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HOW MICRO-ORGANISMS ENTER THE BODY.

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Reprint from St. Louis Courier of Medicine, December, 1888.

The gross facts relating to the causation of most diseases by micro-organisms may be declared proven. Even the bitterest opponents of this theory admit that it offers a better means of explaining the various phenomena of disease than any other. Admitting the first statement to be true many interesting problems present themselves for solution as to how the germs enter the body. For their solution accurate clinical observations are necessary. In this paper I will relate some personal observations and give a short résumé of current views on the subject. The subject is not only interesting but important. If tuberculosis, cancer, or indeed any disease is transmitted by organisms in a way which, though at present unknown, can finally be discovered by patient research, it is worthy our best efforts to determine it since their entrance can be then more certainly hindered. For convenience of consideration we may say that

Micro-organisms enter the body,

I. By the skin.
- *a.* Lesions of the skin.
- *b.* Openings of sweat pores or sebaceous ducts.
- *c.* By the sides of the hairs.

II. By the mucous membrane.
- *a.* Lesions of the membrane.
- *b.* Openings of the ducts or follicles.
- *c.* Pockets, sulci or folds.

III. Localized infection in a manner yet unknown, and giving rise to such diseases as idiopathic meningitis, osteo-myelitis, etc.

IV. Universal infection in a manner yet unknown, but giving rise to hereditary transmissible disease, as syphilis, tuberculosis, splenic fever.[1]

The severity of the infection varies:

I. With the condition of the body as regards idiosyncrasy or strength, or weakness.

II. The amount of infecting material which gains entrance.

III. The character of the infecting material.

IV. The tissue which it penetrates and its location.

Although the entrance of material capable of giving rise to local and systemic disturbance by lesions of the skin has been long appreciated, it has remained for the present generation to determine how the disturbance is brought about, to demonstrate the importance of a sound epithelial covering, and the great dangers of its abrasion or puncture. Some of the ordinary means by which the human body is affected and coming under the first division are illustrated by the numerous instances in which physicians have contracted syphilis and other diseases by reason of an abrasion or hang nail fissure existing on the examining digit. To show that we, as physicians, can not exercise too great care in protecting ourselves, it may be well to mention the case of the late Dr. Edouard Pritzl, first assistant to Prof. Carl Braun in the obstetric wards at Vienna, and one of the most accomplished and successful instructors in the General Hospital. He was a thorough believer in antiseptic midwifery, and yet, notwithstanding the use of all the usual precautions, he contracted septicemia by examining a case of puerperal fever just brought into the wards, and died from the resulting pneumonia. I have seen cases of erysipelas on the tip of the nose caused by an abrasion made by the dirty finger nail when picking it, and the consequent entrance of dangerous germs. An interesting case coming under this head is that of Peter Casserleigh, æt. 42, a veteran of the late war. At Chickamauga, Sept. 18, 1863, he received three Minié balls in the right leg. The one which entered the hip and disorganized the joint, although extensively probed for, was not found by the surgeons, and remained in the tissues without giving trouble for a number of years. Partial use of the right limb was obtained, but on account of the anchylosed joint and shortening, a varicose condition was set up in the veins of the other leg which in 1884 resulted in an ulcer of considerable dimensions, from which pus flowed freely. After the formation of the ulcer, the bullet began to give trouble, swelling and redness developed, and when it was extracted 24 years after entering, it was found surrounded by purulent matter. Thus a lesion on the other

[1] Marchand, Virchow's Archives, Band 109, 1887.

limb gave entrance to germs, which finding the place of minor resistance at the site of the bullet easily gave rise to a suppurating center. This was a veritable metastasis which used to bother our fathers so much, but which is now easily explained. Another interesting case is that of Mr. S. P. Bartlett, Fish Commissioner of Illinois, who consulted me in Aug. 1887, for an acute and painful swelling on the side of his neck which was giving him intense pain. It was opened freely and the interior swabbed out with pure carbolic acid. Pain ceased entirely after this treatment, although it was several days in healing. Upon his inquiring as to the nature of the swelling I undertook to give him a short explanation of the modern views of infection, and told him that by some means he had suffered from an invasion of micro-organisms. Some of the disorganized material was placed under an immersion lens and the germs were demonstrated. I also stated that it was indifferent whether we called this swollen and painful part a boil or carbuncle, since these were virtually obsolete terms, and the treatment was the same, viz., to evacuate the germs and destroyed tissue as well as possible, and thoroughly disinfect the seat of the trouble. I confessed my ignorance as to how and where he suffered this invasion, but in a few days on his return from the Mississippi bottom he gave me the following interesting history. The season of 1887 was extremely dry, and the sloughs and small streams along the river evaporating left millions of fish to putrefy in the sun. Of course myriads of flies were feeding on the carcasses, and one of them saturated with germs lighting on the neck of my patient, was crushed there by a stroke of his hand. By this act some of the germs coming from the putrefying fish through the medium of the fly were rubbed into the open mouths of the ducts and along the hairs, and the poisoning resulted. Mr. B. also told me that two of his employes were similarly affected. One crushed the fly along his neck for some distance, and a half inch in breadth. A second crushed the fly on his arm. The poisoning resulting from these extensive infections coincided exactly with the extent of the crushing. The tissue sloughed out, and one of the men lost his life. They were treated by the old method of poulticing. No worse application can be made in such cases than the poultice as ordinarily made up. I never employ the poultice now. Fine cloths wrung out in hot antiseptic solution, and frequently applied will accomplish more in one hour than the ordinary poultice of flaxseed or bread and milk will in a day. A still better means of penetrating the tissue and neutralizing the poison is by turning the steam spray of an antiseptic solution on the part as recently advocated by Verneuil and used by him with such brilliant results. The possibility of inoculation by the medium of flies, as here related, has been recognized for some time. Spillman and Haushalter (communication rendu a l'Acad. des Sciences, Paris, 1887) found that house flies confined in a room with a tuberculous patient contained tubercle

bacilli in their digestive organs and excrement, evidently taken in from the sputa which they had consumed. It is easy to see how a transfer of these bacilli can be made from them to the human being.

I am in the habit myself of taking as much precaution in the handling of tuberculous sputa as with a typhoid stool, and believe such practice should be universal. Great care should be taken in cleansing the receptacles of tuberculous sputa, since numerous observations have been made of direct inoculation of tuberculosis through a fresh wound or abrasions on a healthy person. I have seen one case of glanders infected from a horse in a similar manner, viz., by abrasion of the skin of the hand while handling. Finally a large proportion of all so called skin diseases, e. g. erysipelas, tinea, etc., have been found to be of a microbial origin. Turning now to the second division of our subject, the entrance of germs by the mucous membrane, much the same might be said under *alpha* as under this head in the first division. A long recognized means of infection are those of a sexual origin about which I need not speak particularly. The introduction of germs to the mucous membrane of the vagina and uterus by unclean hands and instruments has been demonstrated, and thanks to modern teachings its occurrence is now rare. There is one point which I wish to make here. Some scoffer at the use of antiseptic precautions in the vagina and uterus during the lying-in period said that the antiseptic treatment of these organs would soon be carried so far that it would be necessary to immerse the male organ in an antiseptic solution before sexual congress. This remark made as a joke has more in it than at first appears. Who of us has not seen male organs free from actual disease, but so filthy that they must certainly harbor disease causing germs. Inserted into a cavity so favorable for the growth of germs as is the vagina, may not many of the diseases so common to the female genital organs in the lower classes be due to this cause. Will not our efforts at treating these cases with antiseptic injections be useless unless we pay attention to this prime factor in their causation?

Many cases of middle ear disease are undoubtedly caused by an invasion of micro-organisms through the eustachian tube, and having their first growth in the nasal passages. An important point in the treatment of these dangerous affections is to disinfect the nose as well as the ear. Similarly it is very important to keep the mouth and nose in an antiseptic condition during typhoid fever, measles and scarlatina—to say nothing of diphtheria where it is all important. This is a subject to which I am sure too little attention is ordinarily paid, and care in this particular point will prevent many cases of suppuration of the middle ear and of the parotid gland.

Favorite points for the lodgement of germs are the crypts of the tonsils, which by reason of the anatomy of the gland are particularly adapted to their growth. An English writer has

recently affirmed that the germs of diphtheria can lie dormant or grow slowly in these crypts for months, and that repeated attacks of the disease are explained by supposing an acute grafted on the chronic process. Persons in whose tonsils these enlarged and foul crypts filled with germs exist are kept by them in a low state of vitality for years. Trimming of the tonsils by the guillotine drains and empties these crypts, and causes an improvement in the health almost beyond comprehension. When the tonsils are not large enough for trimming I have disinfected the crypts by passing into them a probe coated with equal parts of iodine and carbolic acid. So-called strumous glands in the neck I have found are sometimes due to the entrance of irritating material through the tonsils. The teeth and gums are also favorable structures for the entrance of germs, and the practitioner should not fail to have all foul or suppurating gum margins as well as decaying cavities thoroughly cleansed. No part of the body presents such a favorable site for the growth of germs as the stomach and intestinal tract, and in no part is the growth so disastrous. One half the children born, die before the fifth year, and mostly from gastro-intestinal disorders. The remarkable antifermentative property of the gastric juice, bile and accumulated gland secretions of the intestine prevent a great deal of disturbance. But let a fermentative action be once established; and how difficult it is to overcome it! This can be easily understood when we consider the structure of the alimentary tract. Its follicles folds and lacunæ are peculiarly adapted to the growth of germs, and affords them a safe residence. When the micro-organisms are of a virulent character, as in typhoid fever, dysentery, etc., they cause a sloughing of the glands which they have invaded; and if the patient survives this process, the duration of the disease is comparatively short. But a less virulent germ gains a residence in the bowel or intestine, and a chronic diarrhea or dysentery is set up, which may last through a series of years. Certain germs seem to thrive in acid media, and thus find their best growth in the stomach; others pass on to the small bowel and there find a more or less alkaline fluid in which they can increase, causing typhoid fever, diarrhea, etc. Still another group thrive in the fluid peculiar to the large bowel and cause dysentery. Let some of these be now carried to the liver or spleen in sufficient quantity and an abscess results, giving another example of metastasis. We are now certain that tuberculosis and other diseases can be admitted to the organism by the alimentary tract.

The lungs and pleural cavities are favorite seats of the so-called metastasis of diseases, but the great majority of the germs gaining entrance to the respiratory organs are carried by the inhaled air. We have been in the habit of saying that tuberculosis is necessarily due to heredity, and many persons have suffered through life both mentally and financially because of this mistaken teachiug. Unless one of the parents is suffering

from an active tubercular process at the time of conception or birth, I believe that the child is in little danger. The numerous instances in which children of parents subsequently tuberculous have survived to an old age are proof enough of this statement; but we have still another proof in the fact that in a large percentage of cases no trace of tuberculous ancestry can be found. I firmly believe tuberculosis is infectious, and that isolation of consumptives and disinfection of their discharges are imperative, as I have already stated. The late Dr. Austin Flint preceded his time in declaring pneumonia to be a fever with its manifestation in the lungs. We have now distinguished its coccus and proven the truth of his statement. A corresponding change in the treatment must certainly occur with the change in our ideas of the pathology of the disease. As already stated, the middle ear is very likely to suffer from invasions of micro-organisms which in nearly every instance have their first growth in the naso-pharynx. Thanks to the antiseptic treatment of these affections, they are no longer so dangerous as formerly. In many cases, however, the germs penetrate the mastoid cells and the brain itself giving rise to pus-centers which are only to be relieved by the trephine.

Passing now to the third and fourth divisions of our subject, we find our greatest difficulty. To determine how the germs, causing idiopathic meningitis and osteo-myelitis or measles, scarlet fever, etc., gain entrance, is often impossible with our present knowledge. Von Bergmann in a recent paper on abscess of the brain says: "In this connection there is nothing so important as the knowledge that no abscess of the brain represents a primary disease, but is always secondary coming on as a result of another preceding trouble. The teaching of idiopathic abscesses of the brain can now be considered as an abandoned theory. These pre-existing diseases are certain, and in most instances very clearly characterized." It is probable that the term idiopathic will soon be consigned to an honorary position among medical fossils. The germ of measles and scarlet fever exerts its first visible influence on the mucous membrane of the respiratory passages, and possibly this is the place where the germs enter the organism. If this be true, it is possible that a filtering inhaler may be used to good advantage on those children of a family who are necessarily exposed but not yet poisoned with the germs. That disease can be transmitted from parent to offspring is beyond dispute, but just how it is difficult to determine, since there is a total absence of continuity between the maternal and fetal blood-vessels. This subject engaged the attention of the eminent pathologist Birch-Hirschfeld and Virchow at the recent (1888) meeting of German naturalists and physicians, but no conclusion was reached. Among the diseases transmissible from parent to offspring are syphilis, tuberculosis and glanders. Cancer is usually placed in this class, but I believe it is a mistake. Cancer usually develops at a late period of life, and it is more probable that the germs of the disease

are engrafted on a body of failing strength than that the germs should have lain dormant from conception to the time of their active development. Besides, as in tuberculosis, in a majority of cases no history of heredity can be obtained, and many persons with a distinct history of heredity pass through life without the development of the disease.

Passing to the second division of the subject I state that the severity of the invasion varies, with the condition of the body as regards strength or weakness or idiosyncracy. It is a fact long and well known that individuals have a peculiar aptitude or resistance to certain diseases which can not be explained by ordinary rules. In 1883 I estimated approximately the value of vaccination as follows: Take 100 vaccinated persons and probably 90 of them are absolutely protected from small-pox by the vaccination. Five of them have an idiosyncrasy for it by which they will take the disease if exposed, nothwithstanding the vaccination, and the remaining five have a resistance to the disease and would not contract it even if not vaccinated. The importance of remembering this division is seen when we consider that unthinking professional men are yet condemning vaccination for small-pox and Pasteur's treatment of hydrophobia simply because all cases are not prevented by these procedures. That the severity of the invasion varies as regards the strength or weakness of the patient is so true as to require no proof, and yet one often sees an important exception to the rule whereby a delicate and apparently weak person resists an invasion of the typhoid fever or other germ with greater success than one in the most robust health. The usual explanation of single attacks of any one disease is that the soil for the growth of its germ has been exhausted. The exhaustion of one soil seems to have a more or less favorable effect on the virulence of the succeeding germs, even if of another disease.

3. The amount of infecting material which gains entrance influences the severity of the disease. The system can dispose of a certain quantity of germs, and Mr. Lister declares the blood to be an excellent disinfectant. It is possible that many slight attacks having an obscure pathology are merely due to the effort of the body to throw off a slight microbial poisoning. But let a certain number of germs gain entrance, and an attack of greater or less violence supervenes, depending on the quantity. I believe that the mild or virulent cases which occur in any given epidemic are largely due to this fact.

3. The character of the infecting material. We can readily imagine that the germs vary in their virulence from one epidemic to another, and that thus one epidemic may be mild and another severe from this cause. What influences the character of the germs and modifies or destroys their virulence is a most important point to determine. Unfortunately it has only been determined as yet in a very limited number of diseases. Vaccination influences the small-pox germ by making it less virulent.

4. The tissue which is penetrated and its location often determines the character of the disease. Mr. Pasteur has found that the hydrophobia resulting from bites on the face is more virulent than that occurring at points more distant from the nervous centers. On the other hand wounds are often more virulent in the hand than on the arm, and the foot than the leg, probably because the blood current has not the same opportunity for destroying the germs in the more remote portions as in the nearer. Penetration of germs into certain regions as the palm of the hand or in the neighborhood of joints is more likely to result seriously than when into tissue of the same character elsewhere. Tuberculosis is more or less virulent as it invades different tissues, and the same might be said of cancer. In closing this extended and yet incomplete report I wish to confess to a knowledge of its many short-comings. This paper will have accomplished its mission if it supplies a foundation upon which work in this direction may be done, and leads to a greater appreciation of its importance.

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