THE PRINCIPLES OF BACTERIN (VACCINE) TREATMENT.

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ALTHO the prevention of disease is the goal that is desired, many years will pass by before it is achieved. In the meanwhile a great part of the practitioner's time will have to be devoted to relieving those abnormal conditions that are constantly arising. We do what we can but if it were not for the agencies that are already present in the body, comparatively little would be accomplished. It is well known, however, that there are numerous bodily activities which altogether furnish a greater or less degree of what is called immunity. This immunity may manifest itself in various ways, according to the nature of the infection. All types of bacteria, after gaining entrance into the body, do not cause disturbances in the same way. Certain organisms, particularly those of diphtheria and of tetanus, produce typical soluble toxins which by their absorption cause serious disease. Others will form no toxin while living but after death they break down and set free various poisonous products which in turn affect the invaded individual. Some bacteria simply by sheer number may so overwhelm the body as to cause death.

As every infected person does not die there must be some form of natural protection. In many instances these protective substances will be found in the blood serum if the blood of an animal that has recovered from some infectious disease, such as diphtheria, be taken and allowed to stand, the cells will

coagulate and settle to the bottom, leaving a clear serum. If this be taken and injected into an animal that has never had the disease we will find that it has become immune, it will not develop the disease if diphtheria bacilli are introduced into its body. Important as the serum is, its activities by no means constitute the only means of defense which the body possesses.

Many years ago, Metschnikoff came to the conclusion that the most important factor in the resistance to disease lay in the activities of certain cells of the blood, the polymorphonuclear leucocytes. Experiments since then have shown that a very definite course of events takes place when infection by various organisms, particularly staphylococci and streptococci, occurs. At first the changes are chiefly in the blood vessels but shortly it will be noticed that in the tissues where the bacteria lodge many leucocytes will be present. Further examination will show that, in many instances, bacteria will be found in the body of the cells. On account of this property, such leucocytes are known as phagocytes, this term referring to their ability to take up foreign substances. This activity depends upon the power they possess of independent activity similar to that of the ameba.

For a long time it was believed that this ability to engulf invading organisms depended entirely upon the activity of the leucocytes. That as a result of some

vital power, known as positive chemotaxis, the phagocyte was attracted to the invader. This force, it would seem, could act even thru the walls of the smaller blood vessels and cause the leucocytes to leave their normal surroundings. It was noted, however, that altho positive chemotaxis was the usual phenomena, there were times when the phagocytes seemed indifferent to certain bacteria. At one time it was thought that the leucocytes could take up dead bacteria only, and that was supposed to be the answer as to why organisms were not always found in the cell. It has been demonstrated many times that these phagocytes can take up living organisms and this explains some cases of secondary infections distant from the primary focus.

This belief that the activity of the leucocytes was the most important factor in the phenomena of phagocytosis was a very lasting one, but it has been shown that such is not the case. In 1903 Sir Almroth Wright demonstrated conclusively by some very interesting experiments that the phagocytes would not take up the bacteria unless the latter had been specially prepared. He showed that there existed in the blood serum certain substances that would act upon the bacteria and render them suitable for the leucocytes. These he called opsonins from the word "opsono," meaning "I prepare food for." A definition of them would be that they are substances present in both normal and immune serums which act upon bacteria, and other cells, in such a way as to prepare them for the attacking cell. It has been shown also that these opsonins are quite specific. In other words, one that will act upon colon bacilli will not be particularly active upon staphylococci. Consequently in order that the maximum effect be ex-

erted in any special infection it will be necessary to increase the amount of opsonin for that specific organism.

Altho a certain amount of various opsonins is present normally, yet when infection actually occurs, more must be formed. This may take place as a result of increased cellular activity, particularly in the locality attacked, or the leucocytes themselves may be the source. Inasmuch as the presence of the bacteria stimulate the body to form these protective substances, advantage has been taken of this property and the vaccine treatment has resulted.

As is frequently the case when a new idea is advanced, too much has been expected of this method, and when satisfactory results have not been obtained the entire procedure has been thrown out as no good. Like everything else in the therapeutic line, it must be used with a clear understanding of its limitations. Many exaggerated claims as to its efficiency have been made in the past but at present a better understanding of its value exists.

The method depends upon the ability of dead cultures of bacteria when inoculated into the body, to stimulate the formation of opsonins. By so doing, the resisting powers of the individual are increased, the ability on the part of the bacteria to do harm is decreased, and the patient recovers.

Before taking up the preparation of the vaccine certain explanations are advisable. To begin with, the term "vaccine" is incorrect, but it has become so firmly established that it is difficult to avoid its use. This word was applied originally to the material obtained from a cow and used in vaccinating against small pox. The term is derived from "vacca," meaning cow. A more correct word is "bacterin." These preparations

are also not infrequently referred to as serums, which they are not, a fact which will be grasped readily when the method of preparation is described. No serum enters into their composition.

In actual use are two types of bacterins, the *stock* and the *autogenous*. In the latter the bacteria are obtained by the cultivation of the organisms present in the lesion of the infected person. The stock bacterin is made of bacteria similar to those in the infected individual but obtained from some other source. As a rule better results are obtained by using autogenous cultures, altho in some instances the use of stock bacterins is more satisfactory. Both types are made in the same manner.

Briefly described, the preparation is as follows: The bacterin consists primarily of a twenty-four hour old growth of a pure culture of the micro-organism on agar. This growth is then scraped off carefully so as to avoid, as far as possible, taking any of the culture medium along, and is then emulsified with physiological salt solution. This is then sterilized by heating in a water bath at 60°C for one hour and then diluting to the proper point. This is usually so done that one cc. will represent approximately the dose to be given. This dilution will vary, as the number of bacteria to a dose varies according to the organism used. After the dilutions are completed sterile culture tubes are inoculated with the bacterin and incubated for twenty-four hours to make sure that sterilization was complete. To further insure the sterility of the preparation, 0.5 per cent tricresol may be added.

In order to make the proper dilutions, it becomes necessary to determine the number of bacteria present in the original emulsion. Several methods may be used to estimate this but the most com-

mon one is that suggested by Wright. This consists of mixing one part of the bacterial suspension with an equal volume of normal blood and three volumes of physiological salt solution. After thoroly mixing, a smear is made upon a slide, the smear stained and the number of bacteria and corpuscles in successive fields of the microscope counted until at least two hundred corpuscles have been enumerated. As the number of corpuscles per cubic millimeter is 5,000,000, the number of bacteria per cubic centimeter can readily be determined. The suspension is then diluted so that there will be in one cubic centimeter the number of organisms desired for the initial dose.

Altho the dosage is measured supposedly by the number of bacteria present in the suspension, comparatively little attention is paid in clinical practice to that feature after the first injection has been given. In order to obtain the proper dose for a patient a small amount should be given at first. Then, if there is no reaction the amount should be increased gradually until the patient gives some local or general indication that the substance is having an effect. It is well to maintain this dose as long as the individual shows improvement. It should be remembered, therefore, that in this method the aim is not to give any definite number of bacteria, but to give a number sufficiently great to bring about the desired result.

In employing this method there are certain conditions necessary if success is to be expected. These are well summed up by McFarland.

1. The disease should be of subacute or chronic duration.
2. It should be fairly well localized.
3. It should be caused by a micro-

organism incapable of ready invasion or of much soluble toxin formation.

4. The micro-organism should be known and be capable of cultivation so that the appropriate specific vaccine can be made.

For some time there were numerous advocates of the use of bacterins during the acute stages of a disease. The majority, however, were opposed to this, and experience would indicate that the opposition was based on valid reasons. The stand taken is that when an individual shows general symptoms of an acute infection, his forces are evidently being called upon to respond as completely as possible. If such is the case, why add more bacterial products and in that way throw a greater burden upon the resisting forces of the body. It is in the subacute and chronic infections that the bacterins will be of the greatest value. In such cases there is not sufficient material escaping into the surrounding areas to stimulate the various tissues and cells to the full performance of their

duty. By injecting subcutaneously the dead bacteria the rest of the body is called upon to take a hand and in that way overcome the local infection.

It should be remembered that during bacterin treatment other methods should not be neglected. Abscesses should be opened, wounds drained, foreign bodies removed and everything done that could in any way assist in building up the patient's resistance. If proper cases are selected this method will give very satisfactory results, but it is distinctly limited in its application and should not be considered as a cure all.

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