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—BY—

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## THE MODE OF ENTRANCE OF THE BACILLUS TUBERCULOSIS INTO THE SYSTEM.

BY LAWRENCE F. FLICK, M.D.

ONE of the most important questions to be settled about the etiology of tuberculosis, is how the bacilli gain entrance into the system ; for the prophylaxis against the disease depends largely upon its solution. It is generally held that they gain admission through the lungs by inhalation. This view has apparently been accepted without much inquiry as to its correctness, and even many interesting experiments have been performed to bolster it up, although it is upon its face entirely at variance with the teachings of physiology and of clinical experience.

It is generally admitted that the bacillus tuberculosis cannot live in the air unless protected by some foreign substance, such as pus, or, in other words, that it cannot maintain its existence when isolated. Those who hold the theory that it is inhaled, claim that it gains admission through the medium of pulverized sputa, which is wafted about as dust. Now, the first question that arises is, can pulverized sputa be inhaled? or, to put it more precisely, can it be carried to the air cells or even into the bronchioles by the inspired air? A careful study of the mechanical construction and of the physiological conduct of the respiratory tract would lead us to believe that foreign bodies of any material size cannot readily be carried into the lungs by the air. It is a law of physics that

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a foreign body carried by the air will be deposited upon the first obstruction that can resist the force of the air that carries the body. Nature has laid obstructions in the way of foreign bodies all along the respiratory tract, thereby indicating that nothing was to enter that tract but air. The stiff hairs in the nostrils, the formation of the nose and pharynx, offering many surfaces for the impingement of foreign bodies, and above all the high sensitiveness of the mucous membrane lining the respiratory tract, whereby an expulsive effort is brought about the instant a foreign body touches it, are all safeguards against the introduction of foreign bodies into the lungs by means of inhalation. It is questionable therefore whether enough dried up tubercular sputa could be carried into the lungs by the inspired air, and if it could be carried in whether it would be allowed to remain there for a sufficient length of time to set up tuberculosis.

But even admitting that some pulverized dried-up tubercular sputa may pass all the barriers set up by nature and gain admission into the lungs with the inspired air, and having been deposited upon the respiratory mucous membrane, may resist all expulsive efforts to dislodge it, how will the tubercular bacillus get into the lung tissue? It will have to go in either by absorption or by penetration, for in most cases of tubercular inflammation of the lungs the disease is in the lung tissue itself and not upon the mucous membrane. If it enters by absorption it is taken up by the lymphatic system and carried into the circulation, thus taking a roundabout way to get into the lung tissue. If it enters by penetration it must first escape from the pus in which it has been imbedded, and as soon

as it does so it is exposed to the germicidal influence of the air. In the event of either method of entrance it must, moreover, run the gauntlet of the phagocytic power of the blood. Now, considering the small amount of dried up tubercular sputa that can gain entrance into the lungs by inhalation, and the difficulties which the tubercular bacillus necessarily encounters in its efforts to get into the lung tissue and to establish a colony there, it looks very improbable that inhalation is the ordinary method by which the tubercular bacillus gains entrance into the system.

The inhalation theory of the tubercular bacillus is equally at variance with clinical experience. The fact that tubercular inflammation mostly begins in the apices of the lungs instead of in the base, the appearance of the disease primarily in the membranes of the brain, in the alimentary tract, in the pleuræ, and in bones and such glands as the ovaries and testicles, and the immunity of the many persons who are constantly exposed to inhalation of tubercular sputa dust, are all clinical phenomena which militate against the theory. If the tubercular bacillus gains entrance into the system by inhalation, we ought always to find the primary tubercular disease in the base of lungs or in the lymphatic glands. Of all parts of the lungs the apices are the least likely to become the receptacles of foreign matter by inhalation, first because of their inactivity, and second because of their position; so that when they even do become the primary seat of tubercular disease, the bacillus does not likely first get its lodgment there. The fact that the disease so seldom develops primarily in that part of the body in which it first gains lodgment would therefore bring us to the conclusion that if the bacillus

tuberculosis gains entrance into the system by inhalation, it must do so by the absorption process, and if the bacillus is absorbed we have a right to expect the primary seat of the disease to be found in the lymphatic glands. If the inhalation theory were correct, everybody ought, moreover, to die of tuberculosis; for with the amount of dried up tubercular sputa that necessarily flies about in the air in street cars and in work-shops, it is difficult to understand how anybody can escape the disease.

But what about the experiments that have been performed in support of the theory, and which seem to demonstrate it beyond question or quibble? The most forcible experiments that have come to my knowledge are those of Koch, which consisted of rubbing up tubercular matter in water, spraying it into an enclosure, and compelling animals to inhale the spray. The animals all contracted tuberculosis, which result proved that when tuberculous matter is introduced into the system, tuberculosis results; but proved nothing more. The weak point in the experiments was that there was no precaution taken against the entrance of tubercular matter into the stomach. Spray readily condenses upon obstructing surfaces, and in these experiments considerably more tubercular matter must have been deposited in the pharynx and found its way into the stomach than was carried into the bronchial tubes by the inspired air.

Another theory about the manner in which the bacillus tuberculosis gains entrance into the system, and one which seems to have few believers is, that it gains admission through the stomach. Everybody apparently admits that it can gain entrance in this

way, but few are willing to concede that this is the ordinary or usual way. Whether it is or not will, of course, remain for future experiments to positively determine; but physiology and clinical phenomena certainly seem to indicate that it is.

In the first place, it must be conceded that the alimentary tract is the ordinary avenue into the system for all extraneous matters. Its construction, machinery, and mechanism are all adapted to the expeditious conveyance of matter from without the body into the body. Its purpose is to supply the body with food, and in health and the complete performance of its functions it is capable in a measure of discriminating against deleterious matter, or of rendering it innocuous. The stomach has the power of destroying animal life, and stands sentinel to all that enters the body; but only exercises that power when in possession of all its faculties. In the mechanical process of conveying food into the body, micro-organisms and parasitic animals of all kinds, either in the larval or developed state, likewise find their way in, and unless they are deprived of life by the stomach, will get into the system, seek out a congenial soil, and develop and reproduce themselves. In this way all parasitic animals which prey upon the internal organs of man, of which we have anything like definite knowledge, gain their admission into the body. Is it likely that the bacillus tuberculosis forms an exception? Certainly the stomach is the physiological way for it to enter.

Upon the theory that the bacillus tuberculosis gains entrance into the system through the stomach, the clinical phenomena of tuberculosis are quite intelligible.

From the days of Hippocrates it has been observed that the forerunner of phthisis is a disordered stomach. So close is the relation between the two diseases, that many have been led to look upon dyspepsia as the cause of consumption. The part which the stomach plays is, however, entirely a passive one. Because of its deranged condition, and its consequent inability to destroy the bacillus tuberculosis, the latter gains entrance into the system, by being allowed to pass unharmed into the intestines, being absorbed by the lacteals into the thoracic duct, and being carried with the chyle into the circulation. The bacillus in taking this course into the body, encounters no obstruction or difficulties after passing the stomach, at least until it encounters the blood corpuscles, and is well supplied with the necessary pabulum for its subsistence on the way.

The clinical facts that tuberculosis appears most frequently in the lungs, that its favorite site in the lungs is the apex, that in children it appears most frequently in the intestinal canal and the membranes of the brain, that its primary seat may be in the periosteum, the ovaries or testicles, the pleura, or, in fact, in any remote part of the body, can all be explained upon the theory that the bacillus gains its entrance through the stomach. The contents of the thoracic duct, after mixing with the venous blood, are first of all carried into the lungs; consequently, a larger number of tubercle bacilli enter the lungs, than any other organ or part of the body. It has been shown that the blood exercises a phagocytic influence over bacteria, hence, the farther the bacilli advance in the circulation, the fewer survive, and the more remote an organ or part of the body is from the entrance of

the contents of the thoracic duct, the less its chances are of becoming infected with tuberculosis. The brain, the intestines, and the various organs in the abdominal cavity, probably receive the largest supply of arterial blood in the order mentioned, and, practically, receive it about the same distance from the entrance of the contents of the thoracic duct. We would, therefore, expect that the lungs, the brain, and the intestines, would be the most frequent seats of primary tuberculosis, in the order mentioned, and so we find them in practice. But the number of bacilli that enter an organ or part of the body, is not the only factor that determines the primary seat of the disease; the nature of the soil plays an important role. It has long since been recognized that anything which interferes with the free active circulation of an organ or tissue, predisposes it to tuberculosis. Hence we find the apices of the lungs, the congested membranes of the brains of teething children, the irritated alimentary canal of bottle-fed babies, the bruised periosteum, the thickened pleura, the congested ovaries, spleen, liver, and kidneys, becoming the selected soil for the development and reproduction of the bacillus tuberculosis.

It is also easily understood upon this theory, why so many persons who are exposed to tuberculosis, fail to contract it. The immunity is generally ascribed to improper soil, and whilst this may be part of the reason, it is not the whole reason; for it has been frequently proven by experiment on animals, that the disease will develop in any soil, if the bacilli are introduced in large enough numbers into the circulation. There are two factors in operation in the non-occurrence of tuberculosis in those persons who are

exposed, first the bacilli-destructive power of the healthy stomach, and second the phagocytic power of the blood. Persons who have healthy stomachs, and who do not overburden them with too much or improper food, and who take sufficient exercise in a pure atmosphere to secure them a free circulation of well-oxygenized blood, will not contract tuberculosis, no difference what the exposure. To contract the disease it is necessary first, to be in such contact with infected persons or objects as to enable the bacillus to get into the stomach; second, to possess such a stomach as will, because of temporary or permanent disability to destroy the bacillus, allow it to pass into the circulation; third, to have in some parts of the body localized spots or a spot of torpid circulation, which offer a congenial soil for the development and propagation of the bacilli.

In my paper on the contagiousness of phthisis I have shown that some social relations between parties are probably necessary for the conveyance of tuberculosis from person to person, and that proximity of habitations and casual contact are in themselves not sufficient. It will not be difficult to understand, how tubercular matter finds its way into the stomach, if we for a moment reflect upon social customs. Because of the universal practice on the part of consumptives, of expectorating into handkerchiefs, or into open space, it is almost impossible to come in contact with them, or to remain for any length of time in a place occupied or frequented by them, without getting some bacilli into one's stomach. The lips and hands of consumptives who use handkerchiefs extensively, are necessarily smeared with tubercular sputa, and any persons kissing them, or shaking hands

with them, can scarcely avoid conveying the disease germ into their own stomachs, unless they wash themselves before partaking of food or drink. Drinking out of the same vessels and eating with the same utensils as consumptives, without prior cleansing ; swallowing the dried-up tubercular sputa that is deposited upon the pharynx by the inspired air ; the handling and serving of food by consumptives, such as that by waiters, cooks, grocers, fruiterers, and milk dealers, suggest some of the ways in which tubercular matter may find its way into the stomach.

Whilst I do not wish to be understood that consumption cannot enter the system by way of inhalation, I claim that the stomach is the usual mode of entrance, and that there is ordinarily very little danger of contracting the disease through the lungs themselves. The part which inhalation plays in the etiology of the disease, is the mechanical part of carrying the tubercular sputa into the nares and pharynx, from whence it finds its way into the stomach. The whole question can, however, I think, be satisfactorily settled by experiment, and I hope at some future time to be able to illustrate what I have set forth in theory.





