



RESEARCH ARTICLE

INTERNAL PH IN HEALTH AND DISEASE

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ABSTRACT

A healthy body is determined by the health of each cells which depends on acid-alkaline balance (or pH Balance). It is most crucial which can affect human health status. It impacts immunity, digestion, bone strength, symptoms of joint disease, hormones, and the function of essential internal organs." An improper pH balance that is acidic ph can not only severely impact quality of life, but it can also shorten life. On contrary alkaline ph can reverse the disease process. Even cancer cells thrive in an acid environment. Therefore this review presents a report on "body ph" or "internal ph in health and disease".

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INTRODUCTION

Our body is an amazing chemical lab where myriad of biochemical reactions takes place for accurate, continuous and simultaneous functioning of every cell. All biochemical reactions function their best in alkaline range and are affected by acidic pH (Importance of ph balance, 2015; Nothing Happens Without Chemical Reactions, 2015) Metabolic processes such as, the processes of living, tissue repair, and the metabolism of food-produce a great deal of acid which is extremely dangerous to the mitochondria and even genes (Mark Sircus, 2015). In order to maintain internal alkaline state and to stay alive: oxygen, water, and acid-buffering minerals are necessary which are first line of defense against disease. Disease can only grow in an acidic body, which makes a condition favorable for the growth of bacteria, yeast, fungus, mold, viruses, etc. Even Cancer always strikes those with an over-acidic body (Dr. Ritamarie Loscalzo, 2010) Thus the determining factor between health and disease is pH which is being neglected (Importance of ph balance, 2015; Sonja

Benjamin, 2015; Cancer Cures, 2015). The current sophisticated treatment modalities are being focused at a secondary or symptomatic level and does not simply focus on the crucial cause that is to raise pH. Many doctors, herbalists and nutritionists believe that the main culprit and true battlefield of all ailments is acidic pH or pH Imbalance which has deleterious effect on various body systems, discussed in this article. In 2006, Hanahan and Weinberg proposed 6 hallmarks of cancer, embracing the six biological abilities gained during the multistep development of tumors. In an update in 2011, they have proposed two new emerging hallmarks: (1) metabolic reprogramming. Immune evasion However, these two emerging hallmarks should not be regarded as independent factors but appears to be linked to each other as reported by Mohit et al. (Kareva and Hahnfeldt, 2013; Henning et al., 2004; Barar et al., 2013; We et al., 2011). The pH gradient reversal arbitrates the development of tumor through metabolic re-adjustments and inhibition of apoptosis. (Barar et al., 2013; We et al., 2011) Thus, pH gradient reversal is also now being reckoned as a chief characteristic essential factor for tumor cells survival and propagation, independent of their pathology, genetics and origins (Barar et al., 2013; We et al., 2011; Harguindey et al., 2013; Daniel et al., 2013).

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Hence, it can be regarded as an integral feature of various pathologies. Thus this review highlights the importance of acid–base balance i.e. internal pH in health and disease which could create hopes to develop new treatment modalities in future to treat deadly diseases or could even reverse the disease process.

Definition of pH

pH is defined as the negative logarithm of the hydrogen ion concentration. This definition of pH was introduced in 1909 by the Danish biochemist, Soren Peter Lauritz Sorensen (1868–1939). This value ranges from 0 to 14 pH. Values below 7 pH exhibit acidic properties while values above 7 pH exhibit basic or alkaline properties. (Frederick J. Kohlmann, 2003)

pH value of various body fluids

1. Blood pH:

The bloodstream is the most centralized and sensitive buffered system of the entire body and maintain a slightly alkaline pH with the value of arterial blood Ph is 7.41 and venous blood being pH is 7.36 (Frederick J. Kohlmann, 2003)

2. Interstitial fluids and connective tissue pH:

Interstitial fluid present in the intercellular area and considered as medium for smooth functioning of all tissues. It reflects the pH of blood plasma, blood serum, urine, and occasionally cerebrospinal fluid in diagnosing disease. (Bodyfluids, 2015) A normal pH in these areas is 7.34 and 7.40, sometimes becomes more acidic as body dumps metabolic acids in these areas can dangerously drop to the concentrations of pH = 5.0.

3. Urine pH values:

Urine is slightly acidic in the morning, (pH = 6.5 - 7.0) and generally becomes more alkaline (pH = 7.5 - 8.0) by evening in healthy people primarily because no food or beverages are consumed while sleeping (The Role of pH and Healthy Living, 215)

4. Salivary pH

The pH of saliva is usually between 6.5 - 7.5

Most medical and surgical subspecialists concern themselves with a specific organ (e.g. nephrology), region of the body (e.g. cardiothoracic surgery), or disease process (e.g. infectious disease), but critical care specialists are more often concerned about acids base balance which is responsible for various severe derangements in body systems and area of main focus by intensivists. (John A Kellum, 2000)

Causes of acidic pH

1. Oestrogen levels

It binds to receptor sites on the cells membrane. One natural oestrogen, oestradiol, is particularly aggressive, reduces the

potassium levels, increases the sodium levels, with the resultant effect that the cell becomes more acidic, i.e. uses less and less oxygen, and could result in ill health and cancer.

2. Insufficient sleep

During sleep pineal gland produces melatonin, which helps put into a deeper sleep. Inadequate melatonin levels leads to increased oestrogen levels which further leads to neoplasia.

3. Chemicals and pesticides

If inhaled or ingested can mimic the action of oestrogen within cells.

4. Stress hormones

Hormones like cortisol affect localized hormones like Insulin and steroids around cells in stressful times and can set up acid conditions in the body. Interestingly, people with cancer have higher cortisol levels, more inflammation and more metastases.

5. Low level of blood oxygen

Cancer cells are anaerobic and cannot survive in the presence of high levels of oxygen which is considered as one of the treatment modality.

7. Acid pooling

The body dumps metabolic acids substances from the blood into cells to maintain the alkaline nature of blood. Due to which cells becomes acidic with low levels of oxygen levels and harms the DNA, leads to lysis of most of the acidic cells.

However, some will evolve, and adapt, and survive by becoming abnormal, mutated cells or Malignant cells.

8. Acidic Diet - An acidic pH can occur from, an acid forming diet, meat, fish, poultry, dairy, grains, refined or processed foods, fast food. (The importance of pH balance, 2015; <http://www.natural-health-hope.com/163195767>) Therefore vegetarian diet is preferred for good health.

9. Emotional stress including, worries, anxiety, negative thoughts can cause acidic pH (The importance of pH balance, 2015; <http://www.natural-health-hope.com/163195767>). Therefore meditations is the best practice to control such impure thoughts.

Body reactions to acids

Increased acid levels leads to bone demineralization. Therefore body protect itself from damaging actions of acids by storing these acids in fat cells. This process may save all vital organs from severe damage. By returning to a balanced pH level, body will lose unwanted fat cells. (Henning *et al.*, 2004; Sonja Benja, 2015) Body has 3 ways of maintaining a normal pH range as following:

- a) Chemical buffer system through Carbonic acid / bicarbonate, Phosphate buffer and Protein buffer which acts within seconds
- b) Respiratory controls-which acts within minutes Important in compensating for metabolic acidosis or alkalosis and Permits elimination of the volatile acid (bicarbonate acid)
- c) Renal controls- Acts within hours or days Compensate for respiratory acidosis or alkalosis and Eliminate fixed acids from the body (Edyta Mądry, 2015)

Alkaline pH

Highest alkaline mineral concentration is observed in fetal life which later on gradually acidifies. Therefore degenerative diseases are seldom seen at younger age group. (Edyta Mądry, 2015) Immune system also flourishes in an alkaline environment due to the 800 different strains of Microbiome or the Beneficial Bacteria present in the gut and are our first line of defense and grows well in alkaline diet like fibrous whole foods, whole grains, green vegetables. These beneficial bacteria are crucial to our very existence by consuming yeasts and microbes in the gut at night. Their very presence stimulates our immune system and direct a whopping 85 per cent of our antibody production. They help release crucial vitamins from our food; particularly the anti-cancer vitamins biotin, B-12, folic acid and vitamin K. They even produce a powerful anti-cancer chemical (sodium butyrate) and chelate with and eliminate cancer causing oestrogenic chemicals and nitrosamines, plus heavy metals like cadmium and mercury. (Acid bodies and cancer, 2015)

Exchange of Chemicals in the Body

All cells in the body continually exchange chemicals (*e.g.*, nutrients, waste products, and ions) with interstitial fluid surrounding them through membrane channels, due to a concentration gradient associated with various minerals present in these fluids. Hence, the chemical composition of the blood (and therefore of the external fluid) is extremely important for the cell. If, for instance, the pH of the blood and external fluid is too low (too many H^+ ions), then an excess of H^+ ions will enter the cell. (Rachel Casiday and Regina Frey, 2015; Vander *et al.*, 1994)

Accumulation of metabolic waste

Every living cell creates waste products. The nutrients are delivered to each cell and are burnt with oxygen to provide energy to live. The burned nutrients are the waste products. These waste products, which are mostly acidic, are discharged from our body through various elimination channels. Therefore urine and perspiration are acidic. If our internal environment is not maintained in a state of pH balance, body's ability to eliminate the waste products will slows down. To protect itself, the body converts acidic waste into solid waste and stores it in less critical areas of the body. The accumulation of solid waste can contribute to many health problems including excess weight, clogged arteries, arthritis, kidney stones, and various other chronic illnesses. (The importance of pH balance, 2015)

The **measurement** of pH can be made in a variety of ways such as-

1.Indicators: Indicators are materials that are specifically designed to change color when exposed to different pH values like pH paper which is matched to a color on a color chart to infer a pH value. pH paper is available for narrow pH ranges (for example, 3.0 to 5.5pH, 4.5 to 7.5 pH and 6.0 to 8.0 pH), and fairly wide ranges of 1.0 to 11.0 pH. pH paper is typically used for preliminary and small volume measuring. It cannot be used for continuous monitoring of a process.

2.Colorimeter: This device uses a vial filled with an appropriate volume of sample, to which a reagent is added. As the reagent is added, a color change takes place. The color of this solution is then compared to a color wheel or spectral standard to interpolate the pH value

3.pH meter –It is always recommended for precise and continuous measuring. Most laboratories use a pH meter connected to a strip chart recorder or some other data acquisition device so that the reading can be recorded or stored electronically over a user-defined time range.

4.pH Electrodes-A pH electrode assembly, or sensor, as it is sometimes referred to, consists of two primary parts: Measuring electrode: The measuring electrode is sometimes called the glass electrode, and is also referred to as a membrane or active electrode. Reference electrode: The reference electrode is also referred to as a standard electrode.

Health conditions associated with advanced ph imbalance (acidosis)

Severe acidosis

Crohn's Disease, Schizophrenia, Hodgkin's Disease, Systemic Lupus Erythematosus, Multiple Sclerosis, Sarcoidosis, Rheumatoid Arthritis, Myasthenia Gravis, Scleroderma, Leukemia, Tuberculosis, Cancer

Moderate acidosis

Cold Sores, Depression, Loss Of Memory, Loss Of Concentration, Migraine Headaches Insomnia, Disturbance In Smell, Taste, Vision, Hearing, Asthma, Bronchitis, Hay Fever Ear Aches, Hives, Swelling, Viral Infections, Impotence, Bacterial Infections, Fungal Infections (Candida Albicans, Athlete's Foot, Vaginal), Urethritis, Cystitis, Urinary Infection, Gastritis, Colitis, Psoriasis

Mild acidosis

Acne, Agitation, Muscular Pain, Dizziness, Low Energy, Joint Pains, Food Allergies, Chemical Sensitivities, Hyperactivity, Pre-Menstrual And Menstrual Cramping, Lack Of Sex Drive, Bloating, Heartburn, Diarrhea, Constipation, Hot and Smelling Urine, Mild Headaches, Rapid Heartbeat, Irregular Heartbeat, White Coated Tongue, Hard To Get Up In Morning, Excess Head Mucous, Metallic Taste In Mouth (Importance of ph balance, 2015)

Systemic effect of acidic PH

It will have effect almost on all various tissues such as

1. Gastrointestinal System - Most digestive disorders, such as indigestion, nausea, bloating, gastric reflux, are symptoms caused by excess acid in the gastric region.

2. Heart - Acidity is the principal cause of heart disease.

3. Immune System - Acidic environments are breeding grounds for anaerobic pathogens. Alkaline environment keep harmful bacteria inactive.

4. Respiratory tissues - Exchange of oxygen is hampered in acidic environment and affect the cell to function correctly. When the ratio of acidity is too high then wastes in the form of mucus and infections and viruses build up in our lungs, which leads to colds, bronchitis, asthma, etc.

5. Bones - Arthritis is one of the most disabling diseases related to pH imbalance and accumulation of acid deposits in the joints and wrists which damages the cartilage. Synovial cells fails to produce the lubricating synovial fluids which causes a dryness that irritates and swelling of the joints due to the formation of crystals in the joints.

6. Skin - Ph imbalance leads to infection and inflammation of the skin.

7. Brain - Acidity weakens the nervous system by depriving it of energy. It makes the body physically, mentally, and emotionally weak.

8 Kidneys - Excess acids pooling causes pulling of alkaline minerals from bones and dumping them in the blood. If this occurs frequently enough, the minerals build up in the kidneys in the form of painful kidney stones.

9. Muscles - When acidity increases in the muscle cells, it disrupts the metabolism breakdown of glucose and oxygen to energy. This means muscles perform poorly in an acidic environment. An alkaline system on the other hand allows for much better aerobic metabolism and energy for the body's recovery from strenuous exercise. We can often observe when someone is acidic from their breathing because they take large gulping inhales while doing the simplest tasks like walking and talking, which suggests their body finds it difficult to adequately deliver oxygen into the cells - a symptom of acidosis.

10. Genital tissues - Still much research is being done to discover the exact link between sexual dysfunction and acidity and also infertility and acidity. (Marcus Julian Felicetti, 2015)

Neoplasia and Ph

The intratumor microenvironment in malignancy is intrinsically acidic due mainly to accumulation of lactic acid and this seems to encourage metastases to fire off. It been suggested that the pH inside a tumour can be as low as 6. (Acid bodies and cancer, 2015; High ph therapy, 2015) At a pH slightly above 7.4 cancer cells become dormant and at pH 8.5 cancer cells will die while healthy cells will live. This has given rise to a variety of treatments based on increasing the alkalinity of the tissues such as vegetarian diet, the drinking of fresh fruit and vegetable juices, and dietary supplementation with alkaline minerals such as calcium, potassium, magnesium, cesium and rubidium. (Reshkin *et al.*, 2013) pH of Cancerous cells are in the range of 5.5 to 6.5 (High ph therapy, 2015) Cancer is not compatible in a healthy pH environment full of oxygen. Urine and saliva pH of terminal cancer patients almost always runs between 4.0 and 5.5. When the cancer goes into metastases the pH drops even lower. (Porporato *et al.*, 2011) The current work tests the

hypothesis that neutralizing the acid pH of tumors will inhibit invasion and, hence, reduce the incidence of spontaneous metastases. (Ian *et al.*, 2009) Tumor blood perfusion is lethargic, resulting insufficient supply of various nutrients, including oxygen, to tumor cells. As the tumor grows larger, the intercapillary distance progressively increases. In addition, probably because of progressively increasing Interstitial pressure caused by the increasing tumor cell population, tumor blood vessels are compressed, and the blood perfusion ceases intermittently or permanently resulting in intermittent or permanent hypoxia. (High ph therapy, 2015)

Acids and genes

A normal cell produces its energy in its power stations, or mitochondria in the presence of oxygen. In the cellular membrane there are pumps that rely on magnesium to work properly. The pumps push potassium into the cell and pump out sodium. If too much sodium gets into the mitochondria, the energy producing steps start to use sodium instead of potassium which will still work but not as efficiently. Less oxygen is burned and less energy produced. The waste products will now be sodium salts, which are more 'acid' than potassium salts. This acidity in the power stations' environment then makes the energy production process even less efficient - taking in even less oxygen and producing even less energy. Once the cell has powered down, certain DNA repair genes (like *p53*) are switched off while the genes (like *ras*) that tell the cell to divide rapidly still run at low power and transformed into cancer cell. (Acid bodies and cancer, 2015).As suggested by Mohit *et al.* in his extensive review article that genetic composition of every cell of the body is very sensitive to the changes in the extra cellular environment (Sharma *et al.*, 2015).

Ph and dental caries

When the blood starts to become too acidic and the supply of alkaline buffers in the blood is insufficient to neutralize this acidity, the blood automatically seeks out other ways to reach pH balance. Since calcium is a very alkalizing mineral, the body will start drawing calcium from the bones and teeth in an effort to balance the blood's pH levels. As the body's acidity increases, more and more calcium is removed from the bones and teeth. If left unchecked over a long period of time, it can lead to a loss of bone and teeth density which eventually leads to osteoporosis, porous enamel and dentin which could further lead to various types of dental caries like incipient caries, smooth surface caries, rampant caries, the etiopathogenesis of which has not been clearly understood till date. Thus it could be hypothesized that changes in internal ph could be the primary event followed by changes in salivary ph.. (The importance of pH balance, 2015; Shafer, 2009).Thus reversing internal ph from acidic to alkaline might reverse the dental caries process in future but it needs further research to validate the hypothesis. We might also find the answers for unknown etiopathogenesis of incipient caries, smooth surface caries, rampant caries as well.

Ph and chemotherapy

Chemotherapy works by killing all rapidly dividing cells. If the immune system has been wiped out by chemotherapy or

radiation, cancer is bound to overrun the body even faster than before. (Diagnosed With Cancer? Here Are 11 Effective, Natural Strategies To Kill Your Cancer, 2015) Drugs, medications and toxic chemicals have the effect of lowering the pH of the body, that is the reason why there are side effects to drugs and none of them affect a cure. When body pH drops below 6.4, enzymes are deactivated and digestion does not work properly. Acid decreases energy production in the cells, the ability for the body to repair damaged cells, the ability for the body to detoxify heavy metals and makes the body more susceptible to fatigue and illness. (Porporato *et al.*, 2011)

Ph and therapy

Tumour cells preferentially convert glucose and other substrates to lactic acid, even under aerobic conditions. Since lactic acid has a pH of 3.7 it seemed obvious that the intracellular fluid would become acidic. It was argued, for instance, that anticancer drugs would be more effective if they contained ionizing groups that would cause them to be trapped in acidic environments (Wike-Hooley *et al.*, 1984), or that radioresistant hypoxic cells would have a particularly low pH and might therefore be especially sensitive to treatments such as hyperthermia which are known to act preferentially on isolated cells in acidic media (Freeman *et al.*, 1981).

Ph and reverse aging

Reverse ageing requires two separate steps: chemical and physical. The first step is to lower the acidity of the body so that it can dispose of acidic wastes in the blood and cellular fluids safely and easily. The second is to physically pull out old stored wastes into the blood stream so that they can be discharged from the body". (Acid bodies and cancer, 2015)

Conclusion

Research shows that unless the body's pH level is slightly alkaline, the body cannot heal itself. So, no matter what type of modality is used to improve health problem, the modality won't be effective until the pH level comes up. Drugs, medications and toxic chemicals have the effect of lowering the pH of the body, that is the reason why there are side effects to drugs and none of them effect complete and permanent cure. As dental caries is a diseases characterized by demineralization of hard tissues and is strongly associated with salivary pH imbalance which has been proved through numerous studies .Unfortunately etiopathogenesis of few types of dental caries like rampant caries, smooth surface caries and incipient caries has not been explained and proved .Therefore it could be hypothesized that internal pH could play an important role in the initiation of dental caries ,leading to porous mineralized tissue which facilitate microbial attack but needs further research to validate the hypothesis. Therefore internal pH imbalance should be considered and treated by all therapists in treating various ailments of the body. As we understand the role of pH balance and discover how to control it, we will experience health at an entirely new level when molecular world of pH balance reigns.

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