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THE FUNDAMENTAL PRINCIPLES OF PEDIATRICS*

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Pediatrics, at present, may be divided into two parts; first, that relating to the treatment of disease and perversion of function; second, that concerned with the production of well-developed physique in children. More attention is usually paid to the first than to the second of these branches.

If its scope were broadened, pediatrics might be defined as that branch of science which concerns itself with the animal aspect of the production of human beings. This science could then be divided into two parts; first, that devoted to the production of the highest development of the human being as an animal; second, that concerned with the management of the growing human animal when malformed, or with perverted functions, or subjected to mechanical injury, or attacked by parasitic microorganisms, or poisoned. It is evident then, that the pediatricist should be versed in general biology, bacteriology, protozoology, chemistry and physics.

While the public is not yet fully educated to the advantages of consulting a pediatricist before children are sick, it would be to the advantage of children, of parents, and of the community at large if every child during its most active period of growth were supervised by a well-equipped pediatricist, meaning by this, one who has had a broad training in general science as well as in a special department of medicine. If a physician undertakes to look after the development of a child, he should thoroughly understand the broad principles of human development and of animal life in general; it is not enough simply to be able to follow the ideas of some prominent teacher or authority.

It would prove an advantage to all physicians if the fundamental principles of the management of infants could be firmly established and thus taken out of the field of discussion. In order to attain this result, it is essential that the teachings concerning the chemistry of feeding be in accord with the general science of chemistry, that the problems of infancy falling in the province of physics be recognized as such, and that the teachings concerning animal life and development be true to those principles which have been found to apply to life in all its forms.

While medical men stand well in the forefront when it comes to the relations of human beings and animals to bacteria and protozoa, it must be confessed that they often lag behind in respect to the general care, nutrition

and development of the human being in relation to his environment. The physician may broaden out to advantage at the points where science at large touches these problems.

The life-cycle of human beings, like that of all forms of animal life, may be sharply divided into two periods: first, that in which all of the food is derived from the mother's body in specialized forms; second, that in which none of the food is obtained from the mother's body but a wide variety of forms is taken. It is during the period in which the mother secretes the specialized forms of food that the tissues are produced and become differentiated into organs. When the organs of nutrition are developed, such forms of food are no longer needed and the infant has become a living machine that is able from food to build the future adult. This living machine is operated on much the same principle as a mechanical engine. It takes in fats, sugars and starches, and, by combining them with air procured through the lungs, obtains a supply of energy. This energy, when expended, appears in the form of heat which must be removed as fast as it is liberated, and it is accordingly found that all animals are provided with two cooling systems. For ordinary conditions, radiation of heat into the surrounding air is sufficient, but when the temperature of the air is nearly as high as that of the body, or higher, radiation fails to cool sufficiently, and heat is removed by being changed into latent heat through the evaporation of perspiration.

An infant taking 36 ounces of breast milk daily receives food yielding about 792 calories, or enough heat to raise the temperature of a 14-pound baby 113 C. In other words, this food will liberate enough heat to raise the temperature of the infant above the boiling-point of water. It may easily be appreciated, then, how important is the proper working of the infant's cooling system; yet how few realize that infants and all animals have cooling systems, and that the life habits of many animals are largely controlled by them! Some animals of enormous strength, such as the lion and cat tribe, are incapable of prolonged effort because they cannot get rid of the heat liberated as fast as it is produced.

A large part of the sickness among infants in hot weather may be due to ineffective cooling of the living animal motor. Imagine an infant on a hot day lying in a crib surrounded by curtains. Air movement is stopped, and the atmosphere around the infant becomes so saturated with water vapor from the evaporated perspiration that no more can evaporate, with the result that the infant's cooling system breaks down and vomiting and diarrhea may ensue. Boiling water, and vapor from it, have the same temperature, 212 F., yet the vapor has absorbed almost one thousand degrees of heat and rendered it latent or insensible. As long as the air is not

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saturated with vapor, or is nearly saturated, but in motion, this change from sensible to insensible heat takes place and it is perfectly feasible to be cool and comfortable in air whose temperature is above 100 F., provided this air is dry or in motion and thus capable of vaporizing perspiration. In fact, one can be kept quite cool by a current of hot dry air if a wet cloth is kept next to the skin.

When an infant has been subjected to conditions such as render it unable to liberate its heat properly, the treatment that has proved most successful is to stop all food temporarily, thereby reducing heat production; to give the infant baths to remove heat; to keep it quiet to prevent the expenditure of energy which liberates heat; and to send it to the country where the air is cool or dry or in motion; then, unless there is very acute poisoning, recovery usually takes place.

No doubt bacteria play a large part in the summer sickness of infants, but as they are present in food at all seasons, it is evident that the heat gives them an advantage over the infant which they do not possess in cooler weather, or when conditions are favorable for the infant to rid itself of the heat. Restoring the infant to normal action causes the bacteria to lose their effect.

In hot weather food cannot be needed for its caloric or heating effect; it is required rather for its energy content, and the teaching should be in accordance with this fact. Feeding for energy is, to a large extent, a branch of physics; in the management of summer cases a knowledge of the principles of physics would thus often be of greater value than acquaintance with many of the drugs so often employed. The protein and mineral matter are for building materials and repair, and chemical composition is here the controlling factor, as far as potential value is concerned. It is, however, entirely out of place to value protein by its energy or caloric contents. What would be thought of an architect who determined the suitability of timber for a building by the amount of heat it would produce if burned? The feeding of energy and of building materials must be done with a distinct idea of the purposes they are to serve.

The emphasis on the necessity of plenty of fresh air should not be looked on as a hobby. The animal motor operates by a combination of oxygen in the air and the fats and carbohydrates of the food, and one is useless without the other. Insufficient air means incomplete combustion, and the products of incomplete combustion clog up the animal motor. Air is thus as essential as food.

In managing the nutrition of the infant much can be learned from general biology. In all forms of animal life the mother supplies specialized forms of food to the young until their digestive organs are developed, and no method of feeding that ignores this fact can be of the highest value. Many years ago I called attention to the fact that the protein of all milks has a developmental as well as a nutritive function. An artificial food for infants should contain the building elements and energy foods in about the same quantities as those in mother's milk if the best development is to result. Attention should likewise be paid to see that the food behaves in the stomach like mother's milk, but it will not do to compare foods by their chemical analyses alone, as it has long been known that two foods of the same chemical composition might not be interchangeable in nutritive value, and there are factors involved in feeding that chemical analysis cannot explain. The reason for this

may be found in some of the later work in chemistry, as exemplified in the following illustrations: It is a curious fact that two clays, having the same chemical composition, may have entirely different physical properties, and that clay near the mouth of a river will have different properties from the same substance further up the stream, the two clays being derived from the same parent rock and having similar compositions. Acheson reasoned that this difference might be due to the fact that the clay down stream had come into contact with washings from organic matter, and by adding vegetable infusions to the upstream clay he was able to increase its plasticity and make it act like the clay down stream. Here is a practical illustration of what profound changes the most insignificant additions to a substance may produce. Bodies that are insoluble in water may be rendered soluble if certain foreign substances are present in the most minute quantities. Duncan gives the following illustration:

The mere presence of a trace of a foreign body may make an insoluble body soluble. The following puzzling fact is known to but few: chromic chlorid is a curious substance that exists in two forms, soluble and insoluble. The insoluble violet crystals may be left under water for days unaffected but drop into the test-tube a trace of chromous chlorid, even 0.000025 of a gram, and the violet crystals hasten to bury themselves in the water; the temperature rises and the indigo-blue liquid results. This is an example of what is called physical catalysis, for the chemical properties of the chromic chlorid are the same after as before; it has simply passed into solution. Turning now to chemical catalysis, we are confused by the number of examples, for, owing to the recent ferment of investigation, it would take a dictionary to chronicle them.

Remarkable results have been obtained in industrial chemistry by the use of such catalysts. Substances which have been obtained indirectly by the aid of plants can now be made artificially. Heretofore, when the necessary ingredients to form desired substances were brought together, they would not combine. There was something in the plants, however, that would cause such combinations to take place. Indigo has been obtained from the indigo plant, but it was found that the mere presence of a trace of copper or mercury would make the ingredients combine in the laboratory, and now it is made artificially. Platinum black is used to cause the ingredients of formaldehyd to combine, and other substances will cause metallic gold, silver, platinum and graphite to go into aqueous solution called colloidal solution.

How many factors in feeding may be influenced by such apparent trifles remain to be discovered, but that numbers of the vital processes are thus controlled is beyond doubt. Hunt makes the following statement:

Diet has a marked effect on the resistance of animals to certain poisons; the resistance of some animals may be increased forty-fold by changes in diet. Certain diets, notably dextrose, oatmeal, liver, and kidney, greatly increase the resistance of mice to acetonitrile; their effect is similar in this respect to the administration of thyroid; the effect of an oatmeal diet in increasing the resistance of certain animals to acetonitrile is probably due, in part, to a specific effect of the diet on the thyroid gland; this is an illustration of how an internal secretion may be modified in a definite manner by diet. . . . The experiments show that foods such as enter largely into the daily diet of man have most pronounced effects on the resistance of animals to several poisons; they produce changes in metabolism which are not readily detectable by methods ordinarily used in metabolism studies. The ease and rapidity with which certain changes in function

are caused by diet are in striking contrast with the essentially negative results obtained by the chemical analyses of animals fed on different diets.

According to Alexander:

Bald chemical analyses cannot express the digestibility and availability of a food any more than it can express or explain the action of the digestive juices or, in fact, any other physiologic process. In all these processes can be traced the influence of the colloidal substances, present in the body, whose effects are quite out of proportion to their small mass. As soon as we approach the chemistry of the living organism, we are confronted with problems of colloid chemistry, and there is no doubt but that a correct understanding and application of its principles will throw much light on many other obscure problems in biology, physiology and medicine.

These foreign bodies, whose mere presence causes such profound changes, are called catalysts and a peculiar property which they possess is that, at times, they lose their efficiency. When this occurs, they are said to be poisoned. After a time they may recover their power to produce the changes they formerly caused.

The question as to what this has to do with the practical management of infants may here be raised. McCullom conducted some experiments to see how simple in form the food elements could remain and still be combined in the animal body, it long having been believed that animals could not live for any length of time and develop on the pure food elements. Pure fat, sugar, starch, ash-free protein and the ash of milk were used, filter-paper being employed to give bulk. For a time there was gain, then a standstill and finally a loss. By adding successively such flavoring agents as cinnamon, celery, vanilla, caramelized sugar, distillate from strong cheese and salt, it was found that the loss could be prevented. Leaving the fat out of the food temporarily or changing its form, or altering the sugar content of the food, was found to improve the utilization of the food. "In one instance toward the end of the experiment, bacon fat, freshly rendered and filtered through paper, induced hearty consumption when every other means failed." His conclusions were as follows:

Without palatability the ration may possess all the necessary food ingredients and yet fail to nourish an animal properly. The failure of previous efforts to maintain animals on a mixture of relatively pure, proximate constituents of our foodstuffs was due to lack of palatability of such mixtures. When sufficient care is given to changing the character and flavor of the food supplied in such simple mixtures, it is possible to induce an appreciable amount of growth.

Here is an illustration of the action of catalysts in practical feeding. One worked well until it became poisoned or lost its efficiency. A change in the form or flavor of the food brought another catalyst into action, and it in turn lost its efficacy. The beneficial effect of variety of diet has long been known, but the scientific basis on which it rested has not been suspected hitherto. We often get the same good effect by changing the flavor of the infant's food or by altering the form of the food elements, especially the carbohydrates.

Such facts as these could never have been explained by practical infant-feeding, or rather, the principles could not have been evolved; and this shows the advantage of being familiar with general science and applying principles worked out elsewhere to the management of infants.

That a profound change in the function of the human digestive organs may be brought about by changing the character of the food has been shown by Yakawa, who

fed young men who had been vegetarians all their lives a diet composed largely of beef, milk, eggs and rice. The fats, and particularly the protein, were not well assimilated. There was loss of appetite, lassitude and constipation. Such a result is at variance with the belief held generally that animal protein is better digested than vegetable protein. But this case is an illustration of the biologic principle that all living things tend to adapt themselves to their food and environment. Those who have been trained to digest animal protein develop digestive organs well fitted for this purpose and digest it better than they do vegetable protein, and vice versa.

It has been said that one principle is worth many facts, for it covers them all. If the few main principles in pediatrics could be grasped, a large number of facts might be forgotten to advantage. Pediatrics cannot take the position it deserves, until those who practice it recognize that their work is to help infants adapt themselves to their food and environment, and this calls for at least an elementary knowledge of general biology, bacteriology, protozoology, chemistry and physics. We must broaden our scientific outlook.

Medicine has always advanced more rapidly as an art than as a science, partly because it has not been sufficiently rooted in the principles and methods of general science. The extreme growth and differentiation of specialism has here acted both as cause and effect. Ingenious and successful technic, rather than the more laborious and widely applicable study of underlying principles, has often satisfied. The specialties themselves have been accepted without much appreciation of their relative values. Those of fundamental importance are grouped with others having only local forms that minister to comfort and utility, but not often directly to life itself. It is thus right to make a distinction between a major and a minor specialty. Of the former, pediatrics should take the highest place, as it deals with the first and formative period of life, and consequently renders the most lasting service to the race. It is time that a new account of stock be taken of the various branches of medicine and that they be lined up with a truer perspective as to relative importance. Thus will the dignity and importance of pediatrics be made clear to the profession and the public. It offers to-day the most promising field for advanced work in scientific and experimental medicine. Fully to occupy this field, its followers must apply the general and broad methods of science at large to the solution of its problems.

One of the deepest sayings of Sir Francis Bacon was: "The end of philosophy is the intuition of unity." Let us apply this broad truth to science. The end and object of all science is the recognition of unity.

Primitive Man and Disinfection.—Man has an instinctive repugnance to all noxious odors, and from the earliest time has sought to mask their presence by the use of aromatic substances, says Dreyfus (*Jour. Am. Pub. Health Assn.*). The use of perfumes is probably a relic of the effort of primitive man to counteract this evil. Many religious ceremonies, such as the burning of incense, have also the same origin, and embalming as practiced by the Egyptians is a good example of successful attempts to arrest putrefaction in very early ages. Sulphur has been employed from the earliest times, and Homer describes its use in religious ceremonies. In the time of Hippocrates, sulphur was regarded as an antidote against the plague. Ovid makes mention of the fact that sulphur was employed by the shepherds of his time for bleaching fleeces and for purifying their wool from contagious diseases. During the plague of Athens, Acron, according to Plutarch, stayed the spread of the epidemic by lighting fires in the middle of the public places and in the streets where deaths had occurred; and the lighting of fires during times of plague has been customary until quite recent times.