VAUGHAN (V. C.)

THE INFECTION OF FOOD.

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THE INFECTION OF FOOD.

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Mr. Chairman and Gentlemen:

Numerous examples of poisoning from cheese, canned salmon, sausages, and other articles of food, have been reported within recent years. It has also been demonstrated that in more than one instance the milk-man has distributed the germs of typhoid fever along with the lacteal fluid. There has been a great deal said about the spread of tuberculosis through infected meats. All of these are subjects of the greatest interest to the practicing physician. He does not know at what moment he may be called to treat a case of poisoning from canned meats. When he is confronted with an epidemic of typhoid fever, he must inquire into its origin and at all times he needs to know, and wishes to know, all that can be known concerning the spread of tuberculosis. For these reasons I have been led to collect the best information I can find upon these points and to present the same in a condensed form in this paper.

The infection of meat and milk may be discussed under the following heads:

1. Meat and milk, even when derived from perfectly healthy animals, often become infected with poison-producing germs.

2. The infection may be due to the inoculation of these foods outside the body of the animal from which they are derived, with specific, pathogenic microörganisms.

3. The infection may be due to a diseased condition of the animal from which the food was obtained.

I wish to give especial attention to the question of the infection of meat and milk and their products with poisonous saprophytic germs. I desire to emphasize the fact that these foods, even when derived from perfectly healthy animals, and when kept free from infection with specific, pathogenic bacteria, may and often do develop most potent poisonous properties. It is not

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necessary that food be infected with some specific microörganism, before it can be rendered unfit for use. A sample of good milk may be divided into two portions and one of these under certain conditions becomes highly poisonous in a short time, while the other under different conditions may remain good and wholesome. Of two cans of salmon prepared from the same fish and at the same time, one may become highly poisonous, while the other may remain good.

I will illustrate this by reference to cases of poisoning from frozen custard, which I had an opportunity of investigating, a few years ago. The milk supply to a certain small village had never been questioned. It was in constant use by some fifty or more people, and no cases of illness had arisen which could in any way be attributed to the milk. In preparation for a festival, some gallons of this milk were obtained and made into custard. The custard was divided into two portions, one of which was flavored with vanilla and the other with lemon. The lemon custard was eaten without harmful effect, while a teaspoonful of that flavored with vanilla caused nausea, vomiting, and purging. Of course, it was quite natural to conclude that the vanilla was the poisonous agent, because at first it seemed that the only difference between the samples was that due to the use of the flavorings. Fortunately, however, not more than half of the vanilla in the bottle had been used, and the non-poisonous character of this flavoring was demonstrated by Dr. Novy and myself, each of whom took of the remainder without being harmed. The real difference between the portions of custard is explained by the following: The lemon custard was frozen immediately and was sent to the festival, while the vanilla custard stood for two hours, before being frozen, in a very filthy room, the air of which was said to have been like that of a privy vault. The room had some weeks before been used as a butcher shop and had never been cleaned, and bits of decomposing meat rendered the air foul and supplied the germs with which the custard was infected.

Another illustration of this kind of infection was observed by me in the Milan cases of milk poisoning. The milk remained good and wholesome until it became invested with

the germs in the infected pantry. In these illustrative cases, the facts that the germ did not originate in any specified disease and that they grew in the food before it was taken into the body of the consumer, demonstrate the correctness of the following proposition:

Some of the bacteria with which meat and milk become infected belong to the saprophytic microörganisms.

But it may be asked, how is it possible for a truly saprophytic germ to induce disease and death? This may occur in either of two ways. First, the poison formed in the food before it is taken may be the sole and sufficient cause of the symptoms and death. Second, the germ may continue to grow after it is taken into the body with the food.

Let me point out here the fact that the distinction between intoxication and infection is not so easy and certain as we have supposed. It is customary to pronounce those cases in which the symptoms occur immediately, or within three or four hours after eating the food, as due to intoxication; while those, in which the first symptoms appear later, are said to be due to infection. In the former the poison is supposed to be formed in the food before it is eaten; while in the latter it is supposed to result from the growth and multiplication of the germs within the body. That there is large opportunity for error in this distinction must now be conceded by all who are acquainted with the more recent researches on the bacterial poisons. We now know that some of these poisons require a period of incubation, when employed in small doses, which often extends over many days. This was found to be true by Brisger and Fränkel in their studies of the chemical poisons of diphtheria, and I have observed the same in my experiments with the products of certain saprophytic bacteria formed in the stools of children suffering from summer diarrhœa, and in others obtained from germs found in drinking water. The fact that the first symptoms do not appear until many hours, even a few days, after the food has been taken, does not seem to be absolute proof that the bacteria continue to live and multiply within the body.

In some instances, the germ undoubtedly does grow and

multiply after its introduction into the body and it may be found in the intestines or other organs after death. However, a germ may grow in the intestine and still be a saprophyte. The food in the duodenum has no more vitality than that in the nursing bottle. Moreover, the secretions which are poured into the intestines are not supposed to be possessed of vitality. A germ which will grow in milk in a culture flask, kept at the temperature of the body, and produce a poison, may grow in milk in the intestines of the child and produce the same poison, provided, it is not destroyed or modified by some secretions of the body.

Some of the saprophytic bacteria with which food becomes infected are under certain conditions capable of living for a time at least in a primitive manner. Thus, Dr. Novy found the same germ in a cheese and in the spleen and liver of animals which had been killed by feeding on the cheese. However, the virulent nature of this germ, or, in other words, its capability of overcoming the resistance of the living tissue, seems to have been feeble, and instead of increasing in virulence as it passed through successive animals, it became remarkably less toxicogenic, and finally was without effect upon animals. I infer from this and from similar phenomena which I have myself observed in experimenting with saprophytic germs from poisonous foods, that the toxicogenic properties of these organisms are best manifested when they are grown on dead matter.

The poisonous effects of these bacteria are also largely influenced by the conditions under which they develop. The most important of these conditions are the nature of the infected food, the temperature at which they grow, the amount of oxygen supply, and the time which elapses between the infection and the consumption of the food. I have been convinced that the poisonous properties of certain canned meats are in some instances wholly due to the fact that the germs which they contain grow practically without any air supply. The following brief report of a case of poisoning with canned salmon supports this belief. Early last June, Mr. K., a very vigorous man of thirty-four, ate freely of canned salmon. Others with him at the table remarked that the taste of the salmon was peculiar and refrained from eating it. Twelve hours later Mr. K. began to suffer

from nausea, vomiting, and griping pain in the abdomen. Eighteen hours after eating the salmon I saw him. He was vomiting small quantities of mucus colored with bile, at frequent intervals. The bowels had not moved and the griping pain continued. He was covered with a scarlatinous rash from head to foot. His pulse was 140; temperature, 102°; respiration, shallow and irregular. The stomach and large intestines were thoroughly washed out, the former by inducing free vomiting by the administration of copious draughts of warm water with mustard, and the latter by injection of large volumes of water. After this, ten grains of calomel, followed in two hours by a bottle of citrate of magnesia solution, were administered for the purpose of cleaning the small intestines. After these medicines had operated freely the patient began to improve. The next day the rash had disappeared, but the temperature remained above the normal for five or six days, and it was not until a week later that the patient was able to leave the house.

I obtained the remainder of the salmon and submitted it to various tests. In the first place the absence of inorganic poisons was demonstrated. In the second place, the subcutaneous injection of twenty drops of the fluid expressed from the salmon caused evident disturbance in a white rat, but did not kill the animal. The only germ which could be found, either by direct microscopic examination or by the preparation of plate cultures, was a micrococcus, and this was present in the salmon in great numbers. This germ grew fairly well in beef tea, but the injection of five c. c. of the beef tea culture into the abdominal cavity of white rats, rabbits, and kittens, failed to induce death. However, this micrococcus when grown for twenty days in a sterilized egg, after Heuppe's method of anaerobic culture, produced a most potent poison. The white of the egg became thin, watery and markedly alkaline. Ten drops of this given subcutaneously sufficed to kill white rats.

Evidently in the preparation of the salmon this can was not sterilized. It was sealed and for months, possibly longer, this germ had grown anaerobically and had elaborated a chemical poison.

On the other hand, I have known of several instances in

which canned meats were not poisonous when first opened, but soon became so on standing exposed to the air. In these cases the meat must become infected after the opening of the can.

Another important factor in influencing the effects of these infected foods is to be found in the condition of the person eating the food. Especially is this true of the condition of the stomach. A good, healthy gastric juice will suffice to destroy many of the harmful things which man puts into his stomach. The following case, which was under the care of Dr. C. G. Darling, to whom I am indebted for these notes, illustrates this point.

On April 12, 1892, two young men ate a supper consisting largely of canned salmon.

Mr. A. is strong, robust, and drinks occasionally.

Mr. B., age 28, has suffered from indigestion for months and has found it necessary to select his food with care, but on the night in question he proposed the supper of salmon, of which he was very fond.

Mr. B. took the salmon from the top of the can. A short time before the supper A. took two glasses of beer, but B. did not take any.

The next morning B. had a chill, which was followed by severe headache and pain in the abdomen. However, he went to the store in which he clerked and remained there until 9:30 A. M., when his employer, observing his illness, sent him home. During the day he attempted several times to vomit, but was unable to do so. I was called to see him at 7 P. M., April 13, and found his condition very serious. His mind was clear. He had severe and constant pain in the head; pulse, 120, feeble; respiration, 20. There was a slight eruption on hands and face, consisting of slightly elevated red spots, about the size of a split pea. The spots were more abundant on the right than on the left side of the face, probably because the right side was on the pillow most of the time. The eyelids were red and swollen, giving off a profuse muco-purulent secretion. There had been no movement of the bowels for thirty-six hours. I prescribed for him, but afterwards ascertained that the medicine was not obtained until the following morning. I visited him at 8 A. M., April 14, and found the temperature 103.5, the eyelids more

swollen, and the eruption increased. During the day and following night there were eight movements of the bowels, in response to medicine. The patient gradually became unconscious. The respiration was increased on account of the high temperature, but at no time was there any involvement of the lungs. The kidneys remained active. There was no profuse sweating. The extreme pain in the head persisted. During the night he was aroused with difficulty, but took medicine and nourishment when they were placed to his lips. On the morning of April 15 the fingers were purple to the second joint, but were very warm. The temperature had risen to 105° in the axilla and was not lowered by repeated bathing, but continued to rise and was 107° just before death, which occurred at 8 P. M. Post-mortem examination was not made.

I will now make some general remarks concerning the nature of the chemical poisons formed in meat and milk and their products as a result of infection with these saprophytic bacteria. These poisons may be grouped in the same manner as those which are produced by the more strictly pathogenic germs. First, there are those which combine with acids, forming salts, and which are designated as ptomaines. The ptomaines which are formed in food as a result of the activity of the saprophytic germs, may truly be called putrefactive alkaloids. Then, there are poisonous bacterial proteids. Poisoning with foods is often designated ptomaine poisoning, but my observation has led me to believe that of these two classes the proteids are more frequently present in infected foods. It has been asked whether or not it is possible to induce poisonous effects by the administration of these proteids by the alimentary canal? Is it not true that they are non-diffusible, and that they would be inert if given by the mouth? There is not enough experimental evidence in our possession at present to enable us to answer these questions with certainty, but we have good reasons for assuming that some of them are absorbed from the intestines. In the first place, we must remember that diffusion through a dead animal membrane and absorption by the living intestinal walls are not identical. Unchanged egg-albumin will not diffuse through a dialyser, but

that it may be absorbed by the intestine has been demonstrated. Mitchell found that some of the proteid poisons of the venom of serpents are absorbed by the unbroken mucous membrane.

In the second place, the bacteria in the food may penetrate the intestinal walls and elaborate their chemical poisons in the spleen, liver, and other organs, as the bacilli of typhoid fever and other pathogenic germs do ; or, in other words, there may be true infection.

Since it has been found that some of the bacterial poisons are destroyed by a temperature approaching that of boiling water, it has been assumed by some that this is universally true, and that cooked meat or boiled milk cannot be poisonous, or if so, they cannot owe their poisonous properties to these proteid bodies. This is an assumption which we are not at present justified in making. Certainly, some of the bacterial proteids can be kept for ten or fifteen minutes at 100° C., and for a much longer time at 80° C., without being destroyed. I have isolated one of these proteids which may be dried at 100° C. to a constant weight without any appreciable decrease in toxicity, and in solution it may be kept for half an hour at 80° C. with no effect. However, prolonged heat renders it inert. I believe that cooking meat or milk lessens the danger of poisoning by them, but it does not do away with that danger altogether.

I have met with poisonous foods in which I have been unable to find either poisonous bases or proteid bodies. Two years ago I was called upon to investigate some mince-meat, which, it was claimed, had seriously affected a number of persons. Some of the meat was fed to cats and dogs and invariably produced in them vomiting and purging. This was equally true when the meat was given raw or cooked. Notwithstanding this positive evidence of the poisonous character of the food I was unable to determine the nature of its active constituent. It was tested in the most thorough manner for inorganic poisons, for active ptomaines and for proteid poisons, but with wholly negative results. Furthermore, plate cultures were made and the isolated germs were fed to and injected into animals without effect. It is possible that the poisonous constituent was destroyed by the manipulations resorted to in the

attempt to isolate it. This supposition is probably warranted by the experience of Tizzoni and Cattani, who found that the poisonous proteids of cultures of their tetanus germ is rendered inert by the action of strong alcohol.

Among the foods which frequently produce untoward symptoms are milk and its products. I took the ground, some years ago, that the severer forms of the acute summer diarrhœas of children are due to milk poisoning, and I think that the majority of the members of our profession are now convinced of the truth of this belief. When children must be fed upon the milk of the cow, every precaution should be taken to prevent the infection of this milk with poison-producing bacteria, and when there is any doubt, the milk should be sterilized. I also claimed, at a time when the majority of bacteriologists believed that a specific germ for these diseases would be found, that the poisons were generated in the milk by saprophytic bacteria, and that any one of a number of germs might be, in a given case, the source of trouble. This point is also now admitted to be true. I have shown that cheese may contain a poisonous base, tyrotoxicon, or poisonous proteids. If we expect to find any sample of poisonous cheese containing the same active constituent we will be disappointed. Indeed, it is, with our present knowledge of the manner in which these poisons are formed, highly unscientific for us to expect to find one poison responsible for the effects which follow the eating of all the different samples of poisonous cheese. We must remember that these poisons are due to a variety of species of germs, and that the chemical nature of the product will not only vary with the species producing it, but with the stage of putrefaction. Indeed, it is altogether possible that different parts of the same cheese may contain colonies of wholly distinct germs and consequently different poisons. It certainly is a fact that one portion of a cheese may be poisonous and other portions not poisonous. I have seen samples of cheese, the outer portions of which could be eaten with impunity, while the inner portions were highly poisonous, both to man and the lower animals. Ehrhart has also reported a marked instance of this kind.

The method of making cheese is especially favorable for the

collection of a large number and variety of saprophytic germs. The milk is brought to the factory by the farmers of the neighborhood. There is, in the majority of instances, no intelligent inspection of the cows. Some of the milk cans are properly scalded and aired, while there is always the probability that others are not. The milking may be done in filthy stables, with dirty hands, from unclean udders, and possibly into pails which have not received proper care. Then, I believe that there is no community in which the standard of honesty absolutely prohibits every milkman from diluting the lacteal fluid, and sterilized water is not usually employed for this purpose. Moreover, the cheese-maker is not always duly appreciative of the necessity of cleanliness about the factory, and in the manipulations to which the milk is subjected.

We need some bacteriologist who will do for the manufacturer of cheese what Pasteur has done for the brewers. The ripening of cheese is due to the growth of germs, and a good cheese could not be made without the help of these industrious little workers. The flavor and value of one cheese differs from another according to the kind of germ which takes part in the making of the cheese. The milk brought in from the various farms should be sterilized and then inoculated with the pure cultures of the desired germs and moulds. A plan like this will be adopted some time and when it is carried out intelligently, poisonous cheese will not be made. Moreover, the flavor and digestibility of the cheese made will be greatly improved. At present, the bacterial flora of the cheese, which we eat, is dependent wholly upon accident. It is probably well that we are not, as we take our coffee and cheese, acquainted with all the varieties of microscopic vegetable life which we are masticating and which have been gathered from the barn-yards of the milkmen.

The treatment of poisoning from cheese is usually not very difficult. The poisons act so energetically upon the stomach and intestines that relief is generally secured by the vomiting and purging. The most dangerous cases are those in which these symptoms do not occur. In these instances, vomiting should be induced and the bowels should be washed out

thoroughly. At the same time any weakness of the heart should demand the hypodermatic use of digitalis or strychnia, or both.

The preceding remarks apply with greater force to poisoning with canned salmon, lobster, etc. In these cases, as a rule, there is no purging. The pain in the bowels is often very severe, but generally constipation is an accompaniment. With the appearance of the first symptoms, the materies morbi is in the alimentary canal, and the aim of the physician should be to remove this before absorption can take place. The treatment must be prompt. The administration of antipyretics is, so far as I have observed, useless.

If the absorption of the poison is not prevented and the patient passes into a condition of stupor, the chances of recovery, in case of poisoning with foods infected with toxicogenic, saprophytic germs, is small.

In cases of milk poisoning in infants (or cholera infantum) the discontinuation of the milk is now generally insisted on, and its practice has decreased the mortality markedly. Even sterilized milk should not be allowed at this time, because it soon becomes infected in the intestines. The germs which cause the acute summer diarrhœas of infancy grow most rapidly and produce their most active poisons in milk, therefore it should be an invariable rule to prohibit absolutely the use of this food during treatment. This prohibition is the most important part of the treatment. Every case of cholera infantum is a case of food poisoning and should be treated as such.

The infection of meat and milk, outside the body, with specific, pathogenic bacteria, is so well known to occur, that I will do scarcely more than mention it. The frequency with which typhoid fever, diphtheria, and other infectious diseases are disseminated by the use of infected milk is shown in the current records of medical literature. Milk that has been diluted with water containing the germs of typhoid fever, and the prevalence of the disease, may mark the daily rounds of the milkman. Dr. E. P. Christian, of Wyandotte, sent me, in 1890, a sample of milk and one of water from the well of the milkman. In both of these I found a germ which is toxicogenic to the lower animals,

and which is more fatal than the Eberth germ. Dr. Christian had learned that the different families, in which he had patients sick with typhoid fever, obtained their milk from this man.

It is unnecessary for me to dwell upon this point, since all admit that the infection of these foods outside the body with specific, pathogenic germs frequently occurs, and is accountable for certain epidemics.

The question of the transmission of tuberculosis from cows to man, through the eating of the flesh or the drinking of the milk of the former by the latter, is one of great practical interest. I shall not in this paper, however, enter into any detailed discussion of this part of my subject. I will content myself with a statement of the following propositions.

1. The flesh of a tuberculous cow, even when the disease is localized in the lungs, should not be eaten by man.

2. When the tuberculosis is general, there is danger of specific infection through the eating of the flesh or the drinking of the milk.

3. When there is tuberculosis of the udders, the specific infection may be transmitted through the milk.

4. That infection with tuberculosis through the intestines may occur, has been fully demonstrated by feeding healthy animals with tuberculous tissue, with infected milk, and with pure cultures of the germ.

5. Infection by the way of the intestines is most common in childhood, at a time when cow's milk is used more abundantly than at any other period of life. This is shown by the larger number of instances of intestinal and mesenteric tuberculosis, as a primary disease, among children than among adults. However, I do not believe that any large per cent. of the total cases of tuberculosis at all ages is due to the eating of infected food. In by far the greater number of these cases the pulmonary tuberculosis is the primary disease, and the intestinal involvement is secondary, and there is no evidence that the tubercle bacilli pass through the walls of the intestines, through the lacteals, and on to the lungs without giving rise to any lesions, before reaching the pulmonary tissue. That infection occurs occasionally through the lymphatics we have stated, but in such

instances there are pathological evidences of the route taken by the infecting agent, and the pulmonary involvement is secondary. At present, the weight of evidence justifies the belief that all cases of tuberculosis in which the primary trouble is in the lung, are due to infection through inhalation; while those cases in which the primary lesion occurs in any other portion of the body are most probably due to infection by way of the intestines.