Ray Peat's Newsletter

The Edema of Stress

Our medical culture is bloated with retained errors – especially in connection with tissue water and its regulation. Sometimes, just by finding and eliminating errors, a new pattern will reveal itself in the remaining data.

A popular laboratory assignment for students in physiology is to drink a liter of ordinary or distilled water, and to measure the urine output in the next few hours. Then, in the next class (or with different students), a liter of water with 9 grams of sodium chloride is drunk. The urine output over the next several hours is about a liter less than in the first experiment. Thus, "sodium causes water retention." Textbooks base everything on this simple idea that "water follows sodium." "There are," they say, "no water pumps, only sodium pumps in cells."

Two real-world observations reveal the nature of the mistake in that doctrine.

People who work hard in the summer have noticed that their sweat can be so salty that it leaves salty crystals on their hair, and burns their eyes. They may need salt tablets during the day to keep from fainting. But other people, on a low salt diet, can sweat copiously without losing much salt. The body obviously adjusts its salt retention to compensate for salt intake.

By experiment, this adjustment takes only a couple of days. If physiology labs extended their experiments, they would find that sodium does not cause water retention in any sense that matters physiologically. In fact, in both animal and human studies, there are situations in which increased sodium helps to unload excess tissue water.[1]

The second real-world observation is that millions of women (in my direct observation, several hundred) have severely restricted their salt intake, yet continue to suffer from cyclic edema. Because of the assumption that "water follows sodium," and that body fluids are "isotonic" (with "isotonic" salt solutions, or with intracellular fluids), people seldom measure the osmolarity of blood plasma or serum. Estrogen causes the retention of water independently of sodium, causing the molarity of the plasma to decrease. Uremia and, in general, old age cause the molarity of the blood to increase.

Seeing that salt restriction never helped women with cyclic edema, I explained the mechanisms of water regulation, first to just one woman. Within a month, she was salting her food to taste (i.e., salting it heavily in the premenstrual week), and having no trouble with edema. Since then (1978) I have explained this to many women, and it always works for estrogen-induced cyclic edema, and also for the edema of pregnancy induced by excess estrogen,[2] and for the occasional older person for whom it seems appropriate.

Serum albumin with its associated sodium ions, exerts a colloid osmotic pressure which is important in holding water inside blood vessels. Without its associated sodium ions, its intravascular effect is weakened, while the sodium-deficient water tends to cause cellular swelling.

Swelling of tissue cells is the kind of edema which is a serious problem in brain injury and stroke,[3] as well as in traumatic or toxic injury to other tissues, and whenever there is an inadequate supply of energy to cells,[4] as in hypoxia. At a certain point, the resulting pressure of swollen cells outside capillaries can no longer be compensated by adjustments in the blood vessels and increased blood pressure, with the result that tissue perfusion, nutrition and oxygenation are insufficient. (Thus, a severe sodium deficiency contributes to cellular hypoxia).

When cells can't maintain their energy, they swell if exposed to a standard osmotic environment. This is the ordinary "edema of hypoxia," which is similar to the swelling of cells in tissue culture in "normal isotonic medium."

The conventional story to explain this swelling of hypoxia is that the "sodium pump" requires energy to keep the sodium out, and that inadequate energy allows water to "follow the sodium" into the cell. This explanation is wrong and misleading. While energy deficiency causes cells to swell abnormally, water is also *retained* by normal cells under the influence of energy. Much of the cell's energy, in the form of protein-bound ATP, regulates the colloidal nature of the cell, including its water content.[5] In this well-tested view of the cell, it would be appropriate to say that "sodium follows water," to contrast its medical implications to those of the "sodium pump" theory, and to create an image of the potentially protective function of sodium.

The generalized edema of hypoxia is closely related to the focal edema which occurs in inflammations and cancers.[6] In a focus of inflammation, the local metabolism, especially of glucose, increases

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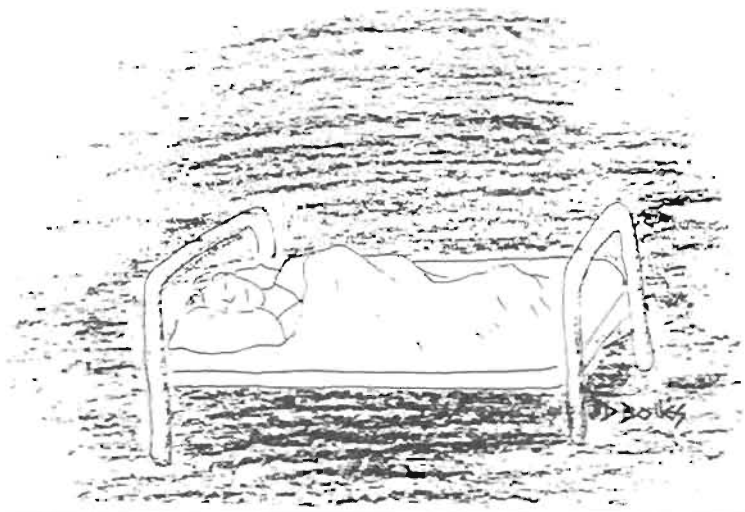
Further Adventures of Dr. Herbinski

Content in the knowledge of giving love, health & organic happiness to his patients for another day, Dr. Herbinski peacefully retires to the Freudian Netherland.



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to compensate for a loss of energy. (In a cancer cell, glucose consumption is often several times higher than that of a muscle cell in maximal activity). The focus becomes acidic. The provoking stimulus causes the ATP-protein complexes to break down, with production of ADP and phosphoric acid, and with changes in protein conformation. The increased dispersion of colloids, and the concentration of metabolites such as lactic acid, ammonia, ADP and phosphate, increase the osmotic and oncotic pressure of the cells. The osmotic pressure can be twice normal.

As early as 1920, there were studies of the extremely high osmotic pressure of serum from uremic patients. If there is systemic hypoxia, this very high osmotic pressure of the blood can be seen as a lucky – or adaptive – defense against the tendency of tissues to swell. Circulation can be maintained under conditions which otherwise would cause tissue swelling and compression of capillaries. Urea is used as a "diuretic" to treat edema of the brain in some circumstances, but it should probably be used more often. A small amount of DMSO (e.g., 1 1/2%) similarly causes cells to shrink.[7] This would seem to explain much of its anti-inflammatory action (yet the doctrine of "membrane pumps" says that permeant solutes shouldn't cause cell shrinkage. The use of hypertonic urea[8] or DMSO, or glucose (about 400 mg. per deciliter, for example[9]) to treat cancer would help to restore circulation, prevent the adaptive leakage of proteins from cells, and allow normal regulatory processes to function more efficiently.

Serum albumin is one of the body's most powerful tools in maintaining homeostasis. Gilbert Ling has demonstrated that serum albumin or collagen, when "denatured" by urea, has a greatly increased oncotic pressure, or tendency to retain water.[10] Under physiological conditions, it is probably a variety of solutes, especially free fatty acids, which cause albumin to adjust its oncotic pressure.

I think the extremely quick changes that sometimes occur in extracellular connective tissue substance (e.g., in arthritis, exophthalmia, or glaucoma) in response to progesterone, pregnenolone, DHEA, or other related steroids, are likely to result from a similar physical effect on the colloidal osmotic pressure of the body fluids, and possibly of the connective tissue substances themselves. Diffusion of oxygen through the lungs can be obstructed by layers of colloidal material, and steroids are involved in mitochondrial structure and stability and other cellular processes, so I don't mean to deny that these hormones also have other powerful effects, just that some early effects in relatively inert tissues are so quick that shifts in water content seem to be the best explanation.

Knowing that old organisms are relatively dehydrated, it is interesting to see that when a young muscle is made to lose some of its water, it functions similarly to a muscle from an old animal.[11] Recently, enzymes from old animals were denatured, causing them to lose their specific folded arrangement. When they were carefully "renatured," it was found that their enzymic function had increased, to become the same as that of enzymes from young animals. This shows that the nature of the "solution" in the cell, the conditions under which the enzymes are synthesized, has subtly modified their shape. Restoring the cell's energy, which governs the cell's colloidal state, might be able to restore all cellular functions to the active, young state, though this state would have to be maintained until protein "turnover" had renewed a large part of the cell structure. ("Protein turnover" refers to the normal process of renewal, in which some proteins are destroyed while new ones are being made).

Energy, in the form of ATP with magnesium, can be effectively supplied to tissues through the blood stream.[12] (Again, it has been the dogma of the "semi-permeable cell membrane" which has blocked the acceptance of this work: ATP simply couldn't get into cells, they said).

Energy, produced under the influence of the thyroid hormone (triiodothyronine, T3), and acting to eliminate edema, can correct many problems that don't seem to have anything to do with "energy." The carpal tunnel syndrome, involving swelling in or around nerves, is often relieved by a thyroid supplement, or by avoiding anti-thyroid foods such as beans and seed oils. (Surgery to relieve the pressure caused by swelling is the conventional treatment). Several people with a diagnosis of "multiple sclerosis" recovered immediately and fully when given thyroid. (Triiodothyronine does influence myelination,[13] but I think the important causal sequence is: first, disturbed respiration, then edema, then demyelination).

Many animal diseases, produced by copper deficiency and its associated respiratory defect, involve swelling of the brain and/or spinal cord. Dogs, horses, and sheep develop weakness or paralysis of the hind legs, as a result of compression of the edematous spinal cord. In chronic copper deficiency, cells absorb an excess of iron,[14] so treatment isn't just a simple matter of giving supplementary copper. Hyperosmotic therapy, to directly relieve the swelling and restore circulation, would probably have to be the first step. In treating either hypoxia or iron-overload, there is the danger of tissue injury from the free radicals produced by reduced iron.

There are many practical, simple consequences of recognizing the interactions of osmotic pressure, metabolism, and inflammation. For example, people with inflammation of the bowel, resulting in obstruction that can't be relieved by an ordinary enema, have found that a hyperosmotic enema (sometimes with aspirin added) can relieve the edema which is causing the obstruction.

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