ACIDOSIS AND NUTRITION

By Dr. Royal Lee

A paper read at meeting of the Lee Foundation for Nutrition Research
December, 1947

The regulation of the acid-alkaline balances of the body fluids is just as vital to our well being as the regulation of temperature. We normally have a blood and tissue condition of mild alkalinity, rated in the pH scale at 7.28 to 7.5. In diseased conditions it may range from 6.95 to 7.8. As 7 is neutral, blood is actually in an acid state if below this figure, and life cannot continue under such circumstances.

pH is the abbreviation for potential hydrogen, and the characteristic of all acids is to afford available or potential hydrogen. Each number of the pH scale indicates ten times the amount of potential hydrogen of the next highest number, so it is evident that the normal blood variation of .2 on the scale really is a doubling of hydrogen ion concentration, no small range in actual acid-alkaline balance.

The pH scale used by chemists ranges from one to thirteen with 7 as the neutral point, 1 to 7 being acid, 7 to 13 being the alkaline range. Pure water is neutral, the hydrogen ion in each molecule is balanced by one hydroxyl ion, the hydrogen ion being one atom of hydrogen of acid nature, and the hydroxyl ion being a pair of one each of the atoms of oxygen and hydrogen, -OH, which is alkaline in nature.

When the pH is neutral, or 7, the number of ions of potential hydrogen and hydroxyl radicals are equal and balanced. At pH 6, the number of hydrogen ions present is ten times as much, but now 90 per cent are available for acid combination, whereas before none were. At pH 5, the number present is another tenfold, with one per cent of them only offset by hydroxyl ions, and so on down to pH 1. The hydroxyl ion concentration from 7 to 13 increases according to the same scale. Above 7 the hydroxyl ions preponderate, below 7 the hydrogen ions preponderate. When the blood of a patient tends to drop in hydrogen ion concentration he is said to have a tendency to acidosis, although the actual condition of the blood in life is always alkaline, or above 7, except in rare occasions.

Why is this pH balance important? Simply because, like the temperature, the chemical activities of the delicate organic constituents of the body vary with its alterations. In a fever patient, the oxidizing processes are accelerated, weight is rapidly lost, and emaciation quickly results unless the fever is brought under control. In a similar way, enzyme activities in the tissues are regulated by pH levels, enzymes that are constructive in nature, that normally build tissues will reverse in their influence and begin to tear down tissue in case of a lowered pH. Infectious diseases like pneumonia cause not only a rise in body temperature, but also a drop in pH. That is why they can be deadly.

Normal blood contains physiological buffer salts that prevent acids or alkalis from producing any sudden change of pH. For this reason, it requires three hundred times as much acid to change the pH of blood a given degree as is necessary when added to water. These buffer salts include sodium and calcium bicarbonate, phosphates, and glutamine. Glutamine is probably the most sensitive. It releases ammonia on the slightest provocation of a pH drop. Ammonia, of course, is one of the strongest alkalis.

If glutamine were commercially available, it would be the ideal remedy for acidosis. Glutamine is destroyed by heat, so is not present in cooked foods. Only a few vegetables contain it; the content depends upon the amount of nitrogen in the soil in which they grow. Celery root is the highest common source. Glutamine either is not synthesized in the human body, or is produced only with some difficulty, for otherwise acidosis would never be a problem. Fresh meat juices would contain it, but meat becomes more and more acid with time under cold storage. Cooked meat, with its glutamine destroyed, contains nucleoproteins which if permitted to decompose in a stagnant intestinal tract, form *guanidine*, which is one of the most potent poisons the animal body has to contend with. It is a poison because it paralyzes nerve endings. It is the

main poison released from normal tissue when it is burned; the pain resulting from contact with hot water quite likely is due to the release of guanidine. Guanidine has a powerful alkaline reaction; possibly fresh meat with its normal content of glutamine which can act as a buffer for both acids and alkalis would be less likely to cause toxic reactions than cold storage meat in patients who are subject to constipation. It is of interest to note that one of the constant findings in arthritis is an atonic colon, and an excess production of guanidine could quite reasonably aggravate if not cause arthritis. The normal route of elimination of guanidine is its methylation and conjugation with acetic acid to form creatine, otherwise known as methyl-guanidine acetic acid. Maybe this reaction is the reason for the reputation for cider vinegar as a tonic and remedy for many forms of chronic metabolic disease. The methyl radical is not to be neglected either. It is normally supplied by one of the Vitamin B complex, choline or betaine. One of the rare amino acids also can supply the methyl radical, methionine.

The basic enemy of guanidine seems to be chlorophyll. Guanidine is very poisonous to green plants because it combines with chlorophyll. Mushrooms, devoid of chlorophyll, on the other hand, thrive on guanidine. It stimulates their growth.

The highest organ in guanidine content is heart muscle. It is one of the primary fatigue poisons. As guanidine precipitates calcium from blood serum, we now see why the patient with an overworked heart may die of a calcified coronary artery. The diffusion of the guanidine from the heart muscle lymph through the coronary walls against the incoming blood certainly could accomplish this calcifying reaction without difficulty. Our general use of cooked foods and pasteurized milk no doubt facilitates this general trend. We might recall the recent tests of pasteurized milk and cooked meat as cat food, by which 900 cats were dispatched, nine lives apiece by this diet, and the outstanding reaction was constipation, pyorrhea, and finally arthritis, with peptic ulcer, liver disease and loss of resistance as interesting accompaniments. Control cats fed on raw milk and raw meat remained in perfect health, while on the cooked foods, life, even for a cat became impossible. (1) This probably explains why the Chinese fail to have cardiovascular disease or arthritis. They eat much more of the chlorophyll-carrying foods than we do, and never see pasteurized milk, refined sugar, or white flour, so they are not deprived of the B complex factors that aid in this protective chain that eliminates guanidine. (2)

The common use of soybean products in China supplies Vitamin F, which is also a factor tending to prevent cardiovascular disease. This was reported by Dr. Snapper in his book Chinese Lessons to Western Medicine, 1941.

The importance of glutamine as a physiological buffer is shown by the editorial comment in the A.M.A Journal for November 22, 1947, in which two thirds of the ammonia appearing in the urine as a result of experimental acidosis was found to originate from glutamine of the blood. The remaining ammonia came from deamination of blood amino acids. The amino acids that can supply ammonia are listed as glycine, dl-alanine, 1-leucine, and dl-aspartic acid.

This ammonia is made available by the kidney to displace the calcium, sodium, magnesium or potassium in phosphates and other salts to be excreted, so that the fixed bases can be retained for physiological uses. Steffanson has shown that men can live on a salt free diet, here the sodium salts must be changed to ammonium salts by the kidney to retain the sodium. If salt is withheld from children, a common reaction is for them to begin to eat soap; they have an irresistible desire for sodium compounds, and soap is sodium oleate. In this case, the lack of glutamine in our common cooked diets prevents the complete retention of sodium, so a real sodium deficiency develops. The Eskimo eats raw meat, gets plenty of glutamine, can save his sodium more efficiently.

The universal calcium deficiency with its consequences of arthritis, pyorrhea, allergic reactions, etc., may be another group of reactions due to our cooking customs, and our consequent inability to retain calcium by the glutamine-ammonia displacement system. In pregnancy the elimination of calcium by the urinary route stops, and it is here that again we will have trouble if glutamine is not sufficiently available. The

common tendency to nephritis in pregnancy is quite probably a consequence of the lack of the metabolic factors required for ammonia production.

If our fixed base reserves in the blood are impaired, the ability of the blood to carry carbon dioxide is reduced. Sodium bicarbonate, calcium bicarbonate, potassium bicarbonate all are CO_2 carriers, probably the sodium salt is the one that is mainly responsible for the transport of CO_2. It breaks up in the lungs, by reaction with oxyhemoglobin and releases CO_2. According to Best and Taylor, half the CO_2 is transported in this way, the other half by direct combination with hemoglobin. It is significant that potassium is the predominant alkali element inside the cells which includes the erythrocyte, and sodium is predominant in the body fluids outside the cells. For that reason, the use of potassium bicarbonate as a remedy for acidosis is more logical than the use of the sodium salt. Potassium chloride or bicarbonate are relatively rare as nutritional factors or as remedies. It is of interest here to note the recent discovery that Meniere's Disease has been successfully treated by the use of potassium chloride in the diet in place of table salt. In acidosis, the outstanding clinical symptom is that of lack of oxygen. Sellards has described the state in his book Principles of Acidosis.

> "When a depletion of bicarbonates occurs, the carbon dioxide accumulates in the tissues. The oxygen brought to the tissues by arterial blood cannot be utilized but is carried away by the venous blood. The effect is equivalent to depriving the individual of oxygen; such patients suffer from symptoms of suffocation and frequently call for air."

The person who has a good buffer reserve in the blood can hold his breath longer than one who borders on acidosis. The record, by the way, is 20 minutes. When we go to high altitudes, we feel out of breath and easily fatigued for a few hours until we adjust ourselves, and usually a dose or two of such alkalizers as "Citrocarbonate" (Upjohn) or "Alkazane" (Warner) stops the yawning and evidences of anoxia.

The use of refined sugar tends to promote acidosis, because pure sugar has a great affinity for basic compounds. When you swallow a strong sugar solution the effect on the mucosa is an obvious irritation. The irritated sensation lasts for some time. That is because the sugar solution abstracts the alkaline salts from the tissues it contacts. So does a drink of citric acid or any other acid. If we try this experiment with a solution of honey or natural unrefined syrup, no irritation is experienced, for these sugar solutions have already been saturated with minerals by contact with living cells and will abstract nothing more from them.

It is this abstraction of basic salts that renders refined sugar unfit for food. As stated in a recent article in *Science News Letter*, "Every time you eat sugar, or something with sugar in it, you get a short but very intensive attack of tooth decay." (5)

The milling and bleaching of flour accomplishes the same thing as the refining of sugar. The mineral salts are lost. Potassium is the main element taken out that we need. Some authorities believe that this causes the spastic type of constipation by reason of the support of the vagus function by potassium, which is so necessary to normal peristalsis. Of course, there are many trace minerals in wheat also lost in refining. The outstanding one is manganese, so essential to bone health and growth.

Cereals contain more phosphorus than most foods in a form that becomes phosphoric acid on assimilation. This also tends to promote acidosis, for while phosphoric acid is an essential food in itself, it must be properly balanced by alkaline ash partners. One nutrition specialist with 30 years experience tells us that he can cure many cases of pyorrhea by telling the patient to abstain from all cereal starches, but eat all the potato starch he wants. The potato starch has an alkaline ash from its potassium content. (6) The same advice no doubt would be good for the arthritic patient. Pyorrhea has been defined as a local form of arthritis; acidosis in some degree. This is commonly expressed as a low calcium-phosphorus ratio, calcium being alkaline, and phosphorus acid. The remedy may be, among other alkaline factors, glutamine. Glutamine as yet, however, is not commercially available, except at the prohibitive price of five dollars a gram. Probably beef blood will be found the best source.

The universal use of citrus fruits in arthritis may be very unscientific, if we accept the idea that acidosis is a predisposing cause. The citrus juice has an alkaline ash, but the neutralization of the acid when ingested by the blood buffers certainly promotes acidosis. This alkaline reserve is NOT reclaimed until the acid is OXIDIZED. This may not happen, for it can be thrown out by the kidneys first. In fact, it is well known that the urine becomes ALKALINE as a result of citrus juice ingestion. That is due to the buffer salts abstracted from the blood in combination with the citric acid. If the patient happens to be getting a lot of green salad vegetables he may be able to tolerate this loss, but *very often the arthritic patient on citrus juices is killing himself by inches.* Immediate improvement in the symptomatic reactions follows in these cases if the citrus foods are dropped from his diet.

If the buffer removed by citric acid should be ammonia from glutamine, we have a situation where the ingestion of raw meat or meat juices would be the only known prompt remedy. The meat itself is acid in reaction, the juices containing the basic salts and most of the glutamine. This probably explains the fact discovered sixty years ago (7) that dogs fed meat without its juices died much quicker than if fed nothing. They will get acidosis from simple starvation, but an aggravated acidosis if fed this kind of meat. In fact, they soon stop eating such meat, but the harm has then been done. They have lost more of their alkaline reserves, and will die sooner than the dogs that received none of the acidic meat.

The general use of meat extracts for convalescent patients arose from these dog experiments. But the extracts as commonly furnished have been cooked and super-cooked in autoclaves, so their only value is in the more rugged constituents such as potassium salts and creatine. The real essential principle that could be there is gone, the glutamine.

The University of Wisconsin proved forty years ago that hogs required fifty per cent more feed if it had been cooked. Since then no hog feeder in his senses has been cooking his hog feed. But we realize that the science of animal feeding is about forty years in advance of our practice of human nutrition. Maybe that is one reason that we can boast of surpassing the record of China in deaths from heart disease about a hundred to one, and her deaths from cancer about ten to one.

REFERENCES

1. Pottenger, F. M., Jr., "The Effect of Heat Processed Foods and Metabolized Vitamin D Milk on the Dentofacial Structures of Experimental Animals." Am. Tol. Orthodontics & Oral SurR., August, 1946.
2. Snapper, I., Chinese Lessons to Western Medicine. Interscience Publishers, 1941, p. 160.
3. Jol. of the A.M.A., November 22, 1947.
4. Sellards, A. W., The Principles of Acidosis and Clinical Methods for Is Study. Harvard University Press, 1917.
5. "Science News Letter," October 18, 1947, p. 244.
6. Personal Communication from Dr. Harold Hawkins, author of Applied Nutrition, 1947, Lee Foundation for Nutritional Research, Milwaukee 3, Wis.
7. Forster, "Versuche uber die Bedeutung der Aschebestandtheile in der Nabrung." Zeitschr. fur BioloRie, IX:297-380.