

tion. The phenomenon is accompanied by increased vascularity, sensitiveness and reddening of the skin surface due to dilatation of the blood vessels. The immersion in a bath moderately warm may elevate temperature by the mere prevention of heat elimination. The primary effect of cold is to produce refrigeration, pallor, and chilliness of the skin surface accompanied by contraction of the capillaries. In the normal individual cold water causes muscular contractions, which produce heat and, if the application is short, the system responds so promptly that no practical reduction in temperature takes place. In febrile states immersion in a cold bath reduces temperature, as Winternitz has shown, when accompanied by sufficient vigorous friction to dilate the peripheral blood vessels. In many delicate and chronically diseased individuals, cold may act as a depressant of temperature unless care is taken to proportionate the coldness of the water to the reactive power of the individual. Colder temperatures can be employed with less discomfort where mechanical stimulation is combined; for instance, in the douche.

Upon the Circulation.—Heat temporarily slows the heart action, increases the force of the pulse, giving way rapidly to a quickened action of both and accompanied by dilatation of the surface blood vessels, reddening of the skin, lowering of arterial tension and perspiration. Mechanical stimulation during the application of heat increased the effects reflexly. The internal blood vessels are contracted as the quantity of blood is relatively fixed. Cold is more decisive and rapid in its action than heat. It slows the heart's action, increases the rate of the pulse, and raises arterial tension. The blood vessels contract, driving the blood from the surface, causing the skin to become pale and slightly shrunken. When reaction takes place, the blood vessels again moderately dilate in what might be described as "a tonic state," so that the general vascularity of reaction following the cold application resembles closely the healthy condition of cutaneous circulation. Most of the results of thermic mechanical stimuli upon the blood vessels are brought about more through reflex action than by any other means, as has been clearly demonstrated by both Schueller and Neumann. It may be noted here that the application of heat, followed by cold, produces a pumplike action beneficial in overcoming congestions or stases in any part of the body.

Upon Respiration.—Heat increases the average number, lessens their depth, diminishes oxygenation and  $\text{CO}_2$  elimination.

Where the heat is inhaled these effects are more rapidly produced. Cold when suddenly applied produces a spasmodic expiration, deep inspiration, greater amplitude of respiration, increased absorption of oxygen and elimination of  $\text{CO}_2$  in the pulmonary capillaries. After reaction the respiration still remains deeper, there is an experienced sense of relief and fullness of the lungs.

By Metabolism, we understand all those varied changes that take place in the tissues resulting in the appropriation of food, and the elimination of waste products by means of which in the normal individual a balance is maintained. Metabolic changes are brought about by the varying action of secretion, absorption, tissue up-building and down-breaking, and excretion. A balanced metabolism evidences an input and output that is just sufficient and proper to meet all the demands of functional activity, repairing of waste, furnishing sufficient force, heat, and to remove the results of tissue waste. It must not be forgotten that an essential part of this process is the absorption of oxygen for oxidative processes. The great channel by which the pabulum is conveyed to the tissues and the detritus removed from them is the blood which, as is well known, is the agent so necessary to the reparative process. Metabolism of tissue may be influenced by (1) activity of function brought about by an increased quantity of blood circulating through the organ or tissue; (2) by change in the composition of the blood in which the presence of increased oxygen stimulates oxidation and tissue change; (3) by increased blood pressure causing more blood to pass through the capillary walls and thus favour nutritive changes; (4) by elevating the temperature of the tissues; (5) by influencing the nervous system, especially the vasomotor and trophic nerves which regulate the capacity of the tissues for absorbing nutriment. Close clinical and some experimental observations have taught me the influence that heat and cold have upon the metabolism of the human body.

I have learned that in their effect upon metabolism they differ rather in degree than in-toto. Heat acts in less degree than cold. Its effects are less likely to be permanent; it enhances the more powerful effects of cold, where it precedes. Cold water has a direct positive and unquestioned influence upon all metabolic activity. Tersely stated, we may say, that under hot and cold water applications we can expect a greater absorption of oxygen and elimination of  $\text{CO}_2$ ; increased quantity of better character of bodily glandular

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