.05	8.6
14	60	28.03	29.00	3.4
15	28	13.08	13.92	6.4
15	34	15.89	16.00	0.7
16	28	13.08	12.44	4.8
16	46	21.50	22.84	6.2
17	26	12.01	12.12	0.9
17	22	10.28	10.24	0.3
18	34	15.89	16.35	2.6
18	240	112.15	119.87	6.8
19	42	19.62	20.00	1.9
19	190	88.78	93.67	5.5
20	28	13.08	13.26	1.1
20	176	82.22	85.52	4.0

Readings were taken initially at the start of the experiment and again after 48 hours on each of the dogs.

percent and the remaining five ranged between 16 and 20 mg. percent of B.U.N. The overall average on these 30 animals was 13.06 mg. percent. Bollman and Adler reported the normal values between 8 and 20 mg. percent. Kingma and Catcott reported the range as 12 and 17 mg. percent and Allison et al. reported that the range was 10 to 22.6 mg. percent with an average of 15.5 mg. percent. Best and Taylor state that the B.U.N. varies with the protein content of the diet and Coffin maintains that high normal values may be expected in well nourished meat eaters. It is observed that dogs in very good state of nutrition gave figures slightly higher than dogs which appeared to be less well nourished. Since the dogs had been ownerless for a considerable time before they were picked up, the lowered nutrition might have had a bearing to the slight lowered value of B.U.N. recorded here. However, the findings compare favorably with the different workers in this field.

Dehydration With Water Depletion

It was observed that the dogs in Group I showed a slight rise of B.U.N. during the periods of water depletion. Water is being lost continuously in small quantities through the lungs and the skin and the major loss is through the urinary tract. This loss of water is normally replaced by ingestion of water. Withholding of water brings about hemoconcentration due to the continued loss of water and as a result there is a reduced urinary output. Due to this oliguria the urea in the blood is retained to a greater extent with the consequent rise in the B.U.N. level. However, the rise seen in dogs with water deprivation for five days was not consistant with the inevitable water loss. This inconsistency has been explained by Wiggers who states that in the preliminary stages of negative water balance, tissues such as

the skin and muscles supply considerable quantities so that the more important organs may not suffer. Consequently hemoconcentration does not occur to any marked extent during this preliminary negative water balance. The hematocrit readings shown in Tables 3, 4, and 5 amply substantiate this statement. In the prolonged water deprivation experiment conducted by Elkinton and Max (20) for a period of 20 days it was noted that when all water resources of the body are exhausted the blood urea increases to such an alarming degree that dogs become moribund and die due to uremia. In practice, however, a water deprivation of such prolonged duration rarely occurs. Though the small but appreciable increase in the B.U.N. levels found in this experiment does not indicate definite disease process, it does illustrate the fact that in the absence of any disease condition, the elevated B.U.N. may point out the possibility of a dehydrated system. Increase of B.U.N. due to dehydration does not normally rise beyond a level of 35 mg. percent. So an increase from 20 to 35 mg. percent of B.U.N. may be regarded as a possible dehydration.

In the second series where dry food was offered and water withheld the rise in the B.U.N. was quicker in onset than when both food and water were withheld. Water lost in metabolizing the food and the accumulation of the end products of protein in the blood seem to be the factors responsible for this rise. When food is withheld catabolism of proteins does not occur in the earlier stages though in the later stages when tissue breakdown takes place for basic nutritional needs of the body increased accumulation of B.U.N. occurs. Peters and Van Slyke (36) state that the concentration of N.P.N. of the blood is chiefly determined by the balance between the rate of protein catabolism and the urinary output. If the fluid in the body available for urine formation is small in comparison with waste nitrogen requiring

elimination, the concentration of N.P.N. in the blood will rise. Cizek (1959) in his studies on the relationship between food and water ingestion in the dog found that a highly watered diet may not be immediately followed by any fluid intake whereas the same food relatively dehydrated induces an ingestion of water in direct proportion to the amount that has been given and with such accuracy that the total intake bears a fixed ratio to the food if the latter has been otherwise unchanged. He further found that the food deprivation results in a prompt drop in the daily drinking, the latter however, gradually increasing as deprivation continues. These observations of Cizek are in agreement with the present finding of quicker dehydration when food is allowed to be ingested without giving any fluid.

Effect of Dehydration Induced by Cathartics

In Group III catharsis was induced by the daily administration of one ounce of magnesium sulphate and dogs in Group IV were given daily doses of one ounce of castor oil for the same effect. In both cases food and water were withheld. Magnesium sulphate being a saline acts by increasing the bulk of the intestinal contents through withdrawal of water by osmosis and producing increased peristalsis and evacuations of intestinal contents. Castor oil irritates and inflames the intestinal mucosa and thereby draws water rendering the ingesta more fluid for evacuation. In both types of catharsis large quantities of fluid are taken from the fluid compartments of the body to yield water for their action. However, it was observed that while fairly good purgation occurred on the first day, on subsequent days the evacuations were considerably less. The results obtained from the cathartic effect were very similar to those obtained in Group II where food

was allowed and water withheld. The average elevation of B.U.N. was higher than in Group I where both food and water were withheld. The rapid dehydration in the body has caused a quicker rise in B.U.N. by preventing elimination of the blood urea through decreased output of urine. However, the dehydration produced is not in proportion to the catharsis induced since availability of water from the partially dehydrated system for the subsequent catharsis is very much reduced. The homeostasis mechanisms of blood and kidneys play an effective role in preserving the fluid content.

Dog No. 12 showed quite a different curve in the B.U.N. level. The rise in the B.U.N. was very rapid and reached 26.07 mg. percent at the end of 24 hours, 40.95 mg. percent at the end of 48 hours and 50.95 mg. percent at the end of 72 hours. Death occurred on the ninety second hour. There were no significant findings observed on necropsy that would account for the death. The phenomenon can only be explained on the possibility of toxemia due to uremic complex. The hematocrit reading did not show unusual hemoconcentration as it increased only from 48 to 56 ml. percent.

Pyloric Obstructions

The results obtained in the pyloric ligation experiments are detailed in the observations. All six dogs showed an initial slight drop in the B.U.N. content during the first 24 hours. The rise in B.U.N., after this initial drop is very marked and approximates on an average of from three to four mg. percent per hour. Symptoms consisted of malaise, depression, severe vomiting, staggering, shivering, ataxia and tetany. Though the animals continued to eat and drink the ingesta was promptly vomited with more and more of gastric secretions. The ingested materials were prevented from entering the duodenum and jejunum where most of the digestion and absorption takes place.

Thus the medium of water is denied for the basic metabolic needs and in addition the severe vomiting produces further dehydration and loss of essential electrolytes thereby aggravating the situation.

Kingma and Catcott studied a dog with complete pyloric obstruction and they noticed that the B.U.N. rose to 126 mg. per 100 ml. in 48 hours and that death occurred within 72 hours. This recording compares favorably with present findings. Haden and Orr in their experiments demonstrated that the first chemical changes taking place during intoxication, incident to obstruction of the upper intestinal tract, are a fall in blood chlorides and a rise in carbon dioxide combining power of the plasma. They also noted that the B.U.N. does not rise until there is a marked depletion of chlorides. Possibly the initial slight drop observed in all these experimental dogs occurred before this depletion of chlorides was pronounced. These workers state that the changes in chloride metabolism are the most striking feature of the intoxication due to high intestinal obstruction. The chlorides are first affected and are lost or used up in some manner. They opine that depletion of chloride is probably related to the increased protein destruction or that the chlorides are used up in the course of increased tissue destruction. The primary fall in chloride may be due to the loss through vomition or in those animals which do not vomit, the loss may be due to utilization of chlorine ion in the course of intoxication. De Wardener points out that, following persistant vomiting in pyloric obstruction, an acute depletion of water, hydrogen ion, chloride, sodium and potassium occurs. Each of these give rise to its own sequence of disturbances in body fluids. The continuous loss of water with sodium and chloride reduces the volume of all fluid spaces including the blood volume which in turn brings

about renal vaso constriction with the resultant diminution of glomerular filtration rate and a rise in B.U.N. Gamble and Ross agree with the above findings and have also demonstrated that injection of sodium chloride solution tends to restore normal plasma values and greatly prolong the life of the animal. Tetany which sometimes occurs during the late stages have been studied by Harper. He suggests that the excessive removal of gastric secretions elevates the blood pH rendering it alkaline and this uncompensated alkalosis leads sometimes to tetany by inducing a decreased ionized serum calcium.

It is observed that complete obstruction of pylorus induces a very rapid and high blood urea nitrogen due to the combined effect of water and electrolyte loss. The high content of urea in the blood produces the toxic effects of uremia. In addition the obstructed segment elicits a larger quantity of toxins which are absorbed to produce a quicker lethal effect. As a result of these combined toxic syndromes five of the six dogs died between the sixtieth and seventy-second hours while the sixth died between the forty-eighth and sixtieth hours. Gamble and Ross also point out that accumulation of urea in the blood may not be due to renal disability following dehydration but to rapid destruction of protoplasm caused by the poisonous agent absorbed from the obstructed portion.

These evidences suggest that surgical intervention in cases of pyloric obstruction is indicated at the earliest possible period since any delay favors the development of toxic factors and an early lethal termination. It is of interest to note that when the condition is diagnosed, prompt treatment with subcutaneous or intravenous injection of saline considerably prolongs the life of the animal by correcting the dehydration and alkalosis. This has been illustrated by the work of Wangensteen and Gamble and Ross.

Obstruction of the Ileum

Kingma and Catcott reported over the B.U.N. of one dog where complete obstruction of the ileum was made. Their results demonstrate that the B.U.N. varied between 29 and 47 mg. percent. Haden and Orr found that ligation of ileum at the ileocecal valve is followed by little increase in nitrogen and no change in the chloride or carbon dioxide combining power of plasma. Wangensteen and Leven comparing the obstructions at the various levels conclude that when obstruction is established in the lower part of the ileum dogs survive much longer and the vomition is not great. Dragstedt in discussing the causes of death in intestinal obstructions maintains that in upper intestinal obstructions death is associated with failure of reabsorbtion of gastric and pancreatic juices which are lost by vomiting. However, in lower obstructions there is a considerable length of absorbing intestine between the stomach and site of obstruction which helps in absorption. Injury to the intestinal wall due to distention or strangulation will upset the blood supply and permit the absorption of toxic products.

The results obtained in the present series of dogs Nos. 24 to 30 indicates that the fluctuation in the levels of B.U.N. is almost negligible and of little or no significance. Dog No. 25 showed a small rise up to 25 mg. percent on the second day presumably due to the temporary effect of vomition and the B.U.N. dropped to a normal level on the third day. Dog No. 28 also showed a small variation on the fourth day rising to 22.12 mg. percent and dropping to the normal level in the next 24 hours. This rise also was a temporary effect of vomition on the blood concentration.

It is significant to note that obstructions at the site of ileocecal valve did not show any increase in the level of B.U.N. Since most of the

food and water ingested is absorbed and since there is proper excretion of urine there is little chance for the increased retention of the urea formed in the body.

The marked disparity between the findings in B.U.N. levels at the pyloric and ileac sites may aid in the location of the site of the obstructions. When the B.U.N. level exceeds 50 mg. percent the need for immediate corrective therapy is well established. Clysis with saline solutions may prevent dehydration and further deterioration.

Infectious Diseases and B.U.N.

Infectious diseases, as a rule, show slight increase in their B.U.N. level. This increase is due primarily to the effect of dehydration caused by the increase in the body temperature and tissue destruction. Many disease states which are otherwise unrelated have certain features in common such as starvation, dehydration, vomiting, diarrhea, sweating and renal dysfunction. Dehydration sets in motion a transfer of fluids from cells to extracellular fluids so that the water deficit is shared by all phases of the body fluid. Consequently early negative water balance is not reflected in the blood to any extent. However, the comparable increase in B.U.N. from its original level is indicative of this loss in body fluids. Determination of B.U.N. in all diseases helps to assess the degree of dehydration and tissue destruction and may indicate the need for corrective therapy.

Marked increase in B.U.N. has been reported by many workers in leptospirosis of dogs. Mosier (36), points out that elevated B.U.N. finding is a valuable guide in chronic as well as the icteric and acute hemorrhagic types of leptospirosis in pet animals. McIlnay (33), reports values of 60 to 180 mg. percent of B.U.N. in positive cases of leptospirosis. Twiehaus (39),

discussing on the gross changes observed in leptospirosis of dogs, indicates that dehydration and icterus are a common finding in most cases. Further, congestion of mucous-membranes, petechial and echymotic hemorrhages of various organs are the outstanding findings in necropsy. The kidneys usually show mild to severe pathological changes.

The high value of B.U.N. encountered in some cases of leptospirosis is contributed by a combination of various factors. The diarrhea, vomition and the extensive hemorrhages in the various organs will produce a marked dehydration. The tissue damage contributes to the formation of increased blood urea and the kidney dysfunction aggravates the retention. Thus the combined effect of all these symptoms produce the increased elevation of B.U.N.

SUMMARY

A review of the literature revealed that determinations of B.U.N. in small animal practice is predominantly directed towards assessing the renal damage and leptospirosis. Though mention is made concerning the elevated findings in intestinal obstructions, the determination of B.U.N. is rarely utilized for this purpose. The review also disclosed that relatively minor studies had been conducted in evaluating the B.U.N. with respect to dehydration in the body and intestinal obstructions. This study was directed to fill in the existing deficiencies in the available information.

The normal range of B.U.N. in the 30 dogs utilized in this study was found to be between 9.12 to 20.00 mg. percent with an overall average of 13.06 mg. percent. It was also observed that dogs in very good state of nutrition gave figures between 15 and 20 mg. percent while dogs with a lesser degree of nutrition showed a variation between 9.12 and 15.00 mg. percent.

Withholding food and water produced a gradual increase in the B.U.N. content of blood due to hemoconcentration and oliguria. The average percent increase over the initial B.U.N. level was 35.1 percent at the end of 24 hours and the subsequent percent increase was 65.3 at the forty-eighth hour, 86.9 on the seventy-second hour, 107.1 on the ninety-sixth hour.

When dry food was allowed without access to water the rise noticed was quicker in onset and the B.U.N. level rose on an average from49.7 percent at the end of the first day to 146 percent at the end of the fifth day. These figures account partly for the formation of urea from the ingested food and partly for dehydration in utilization of water for metabolizing the food ingested. Consequently the hemoconcentration and the resultant oliguria are more marked.

Induction of dehydration by means of catharsis and withholding of food and water produced hemoconcentration and oliguria at a more rapid rate than when catharsis was not induced. The rise in the B.U.N. content averaged an increase of 28.3, 86.5, 120.3, 114.5, and 116.8 percent at each consecutive 24 hour period,respectively over the original level.

Complete obstruction of the pylorus produced a slight decrease from the normal B.U.N. in the course of the first 24 hours. This apparently occurs before the depletion of chloride becomes effective. Thereafter, the loss of water and effective chloride depletion due to the persistant vomiting produces a steep rise in the B.U.N. content which rises at the rate of three to four mg. percent per hour. The overall increase was 807.5 percent at the end of the sixtieth hour. All the six dogs in this series died between the sixtieth and seventy-second hour after the pylorus was ligated. These early fatalities emphasize the need for surgical intervention to correct the malady before the sixtieth hour.

The intestinal obstruction at the ileocecal site evinces practically no increase in the B.U.N. level. The percentage increase recorded was 17 percent over the normal. These animals showed little discomfort compared to that evinced by dogs in pyloric obstruction series.

The Lamotte Kit for blood urea (B.U.) determinations were used on 12 dogs and was compared with the results obtained simultaneously with Klett-Summerson photoelectric colorimeter. The percentage difference between the two methods was very slight and ranged between 0.2 to 9.6 percent. Hence this field kit could be used in the field with confidence in its accuracy.

The degree of hemoconcentration in the dehydration experiments were checked in 12 dogs by hematocrit studies. Heparinized microcapillary tubes and the hematocrit electrofuge was used for the determinations and the results obtained showed a definite increase in value of the readings compared with the original values.

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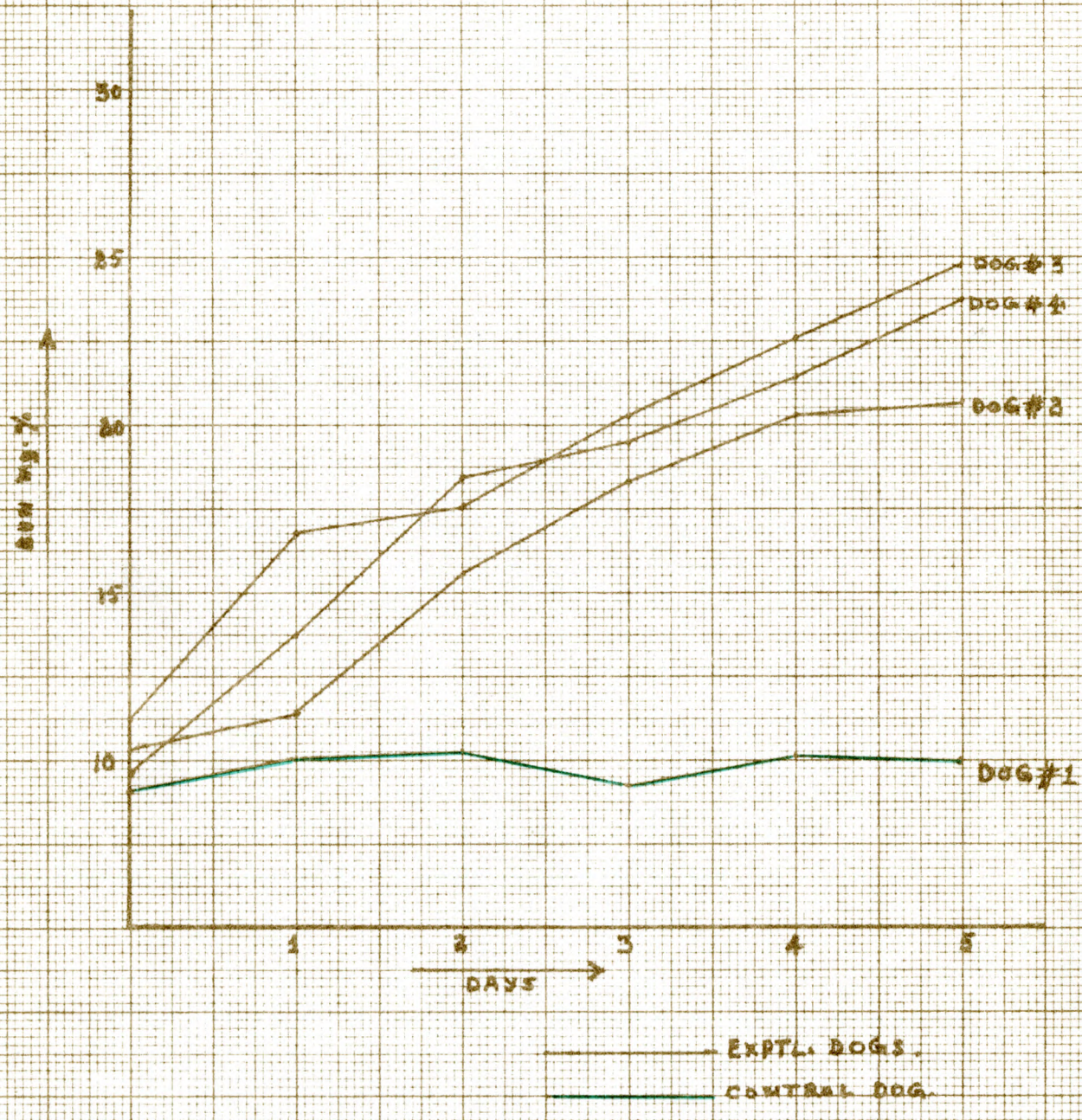
APPENDIX

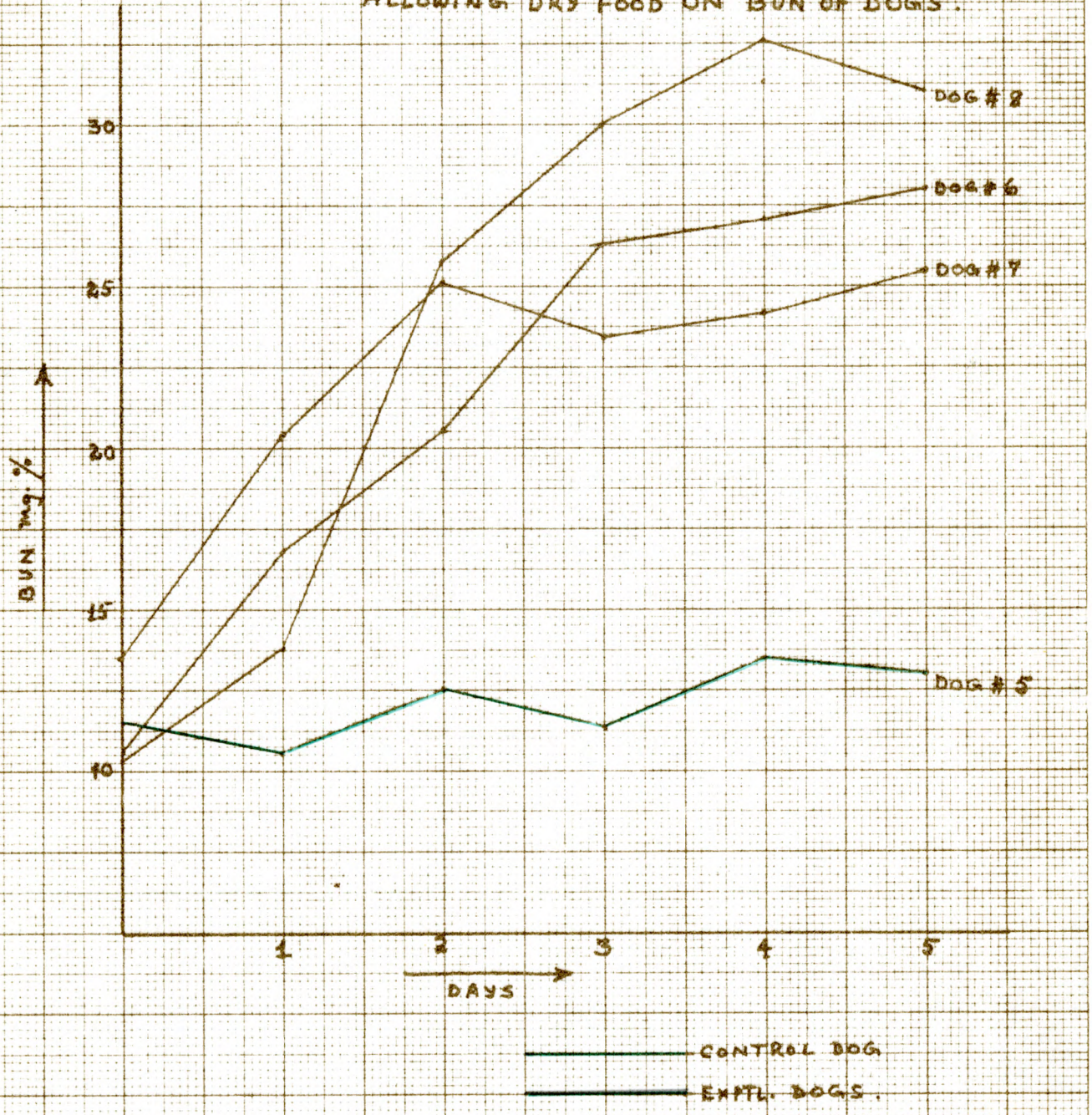
GROUP I

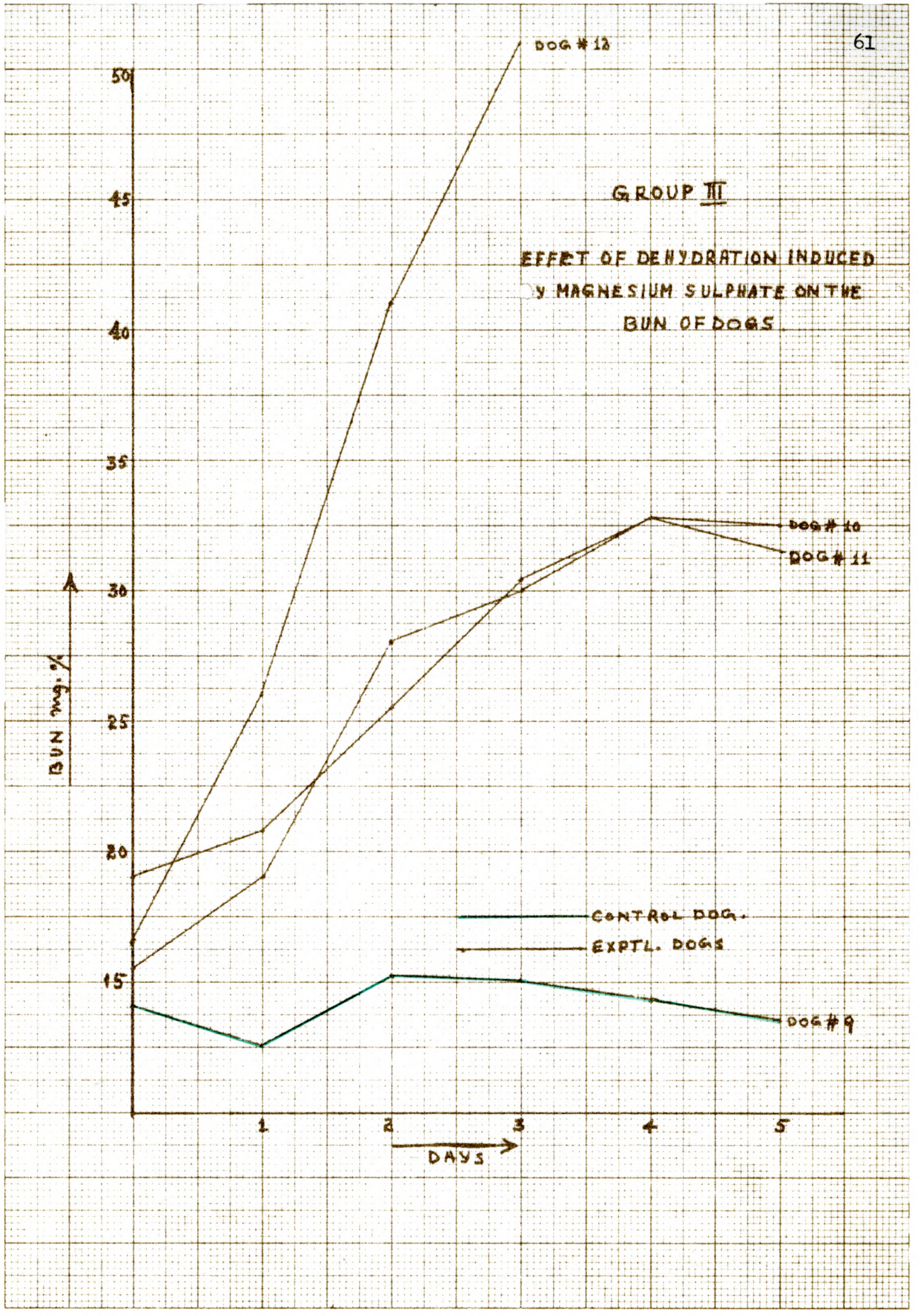
EFFECT OF WITHHOLDING FOOD & WATER ON THE BUN OF DOGS



GROUP III.

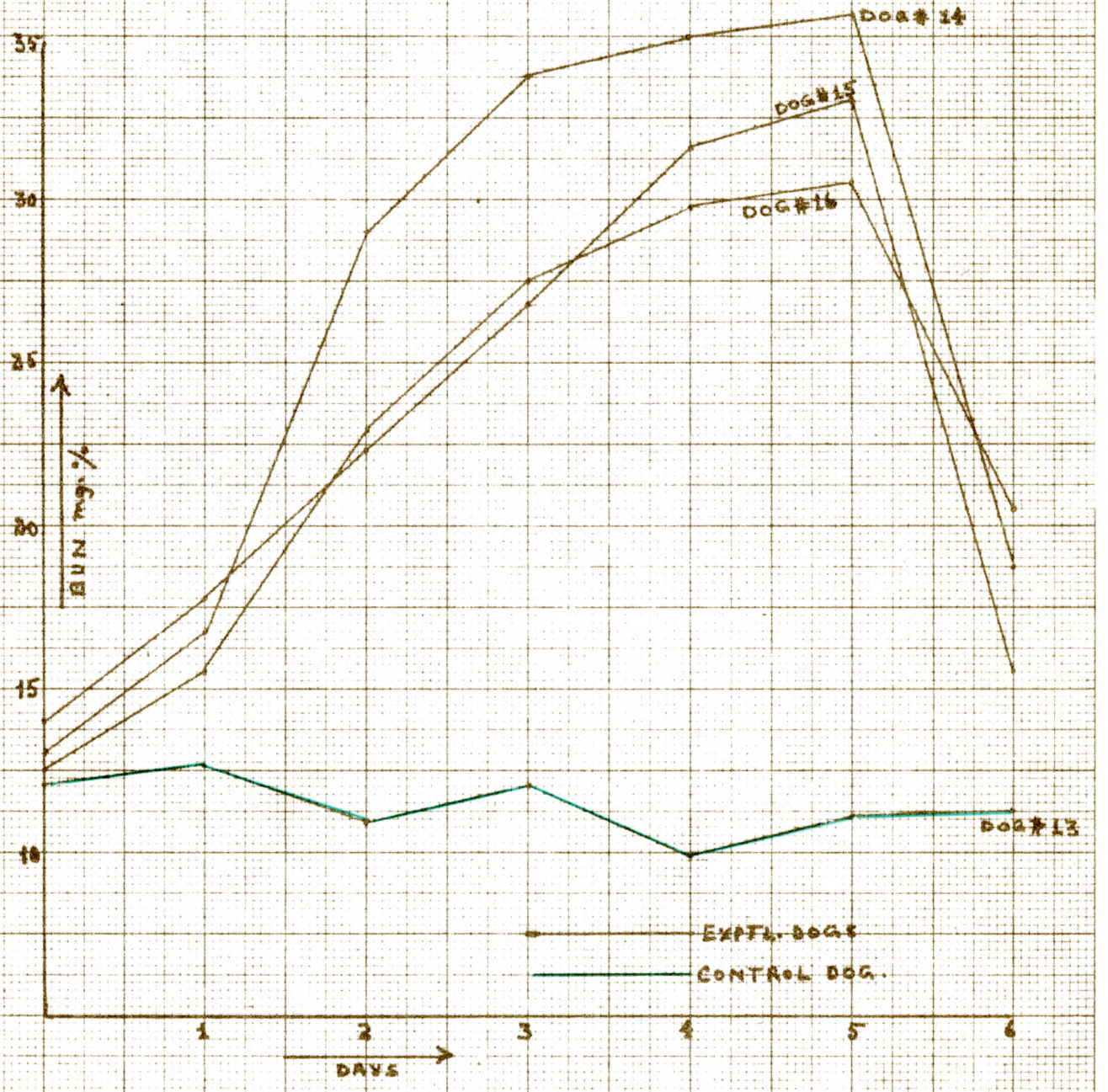
EFFECT OF WITHHOLDING WATER AND ALLOWING DRY FOOD ON BUN OF DOGS.

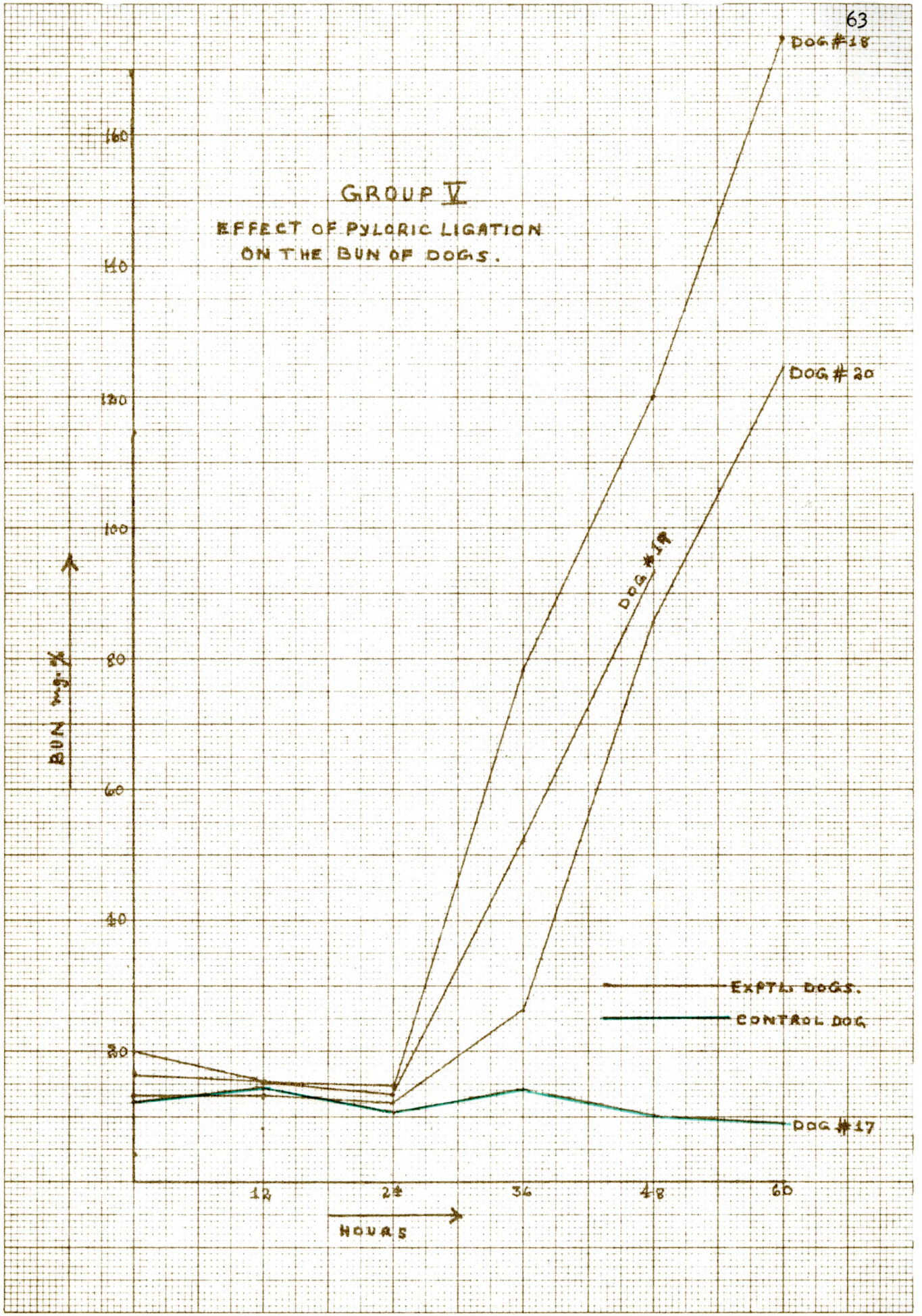



GROUP III
EFFECT OF DEHYDRATION INDUCED BY MAGNESIUM SULPHATE ON THE BUN OF DOGS
BUN mg. %
DAYS
DOG # 12
DOG # 10
DOG # 11
DOG # 9
CONTROL DOG.
EXPTL. DOGS
50
45
40
35
30
25
20
15
1
2
3
4
5

GROUP IV

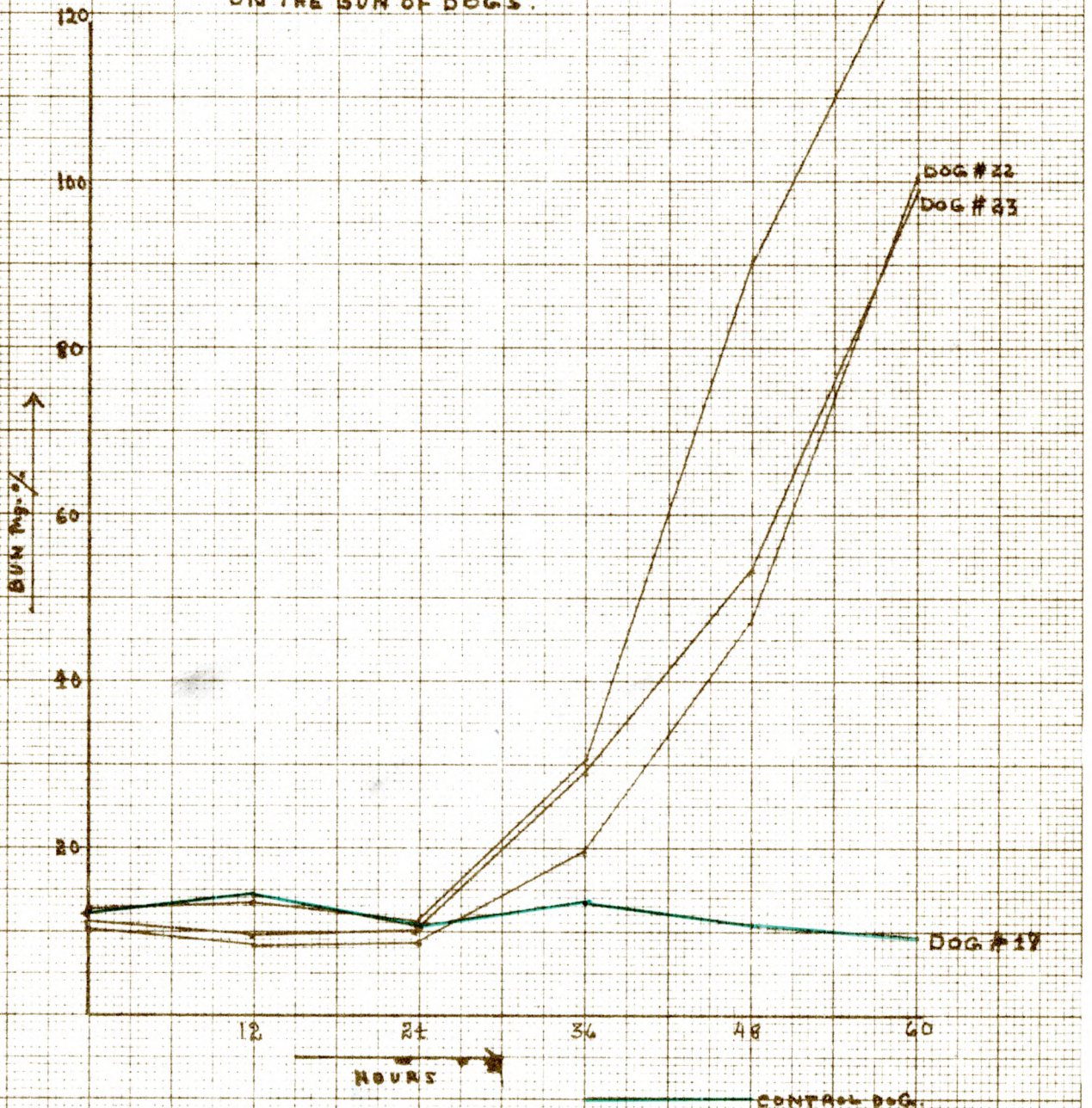
EFFECT OF DEHYDRATION INDUCED BY PURGATION WITH CASTOR OIL ON THE BUN OF DOGS.




GROUP V
EFFECT OF PYLORIC LIGATION
ON THE BUN OF DOGS.
DOG #18
DOG #20
DOG #19
DOG #17
EXPTL. DOGS.
CONTROL DOG.
BUN mg. %
160
140
120
100
80
60
40
20
12
24
36
48
60
HOURS

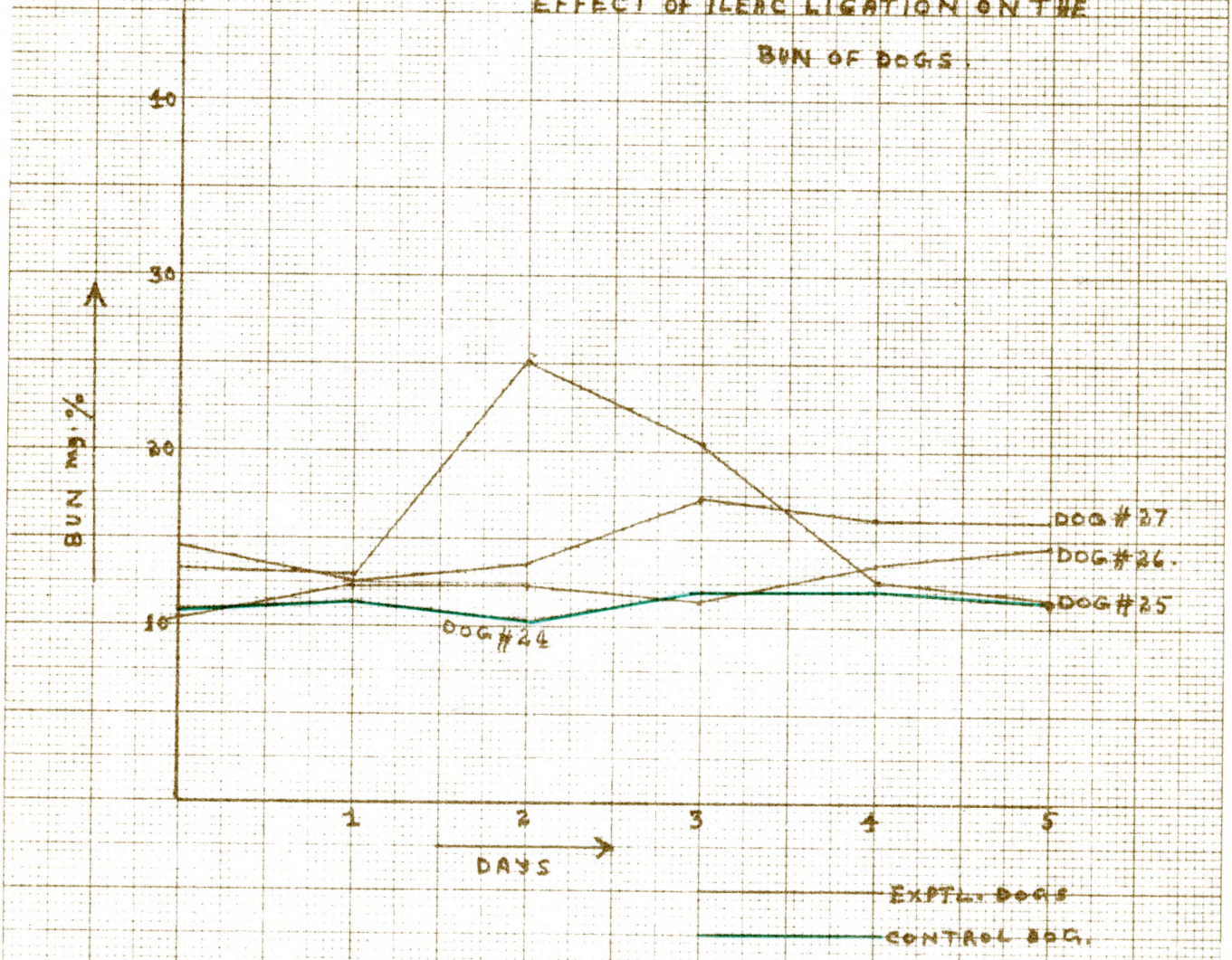
GROUP V

EFFECT OF PYLORIC LIGATION ON THE BUN OF DOGS.



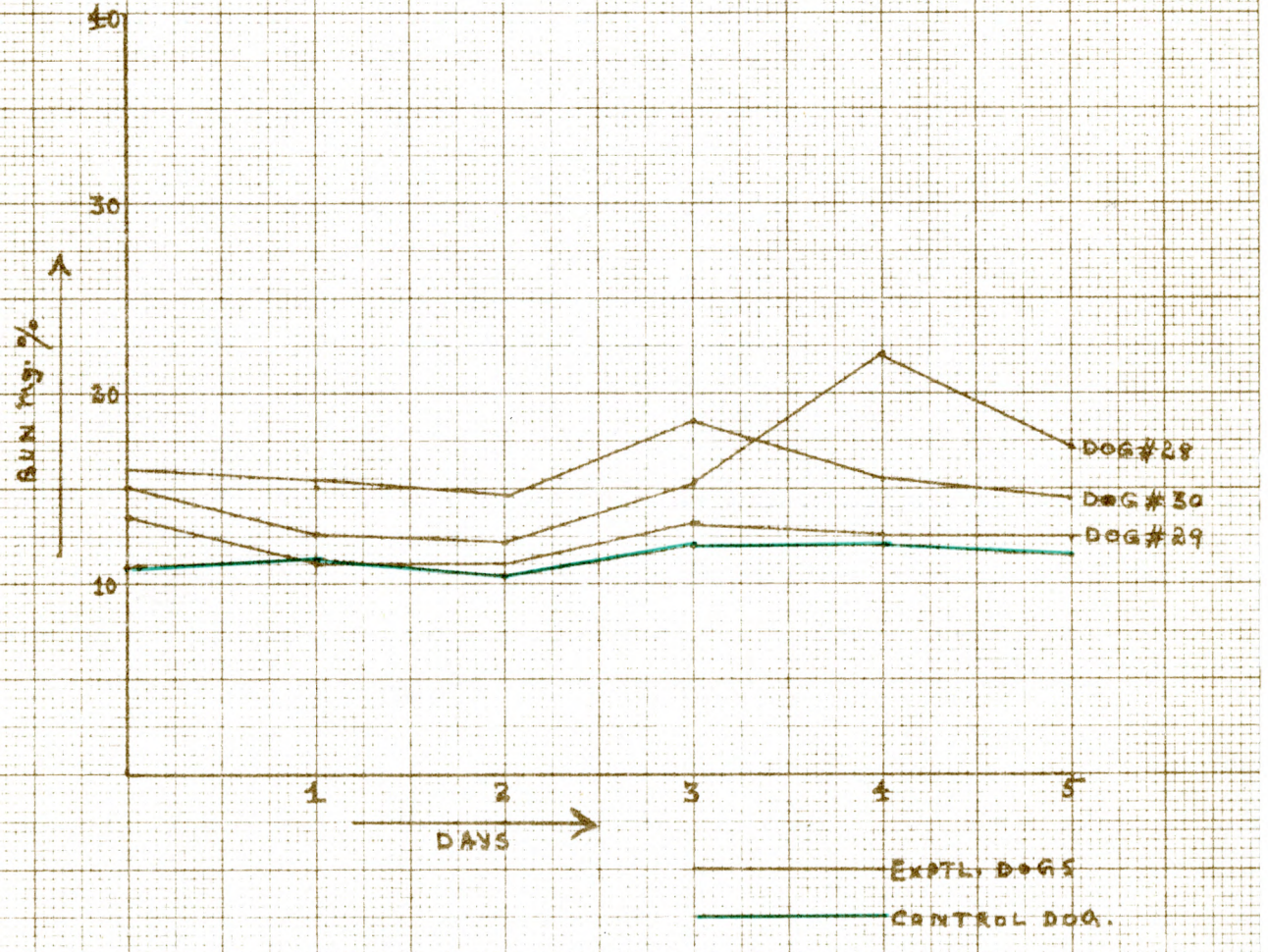
GROUP VI

EFFECT OF ILEAC LIGATION ON THE BUN OF DOGS.



GROUP VI

EFFECT OF ILEAC LIGATION ON THE BUN OF DOGS.



A STUDY OF THE EFFECTS OF DEHYDRATION ON BLOOD UREA NITROGEN IN THE CANINE

by

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Only limited investigation has been done in the past regarding the relationship of blood urea nitrogen and dehydration in the canine species. Workers in this area have stressed the electrolyte imbalance in dehydration and have generally ignored the blood urea nitrogen levels. In the field of Veterinary Medicine and particularly among the canine and feline species dehydrations as a result of carelessness on the part of the owner, prolonged vomiting, severe diarrhea, marked diuresis, pyloric stenosis, unconscious and mentally disturbed animals are commonplace. The present work was directed towards assessing the changes in the blood urea nitrogen in dogs in the different phases of dehydrations such as water depletion, induced catharsis, pyloric and ileac obstruction.

Deprivation of water alone or food and water for five days produced a gradual hemoconcentration and oliguria. The retention of urea in the system due to the resultant oliguria was reflected in the B.U.N. determinations and the rise was found to be increased at the rate of 35.5 percent, 65.3 percent, 86.9 percent, 107.1 percent, and 122.8 percent over the normals at the end of each day for the five days.

The induction of catharsis in addition to withholding of food and water showed quicker hemoconcentration and oliguria as reflected in the increased levels of B.U.N. The rise in the B.U.N. content registered an increase on an average of 28.3 percent, 86.5 percent, 120.3 percent, 114.5 percent and 116.8 percent at the end of each day for five days.

The experiments on intestinal obstructions were studied at pyloric and ileo-cecal levels as these are the two sites where stenosis or obstructions are commonly observed. Complete obstruction of the pylorus produced a small drop in the blood urea nitrogen level in the first 24 hours

and this appears to occur before the depletion of chloride due to vomiting became pronounced. The rise in the B.U.N. level after this was very marked and averaged about three to four mg. percent per hour. The increase recorded was 807.5 percent over the normal at the end of the sixtieth hour. All the experimental dogs died between the sixtieth and seventy-second hours after ligation of the pylorus. Intestinal ligatation at the ileo-cecal site evinced practically no increase in the B.U.N. level. The percentage increase recorded was 17 percent over the normal.

A comparative study of blood urea nitrogen determinations by Lamotte Kit method and Klett-Summerson photoelectric colorimetric method was made during the course of the above study. The percentage of difference between the two methods was very little and ranged between 0.2 to 9.6 percent.

Hematocrit studies were checked on 12 dogs undergoing dehydration experiments by the use of heparinized microcapillary tubes. It was observed that the hemoconcentration as a result of dehydration was also recorded by the hematocrit which showed definite increase in value from the original readings.