Professor Dr. med. Klaus F. Kopp

URL dieser Seite:
http://www.kf-kopp.de/wissenschaftliche-arbeiten/the-bicarbonate-deficiency-syndrome-bds/

The Bicarbonate-Deficiency-Syndrome (BDS)

The daily Substitution of Bicarbonate, Benefit and Effect on Health and Wellbeing in General and in Medicine.

Summary

On various occasions the INTAKE of Sodium-Bicarbonate, (Synonym: baking-soda) Chem. Formula $NaHCO_3$, is being recommended for the "IMPROVEMENT" of the Acid-Base-Balance in the body. Recommendations of dose are rather vague. The specific need of different individuals with metabolic differences and/or varying kidney-function, age and weight has so far been never defined.

In clinical Medicine the Indications and Rules for the quantitative prescription for patients with renal disease, be it by Intravenous Infusion or Oral Intake of Sodium-Bicarbonate, preparations are well defined. However, because of scrupulous hesitations about the drawback of a hypothetical increased Sodium-Load the views are controversial and at least precautious. UNFORTUNATELY, this view is due to a most regrettable, so called "scientific" error

(see **Addendum**).

On the basis of scientifically validated physiological and biochemical knowledge and based on the personal scientific experience of the author the benefit and the usefulness of the substitution of Sodium-Bicarbonate to the organism for the prophylaxis and therapy of a multitude of ailments is extremely high. As a rule, because of RENAL PHYSIOLOGY the Sodium-Bicarbonate-level in the organism even of "healthy" persons of older Age is pathologically LOW. In the case of any disease LOW Bicarbonate-Blood-Levels are always encountered. However, Sodium-Bicarbonate plays a central role in the maintenance of the Acid-Base Balance in the organism and in addition in the optimization of blood perfusion in the circulation and therefore in the Oxygenation of all body-organs.

Therefore, it is to be expected that in the future not only in Clinical Medicine, but also in the general Public, because of socio-economical reasons, the Use of Sodium-Bicarbonate or Baking-Soda either as food-additives or in drinking fluids will increase significantly.

Physiological Principles - Introduction

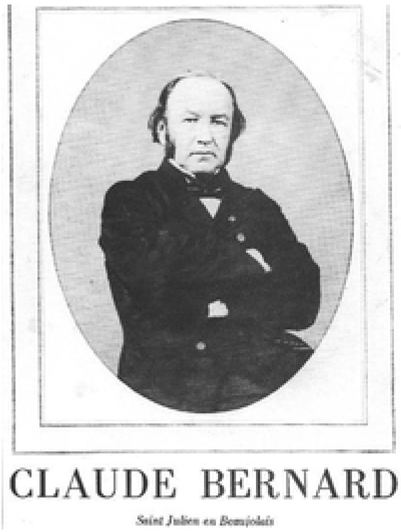

Fig. 1

Our body-temperature of 37.5 o Celsius or 99.5 o Fahrenheit is known to be a physiological value which is normally maintained at a constant level, i.e. we are ISO-therm. In the organism another constant physiological value is the parameter of the Acid-Base-Balance which is the pH-Value in the Blood. This value is also being kept exactly constant in an extremely narrow range between pH 7,35 and pH 7,45 due to various buffer-systems. Therefore, MAN, like all land-living mammals, is a ISO-pH-Organism or a pH-Homeostasis-Organism. The correct function of all biological and biochemical processes in the organism therefore depends on the constancy of pH or on the constancy of the Acid-Base-Balance. This was first pointed out in 1860 by the famous father of modern experimental Physiology the great French Scientist and Researcher CLAUDE BERNARD (1813 – 1878), see Fig.1

Quote:

"The constancy of the -Milieu Interieur- (= Homeostasis) is the prerequisite for a free and independent life within varying environmental conditions".

Four buffer-systems are present in the blood to maintain the constancy of the blood-pH-value. The Carbon-Dioxide (CO_2) - Bicarbonate- $(HCO_3)^-$- System with almost 75 % is the prevalent Buffer-System in the Blood. The most important natural buffer-substance in the blood is SODIUM- BICARBONATE ($Na^+HCO_3^-$). Hemoglobin provides about 25 %, Proteins about 1 % and Phosphates with < 1 % constitute the total Buffer-Capacity of the blood.

In the young healthy human individual, the Acid-Base-Balance is maintained constant primarily by the kidneys which excrete the daily produced metabolic organic acids with the acid urine. The volatile CO_2 is being ventilated by the lungs. The average amount of the daily production (and excretion) of acids in the body of a 70 kg human being is about 50 to 80 nMol/day. The Blood-Bicarbonate-Concentration of 25 mMol/L (i.e. pH) is being maintained constant by the De-Novo-Synthesis of Bicarbonate from CO_2 + H_2O in the tubular cells and by the tubular back-resorption of filtered $NaHCO_3$ from the intratubular fluid.

Patients with reduced kidney function because of various renal diseases are therefore prone to problems of the acid-base-balance and are certain to develop a deficit of sodium-bicarbonate i.e. acidosis of the organism. The ailing kidney is unable to excrete the ongoing production of metabolic acids nor is it able to produce or reabsorb sufficient amounts of bicarbonate from the glomerular filtrate. Details may be found in the textbooks of Renal-Pathophysiology.

Even in health, the physiological aging process causes a reduction of the renal function which begins at the age of 25 to 30. Thus acidosis, due to a deficit of bicarbonate, begins to develop early in life as a "normal" fate. The age-dependent renal function-loss can be precisely calculated with the "*Cockcroft-formula*". At the age of 60 to 70 years the "normal" renal function will be reduced to about 50 % of the function at the age 25.

Alkalinization of the organism may be achieved by a strict vegetarian or vegan nutrition, or through an increased intake of citrates which are metabolized into bicarbonate (~ 60 mMol/day), however because of the one-sided and unbalanced alimentation deficiencies for vitamins, proteins etc. will occur like in the rice-growing population in China and India (Beri-Beri). The daily protein-requirement of an adult person is approximately 0,59 G/Kg BW and is even higher if only vegetarian proteins are ingested, because of the lack of certain amino-acids. All proteins contain Sulphur, Phosphate, Nitrogen which need to be excreted after their reaction with oxygen as acid metabolites by the kidneys, as sulphates, phosphates, urea, uric-acid etc. The average daily Acid-load of the body (70 Kg BW) is in the range of 40 to 80 mMol/day, sometimes even far more. After the age of 25 the task to excrete these amounts of acids is far in excess of the capacity of what even perfectly healthy kidneys are able to perform.

WHY ? The "HOMO heidelbergensis" reached an age of at maximum 25 to 30 years. During this short lifespan his kidney function was 100 %. In contrast, in modern civilisation the lifespan of man reaches up to 100 years and beyond. Unlike his cerebral development the anatomy and the function of his kidneys have remained at the developmental stage of his stone-age ancestors. This was adequate for the differing environment 500.000 years ago, where man lived as a hunter and gatherer. Therefore our stone-age kidneys are inadequate to fulfil the demands imposed by a modern and totally different environment. The excessive supply of meat, fish and dairy-products i.e. the luxury consumption of proteins, in addition the consumption of alcohol, life-style stress and demands, top-accomplishments in sports and trades and professions, radical diets and not to forget diseases and illnesses with fever or malignomas with cytostatic or radiation therapy will lead to excessive amounts of protein-degradation products due to protein-catabolism.

The excretion of these enormous amounts of waste substances is a demand on the kidneys which at uttermost can be fulfilled in youth. Therefore the Bicarbonate-Deficite-Syndrome (BDS) is necessarily a result of the imbalance of all the factors described and the actual age of the kidneys.

The recognition of these facts is not a novelty. In the past centuries the privileged Nobility was plagued by typical ailments, resulting from luxury consumption of meat and fish as there was gouty arthritis i.e. podagra. In modern civilization a multitude of Civilization-Ailments can therefore be identified which are all due to the BDS.

Many of the natural-science or nature-cure treatises which deal with the "Improvement of Acid-Base-Balance" testify that the problem is being realized but unfortunately no answer is available concerning which pH in the body or in any body-compartment is to be recommended or should permanently be maintained or how to measure it.

Therefore the author will now provide a precise but simple answer based on scientific results and clinical experience how to achieve an Optimum Acid-Base-Balance or the Optimum Body-pH using the varying possibilities for the intake and supplementation of Bicarbonate be it as powders or tablets or using Mineral-Waters or similar drinks with a high content of Bicarbonate.

Classical Scientific Principles And Bases

Fig. 2

For the fundamental understanding of the role of Sodium Bicarbonate in the organism some of the historic scientific discoveries and publications need to be mentioned. The ingenious american Physiologist Homer W. SMITH (1895 – 1962), see Fig. 2, investigated in his Marine Sea-Life Laboratory on Long Island (New York) USA by comparative research methods the function of the kidneys in primitive organisms, of fish, amphibia and mammals.

He described the kidneys as THE ORGAN, responsible for the "Homeostasis" á la Claude Bernard of all organisms which are in the possession of kidneys. Amphibia and early mammals were thus able in the period of Devon-Carbon to leave the seawater which at this period was highly saturated with bicarbonate and to proceed to landlife. All organisms which so far were living in the seawater perfused their circulation directly with seawater flowing through gills, so that their milieu Interne was exactly identical to the surrounding seawater. When stepping on land, those creatures , because of their kidneys, were able to preserve this seawater- milieu EXTERNE inside their body and inside their circulation as their Milieu INTERNE, see Fig. 3

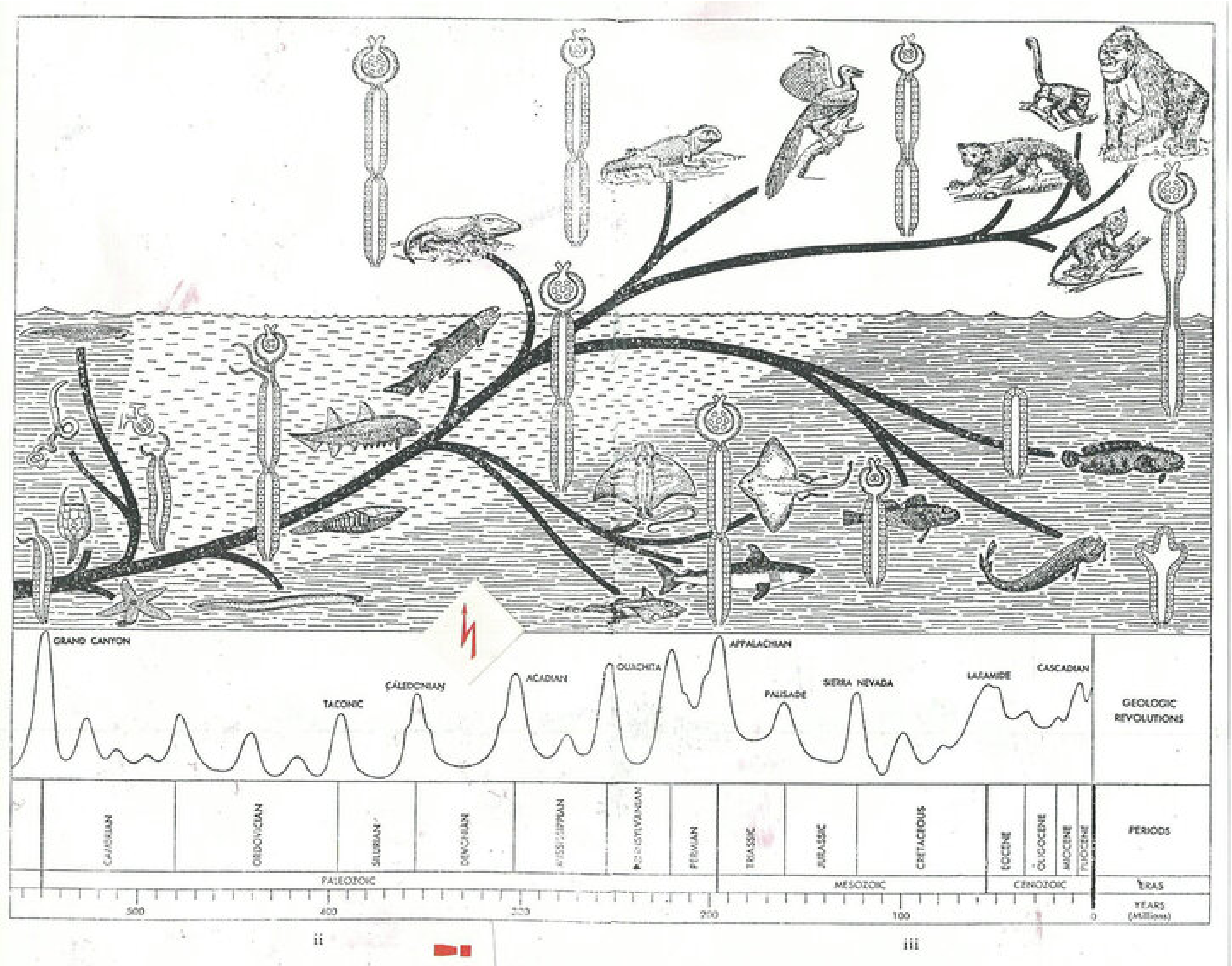

Fig. 3

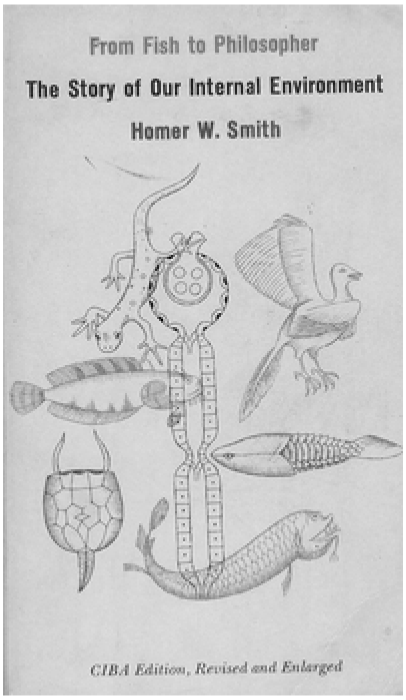

Fig. 4

The same still applies for the human body at present. The books of Homer W. Smith: “From Fish To Philosopher“ and “The Kidney, Structure and Function in Health and Disease” are classics and a MUST for anyone who works or deals with Nephrology including the author of this text, see Fig. 4

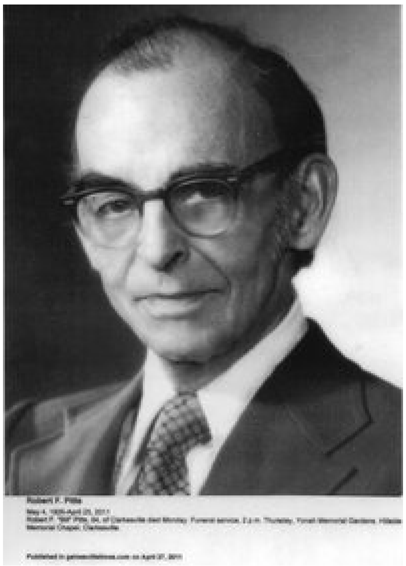

Fig. 5

The basic understanding and knowledge of the bicarbonate -bloodlevel, its uptake and the excretion of bicarbonate in the organism of higher animals including man was described by Robert F. PITTS (1926 – 2011), see Fig. 5

The author of this text was very fortunate to meet Robert F. Pitts in 1969 in his laboratory in Chicago USA during a visit of the American Society of Nephrology Congress in Washington D.C. The famous self-experiment of Robert F. PITTS together with his two co-workers J. L. Ayer and W. A. Schiess was published in the Journal of Clinical Investigation 28:35, 1949

Fig. 6 and 7 represent page 199 and 200 of the Textbook: “PHYSIOLOGY of the KIDNEY and BODY FLUIDS” of ROBERT F. PITTS .

Unfortunately, this brilliant textbook, after its Third Edition in 1974, has never been published again and has thus disappeared from the teaching catalogue of Academia and worst of all, out of the brains and knowledge of any Nephrologist. Since then, Teachers and Learners at the High schools of Medicine and Nephrology, are just busy to study the function and the technology of dialysis-machines instead of the Physiology of the Human Kidney.

of lungs and kidneys is reduced. Second, the hydrogen ion concentration of body fluids is no more dependent on the concentration of carbonic acid than on that of bicarbonate ion. Indeed, it is determined by their ratio and therefore is equally dependent on lungs and kidneys.

The thesis will be developed that the tubular secretion of hydrogen ions in exchange for sodium ions is the key mechanism underlying the reabsorption of bicarbonate, the generation of titratable buffer acid and the excretion of ammonium salts. The extent to which this ion exchange mechanism is engaged in each of these processes is determined by the nature and concentration of buffers delivered into the urine in the glomerular filtrate. If the bicarbonate concentration of the filtrate is normal or above normal, the mechanism will be largely engaged in the reabsorption of this anion; little ammonia and titratable acid will be excreted. If the bicarbonate concentration is below normal, the mechanism will be only partially engaged in the reabsorption of this anion, and more titratable acid and ammonia will be excreted. Finally, if the concentrations of all buffers in the filtrate are low or if their pK values are unfavorable (β-hydroxybutyrate and acetoacetate), the buffer deficit will be made up largely by the tubular synthesis and secretion of ammonia into the urine at the sites of hydrogen-sodium exchange.

Renal Reabsorption and Excretion of Bicarbonate

Gross Characteristics

The gross characteristics of the processes of renal reabsorption and excretion of bicarbonate in man are illustrated in Figure 11-1 (1). If ammonium chloride is ingested for several days before an experiment, the plasma concentration of bicarbonate is reduced from a normal value of 26-28 mM/L to about 13-15 mM/L. If sodium bicarbonate is infused slowly, the plasma concentration gradually increases. All bicarbonate filtered through the glomeruli is reabsorbed, and none is excreted until the plasma level attains a value of 26-28 mM/L, which is the so-called renal bicarbonate threshold. As still more bicarbonate is infused and the plas-

Fig. 11-1.—Filtration, reabsorption and excretion of bicarbonate as functions of plasma concentration in normal man. (From Pitts, R. F., Ayer, J. L., and Schiess, W. A.: J. Clin. Invest. 28:35, 1949.)

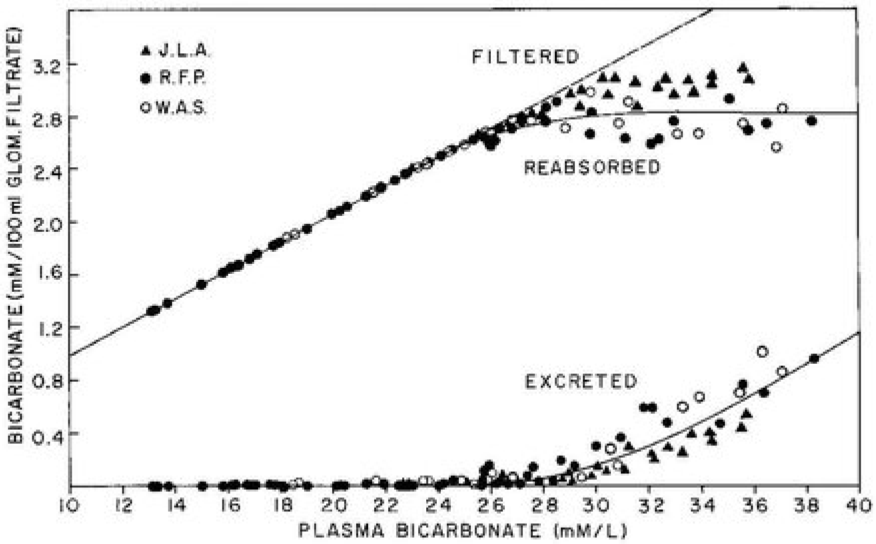

Fig. 6

ma concentration increases above 28 mM/L, a limited amount of bicarbonate, equal to 2.8 mM/100 ml, or 28 mM/L, of glomerular filtrate, is reabsorbed. All filtered in excess of this quantity is excreted in the urine. Processes of reabsorption and excretion of bicarbonate in the dog are essentially similar to those in man, except that the threshold is slightly lower, 24–26 mM/L, and the transport rate slightly less, 2.6 mM/100 ml, or 26 mM/L, of glomerular filtrate (2).

Under normal conditions in man, the plasma concentration of bicarbonate is poised at a value slightly below the renal plasma threshold—perhaps 27 mM/L. If the filtration rate is 125 ml/min, 180 L of plasma are filtered per day, delivering into the tubules some 5,100 mM of bicarbonate. Only 1–2 mM is excreted in 1.5 L of urine of pH 6. Accordingly, more than 99.9% of the filtered bicarbonate is reabsorbed.

If the plasma concentration of bicarbonate were to exceed the renal threshold, owing to the ingestion of bicarbonate or to the metabolism of salts of organic acids, the continued reabsorption of 26–28 mM of bicarbonate per liter of filtrate and excretion of the excess would gradually lower the plasma and interstitial fluid concentrations to the normal range. Excretion would then cease. If there always was an excess of inorganic cations in the diet, as there is in herbivorous animals, the processes of reabsorption and excretion alone would serve to stabilize the bicarbonate ion concentration of the body fluids within the usual limits of normal.

The reabsorption in man of 28 mM of bicarbonate per liter of glomerular filtrate, or in the dog of 26 mM/L, should not be construed as indicating that bicarbonate reabsorption is Tm-limited in the same sense that glucose is. The infusion of bicarbonate in both man and dog progressively increases the filtration rate. Constancy of reabsorption, when plasma concentration exceeds the renal threshold, obtains only if reabsorption is factored by filtration rate, not by time. The teleologic significance of this relationship is evident, even though the mechanism is not. If an animal with a very labile filtration rate, such as a dog, were to be in bicarbonate balance in the fasting state and if bicarbonate reabsorption were truly Tm-limited in terms of millimoles per minute, the ingestion of a large meal of meat and the attendant increase in filtration rate would rapidly deplete the circulating bicarbonate stores. Actually, an increase in filtration rate is accompanied by no increase in bicarbonate excretion; the increased filtered load is reabsorbed. Because both chloride and bicarbonate exhibit this reabsorptive characteristic and since they are the major anions associated with sodium in the filtrate and tubular urine, it is probable that this characteristic is imposed on them by the sodium reabsorptive mechanism (see Chapter 7).

Bicarbonate Reabsorptive Mechanism

The reabsorption of bicarbonate is depressed and excretion is increased by the administration of a variety of *N'*-unsubstituted sulfonamide compounds, all of which are inhibitors of the enzyme carbonic anhydrase. This fact suggests that the enzyme plays a key role in the reabsorptive mechanism.

Carbonic anhydrase.—In 1935, Roughton discovered carbonic anhydrase in red blood cells (3). This enzyme greatly increases the rate of attainment of equilibrium in step 1 of the following reaction:

$$CO_2 + H_2O \underset{}{\overset{1}{\rightleftharpoons}} H_2CO_3 \underset{}{\overset{2}{\rightleftharpoons}} H^+, HCO_3^-$$

In the absence of enzyme, step 1 is slow. Step 2, on the other hand, is inherently rapid and is uninfluenced by the presence or absence of enzyme. Catalysis by carbonic anhydrase facilitates the rapid conversion of bicarbonate ion into carbon dioxide in the brief interval that any given unit of blood spends in a pulmonary capillary. It likewise facilitates the rapid conversion of carbon dioxide into bicarbonate ion in the tissue capillaries.

Fig. 7

In Fig.11-1 of his Textbook Robert F. Pitts demonstrated “the so-called renal bicarbonate threshold” at which filtered bicarbonate is being excreted. In addition, he was able to demonstrate, that: quote on page 200: “The infusion of bicarbonate in both man and dog progressively increases filtration rate”

All mammals including man, therefore are equipped with a mechanism of overflow for bicarbonate. As soon as the storage capacity of the body for bicarbonate is full or is exceeded, the maximally, vasodilated kidney will immediately excrete the bicarbonate-surplus and thereby maintain the blood-bicarbonate value at a constant level at approximately 25 mMol/L and thereby preserves the homeostasis of pH.

The practical usefulness and benefit of this phenomenon has up to now not been recognized in Clinical Medicine nor has it ever been used therapeutically (except by the author).

Another Milestone was discovered by Jürgen Schnermann at the Institute of Physiology of the L.M.-University of Munich, Germany and was published in 1975: Regulation of single nephron filtration rate by feedback – facts and theories. Clin. Nephrol. Vol. 3, pp. 75 -81.

J. Schnermann therein described the feed-back mechanism in the kidney between the intrarenal vascular blood flow, urine-volume and the urinary concentration of either NaCl or NaHCO3. This phenomenon is known since under the name of the Director of the Institute of Physiology at that time Klaus Thurau, as the THURAU-MECHANISM. It is the evidence of a close interrelationship between the arterial bloodflow or the oxygenation of tissues and the Acid-Base-Balance: the lesser the acidosis, the better will be the arterial tissue perfusion.

Unfortunately in man there is no indicator of the body's reserve or level of bicarbonate. The human organism has no filling mark for bicarbonate like the filling mark in automobiles for fuel or oil. However, the level of bicarbonate in the body as outlined above, is therefore a most importance and a most interesting physiological value. The problem how to estimate this value is relatively easy to solve. According to Robert F. Pitts the addition of bicarbonate to the body (preferably by mouth) will lead to the appearance of bicarbonate in the urine as soon as the physiological renal threshold for bicarbonate is exceeded. Therefore, the measurement of Urine-pH will clearly indicate the presence of bicarbonate in the urine, pH > 7,0 to 8,0 , or its absence, pH < 7,0. Thereby it is possible to recognize whether the blood-bicarbonate level is above or below 25 mMol/L, see Fig. 6.

Measurement of pH

The proposed KOPP's procedure and direction therefore is as follows:

At the end of **every** passage of urine one should test the urine-pH with a suitable pH-Indicator-paper e.g. *Uralyt-U (MADAUS®)* range pH 5,6 – 8,0.

Urine is the best available body-fluid reflecting the conditions within the body and above all, it is the physiological excretion fluid produced by the kidneys in order to eliminate the metabolic waste substances and also to eliminate any bicarbonate in excess of its threshold value in the blood.

If the urine-pH is in the acid range i.e. below pH 7,0 this indicates only the absence of bicarbonate in the urine because there is a deficit of bicarbonate in the blood. The greater the blood-bicarbonate deficit is, the more acid the urine-pH will be, because more unbuffered acíd waste substances will be excreted. The maximum acidification capacity of the healthy human kidney is at pH 4,5. The urine-acidity of dogs is much lower, around pH 2,0.

Diseases of the kidneys are associated with a diminution of the acidifying capacity of the kidney reflecting its diminished ability to concentrate any given compound. In kidney disease urine-pH values are therefore not found in the low acidotic range but at higher levels i.e. pH 6,5 or even higher, falsely suggesting the absence or low degrees of organic acidosis. Therefore, due to the insufficiency of the ailing kidney to adequately excrete acids, renal diseases are always associated with severe systemic acidosis. It can be measured by determining the blood-pH or the bicarbonate level in the blood using the blood-gas-analysis and is expressed as the negative (or positive) Base-Excess (BE). However, in clinical Nephrology the acidosis associated with kidney disease so far remains neglected or unrecognized. It is rarely being treated adequately and is therefore very frequently encountered as the Bicarbonate-Deficiency-Syndrome (BDS).

Urine-pH can only reach the alkalinity of pH 8,0 due to the presence of Bicarbonate. Normally no other chemicals exist in the body with an alkalinity higher than pH 8,0. However, in advanced liver failure Ammonia may be found in the urine at the pH of 8,0. Ammonia may also be present in the urine as a split-product of urea which is decomposed by bacteria present in an infected urinary tract.

As soon as no bicarbonate can be detected in the urine, bicarbonate should be ingested either orally or if necessary intravenously in order to relieve the bicarbonate-deficit. For the healthy 70 kg-BW human person and depending on age, a minimum of 6 to 10 Gramm $NaHCO_3$ per 24 hours may be required to replenish the body's bicarbonate stores and to reach the so called KOPP's Optimum, i.e. when surplus bicarbonate appears in the urine. Patients with renal insufficiency or absence of kidney-function e.g. dialysis-patients will require higher amounts of bicarbonate in order to compensate the non-excreted acid metabolic waste. Experience shows that the varying demand of bicarbonate in each person can only be identified by measuring the urine-pH or by blood-gas-analysis in the laboratory. Urine-pH only indicates wether or not the body bicarbonate stores are full or deficient. It does not show the amount of the deficit. The daily amounts of bicarbonate which need to be ingested in order to fill the deficit may therefore vary rather surprisingly, depending on diet, physical exercise, kidney function etc.

Kopp's optimum Urine-pH is pH 7,5 - 8,0

Why?
The normal narrow physiological pH-range in the blood is pH 7,35 – 7,45.

It is only slightly lower than the Optimum Urine-pH of pH 7,5 – 8.0 recommended by KOPP, which indicates a surplus of bicarbonate that appears in the urine, due to the ingestion of sufficient bicarbonate. Therefore, this represents a guarantee for the maintenance of a normal blood-pH. Urine-pH-values lower than pH 7,0 therefore indicate a blood-bicarbonate deficit (Fig 4). The bicarbonate surplus in the blood is sufficient to neutralize sudden acic-loads e.g. the lactic acid- outflow from muscles during exercise or even the metabolism of alcohol from several Whiskeys. The reserve of bicarbonate may just last until the next passage of urine. If not, a deficit, if present can easily be detected from the urine-pH lower than 7,0. After the voluntary or involuntary ingestion of a slightly higher amount of bicarbonate, urine-pH will remain at the maximum value of pH 8,0 which only indicates that bicarbonate is continuously being excreted.

However, a urine-pH of 8,0 may be present from other pathological causes. In cirrhosis of the liver or in urinary tract infections with urea-splitting bacteria the alkalinizing agent is Ammonia. Therefore, in all cases where a urine-pH of 8,0 CANNOT be attributed to the ingestion of bicarbonate the medical diagnosis (and therapy) of its cause and origin is required.

The answer to the question whether or not bicarbonate can be overdosed is rather easy, as long as the amounts ingested are not excessive. According to the Pitts-mechanism any surplus amount in the blood will be immediately excreted by the kidneys as shown in Fig. 4.

The oral intake of Bicarbonate may lead to the formation of carbon-dioxide (CO_2) gas and foam in the stomach, with eructations and heartburn and sometimes to diarrhoea. In patients with far advanced renal failure or in patients on dialysis sodium bicarbonate should be administered with caution and should be controlled by the patient using the measurement of urine-pH. Suicidal overdosage requires clinical therapy.

Civilization-Ailments may be caused by a deficit of Sodium Bicarbonate

Osteoporosis, Diabetes, Cardio-Vascular Diseases, Hypertension, Fluid retention, Edema, generalized or local, Renal Insufficiency leading to Dialysis, Malignancies etc.

In the Introduction, the influences of civilisation on nutrition and environment and their consequences leading to acidosis of the organism have been mentioned. Therefore, the civilisation-ailments mentioned above are always associated with the presence of acidosis as a consequence of a variety of causes.

Post-menopausal osteoporosis in females is caused by the additional deficit of ovarian hormones which needs to be substituted. However, without the correction of the simultaneously existing bicarbonate deficit the hormonal therapy remains ineffective.

Hypertension/High blood pressure
The elevation of blood pressure into pathological ranges may be caused my numerous abnormalities and disturbances in the body which are extensively described in voluminous medical textbooks.

However, in certain cases, no cause can be found in spite of the exhaustion of all diagnostic tools.

Essential Hypertension or hypertension of unknown origin is then the diagnostic denomination. The accompanying acidosis e.g. the deficit of bicarbonate which is always present is constantly neglected and never treated. In fact, acidosis itself may be the underlying cause of this type of hypertension, which as a proof will disappear if the acidosis is properly corrected. The underlying origin of the elevation of blood pressure is the generalized vasoconstriction which always accompanies an existing deficit in bicarbonate and is mediated by the secretion of vasoactive hormones of the renin-angiotensin-aldosteron-group.

The prescribed medicine therefore usually comprises only the pharmacological hormone-antagonists against the hormones of the renin-angiotensin-aldosteron-group Unfortunately, the bicarbonate-deficit is never being treated. Substitution of bicarbonate is usually very effective in lowering the blood pressure into the normal range provided that no significant secondary damages of hypertension are already present in the body e.g. in the kidney. *Alkalotic volume-contraction*

The term for the physiological condition which is created if bicarbonate is sufficiently substituted is called *Alkalotic Volume Contraction*.

Brain-edema, post-traumatic or pre-peri or post-operative, is associated with hypoxia and acidosis which allows the influx of fluid into the cerebral tissues thereby causing its swelling. It can be counterbalanced by the addition of sodium-bicarbonate to the organism, thus producing the physiological state of “contraction alkalosis” . (See “Reference 3)

Edematous conditions, generalized or local

Fluid retention in the body often occurs due to a deficit in bicarbonate, because after the age of 25 a 10 % decline of renal function occurs with each decade that follows.

Swelling of the ankles, periorbital swelling, “eye-rings” are frequently observed.

Vertebral disc prolapses which protrude into the spinal canal cause inflammatory reactions which cause local fluid accumulations due to the surrounding acidotic milieu. Thereby the volume of the herniated disc will increase . Contraction alkalosis and diminished swelling can be produced by the intake of sufficient doses of sodium-bicarbonate and may significantly improve the neurological symptoms of spinal compression like pain, paresthesia and paralytic symptoms in the corresponding limb.

Diabetic acidosis is a condition which occurs in diabetes particularly if it is insufficiently treated with diet or insulin and is somewhat more familiar to those who are concerned. However, diabetic acidosis or the deficit of bicarbonate in diabetics is rarely adequately treated. The control of glycemia with diet and insulin would be greatly facilitated with the intake of bicarbonate, a possibility which remains to be neglected by most diabetologists. Furthermore it is totally ignored that the most feared late vascular complications of diabetes, leading to amputations, blindness and kidney-failure with dialysis, can be significantly delayed or even be prevented due to the specific vasodilating property of Sodium Bicarbonate. The catastrophic personal fate should be reason enough to maintain a prophylactic control of acidosis by administering bicarbonate to the affected individuals which in a socio-economic view would be much cheaper, than chronic dialysis therapy at a cost of more than € 1000.- (one thousand Euro) per WEEK.

Osteoporosis

Osteoporosis occurs in various clinical forms. Postmenopausal osteoporosis which occurs in women has been mentioned before. Osteoporosis of older age is a global problem and is not completely understood. Personal clinical and scientific experiences of the author suggest that chronic acidosis leads to a change in the homeostasis of the bone-cartilage system towards catabolism with loss of mineral-salts from the bone. Supplementation of bicarbonate, sufficient to completely fill the body stores creates anabolism with an influx of Calcium-salts into the bone-matrix and thereby will prevent osteoporosis. The yearly cost of osteoporosis in the budget of any country should be reason enough to support a daily, sufficient and permanent supplementation with bicarbonate.

Malignancies, Genesis, Growth and Metastasis. Prophylaxis and Therapy. Acid-Base-Balance in Chemotherapy, Radiation and Immunosuppression.

In malignancies the cellular milieu is rather acid and malignant cell proliferate best in an acidotic surrounding (Otto H. Warburg Hypothesis). It can also be assumed, that the formation of malignant cells is favoured in an acid milieu and is inhibited by alcalosis. Observation from vegetarians may support this assumption. Immunosurveillance which is responsible for the elimination of malignant cells may not function at optimum if the milieu is acidotic.

Scientific experience and measurements of the author have shown, that patients undergoing chemotherapy are severely acidotic. Supplementation with bicarbonate was able to neutralize and avoid the severe side-effects of chemotherapy, e.g. nephrotoxicity leading to acute renal failure and dialysis.

Sports, Athletics, Muscular Metabolism

The muscles are the organ that enables the human body to move. Striated skeleton muscles represent the biggest parenchymal organ participating with 25 % to 40 % to the total weight of the body. The muscles of the extremities perform rapid movements of large amplitudes. Spine muscles are predominantly responsible for the bodies posture.

The metabolism of the resting muscle is rather low and depends almost entirely on the aerobic degradation of carbohydrates. The energy for the contraction of muscles basically is derived from the oxidative breakdown of nonesterified fatty acids and glucose as well as from glycogen which is stored in the muscle cells. Energy-rich organic phosphates are thereby synthesized, simultaneously lactic acid accumulates inside the mycoplasma of the muscle cell. This will lower the pH inside the cell. The muscular metabolism will be diminished and blocked at an acidotic pH of 6,4. It will ultimately result in the loss of muscular performance and power. The oxidation of glycogen and glucose which provides the muscular energy eventually results in the production of CO_2 i.e. carbonic acid, which needs to be eliminated by the lungs, otherwise respiratory acidosis may develop. Many athletes are consuming so called “Energy-boosters” or drinks which are rich in calories and proteins. This increases the production of metabolic waste and of fixed organic acids to more than 40 to 80 mMol per. Even the very young and healthy kidney is unable to eliminate this surplus of acid load as the human urine pH is limited at pH 4,5. The acids that remain in the body will lead to metabolic acidosis with a corresponding deficit of bicarbonate ($NaHCO_3$). High performance sports will inevitably lead to metabolic acidosis as the production of CO_2 and lactic acid in the muscles is increased. Neutralization can be achieved by providing adequate amounts of sodium bicarbonate. In addition, the physiological improvement of renal function as described earlier in this article will optimize the urinary excretion of acid. Based on scientific and practical experience all argues for the use of sodium bicarbonate when performing sports.

Lastly, it should be understood that the results and compiled experience, how to maintain the pH optimum in the body described by the author in this article, has been gathered over a cumulative period of 30 years of scientific research and clinical occupation with the subject.

Discussion

In addition to the deficiency of bicarbonate various other deficiencies may simultaneously exist in the organism e.g. for iodine, iron or hormones etc. caused either by age or environmental conditions as described before. The human organism, a land-living mammalian is similar to a highly complex bioreactor with countless chemical reactions taking place simultaneously. The constancy of the “Milieu interieur” à la Claude Bernard e.g. the constancy of body-temperature and the maintenance of the acid-base-balance are preconditions for the normal function of this system. Hormonal or neurogenic factors stimulate or delay the bioreactive processes, catalyzers accelerate them. Vitamins, enzymes, trace-elements, buffer-systems, oxygen and carbon-dioxide and the concentrations of the various reacting substrates including their metabolites act in concert on the different biochemical reactions. If any deficiency-situation occurs, those reactions will be influenced in one or the other direction.

Therefore, it is very rare that any pathological situation could be attributed to only one single missing component or only one deficiency syndrome. However, many of the existing different interpretations, teachings and dogmas about any disease can be explained from the differing points of view of each examiner resulting from their specific field of interest. The result is often a “terrible simplification” which is of course not permissible. Unfortunately sometimes narrow-minded, even malicious prognoses are generated or miraculous cures are promised, based on miracle products and drugs which may even be harmful or toxic.

In dealing with the deficit of bicarbonate or the Bicarbonate-Deficiency-Syndrome (BDS), the acid-base-balance in the organism, i.e. the molar concentration between H+ and OH- is concerned which constitutes the most important buffer-system of the body.

Therefore, as soon as a BDS is recognized it should be corrected adequately. As stated before, due to age, environmental influences and its obligatory association with any disease the BDS is far more frequent than commonly assumed.

Summary

The practical benefit of a widespread optimal substitution with bicarbonate is extremely large and limitless. Osteoporosis, gout, complications during pregnancy (eclampsia, EPH-gestosis), post-traumatic complications e.g. swelling of the brain, compression of the spinal cord in vertebral injury, typical late complications of diabetes and of hypertension, including the need for acute or chronic dialysis, intolerance of chemotherapy and other conditions, may be avoided.

Donor organs for transplantation remain viable over prolonged periods of time and their availability which is so far rather limited, will be enhanced (Lit. 17)

So far, the benefit and the effectiveness of sodium bicarbonate is used and practised only at a rather limited degree. In the alternative or empiric cure medicine many recommendations for the improvement of the acid-base status are being made. They lack precise recommendations and remain rather vague. They however show that mankind is perceiving the problems associated with acidosis and that the awareness of a deficiency is present, requiring balanced substitution.

Addendum

The following information is essential for the understanding of the “scientific “error mentioned in the beginning: **Sodium = Na** is it **Bad** ? or **Good** ?

Sodium, as the positively charged Na +- Ion, is always ligated to a negatively charged Cation e.g. Cl- or HCO3- . If it is bound to Cl – it is called NaCl = **kitchen salt** or common **salt** or **sea-salt** and if Na+ is bound to HCO3 – it is called NaHCO3 = **baking-soda** or **Sodium Bicarbonate**. These two substances are two different chemical compounds with entirely different and even opposite properties and actions in the organism.

NaCl = Salt may indeed be harmful or “*bad*” in certain situations.

Sodium Bicarbonate, NaHCO3, is the natural physiological buffer in the mammalian organism and and if it is substituted at normal concentrations it may be considered as “good”. However, the excessive intake of 100 Gram of Sodium Bicarbonate is certainly not advisable and would require medical treatment.

Therefore, the chemical ion Na + or the element Na = Sodium is neither bad nor good, only the two different compounds are acting in different ways which may be desirable or undesirable.

It is therefore most misleading if even in scientific texts Sodium-Chloride e.g. NaCl is simply referred to as Sodium.

Thereby the confusion is created whether or not the compound in question is really SALT or any other chemical compound e.g. Sodium Bicarbonate. Being aware, that the consumption of Salt may be detrimental even for healthy persons and much more so for all conditions where the intake of salt is clearly contraindicated , the food industry reduces the Sodium–content of various food products, diets or mineral-waters at a high cost. Even the most desirable amount of Sodium-**Bicarbonate** contained in mineral waters is unfortunately reduced, whereas only salt, if at all present, should have been removed.

Therefore, the labeling of the so treated products erroneously mostly reads: “low in ***SODIUM***” whereas it should read : “low in **SALT**”.

For many reasons, this constitutes a rather unhealthy and economically a very costly “scientific ERROR”.

Prof. Dr.med. K.F. Kopp