

In a series of tests we found that the least proportion of diphtheria toxin which was necessary to give lasting immunity was not quite harmless in guinea pigs. Thus of four guinea pigs receiving a mixture of 1 unit plus  $\frac{1}{2}$  L+ the two larger remained permanently well, while the two smaller finally died of paralysis. Four guinea pigs receiving one half the quantity of the same mixture all remained alive. Two other series receiving still larger quantities of the same mixture acted as the first lot. Some of these guinea pigs received six months later two fatal doses of toxin without serious poisoning.

It is interesting to note that three of these animals received repeated injections of toxin in increasing amounts, until finally 6,000 fatal doses were given in one injection. The blood of the animals at this time contained from 25 to 30 antitoxin units per cubic centimeter. It is possible that the toxin used in these experiments which was produced by Culture No. 8 may have more tendency to promote late paralysis than that from other cultures such as used by Smith.

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**Antiperistalsis in its relation to tubercle bacilli and other bacteria in the alimentary tract.**

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Fifteen years ago Grützner showed that charcoal, starch and similar substances when introduced in normal salt solution into the rectum, ascended in the intestinal tract and after from four to six hours could be demonstrated in the stomach. His work was confirmed by some and refuted by others. This problem has of late assumed a new aspect inasmuch as some workers have claimed that when bacteria are introduced in the same way, within a short time they ascend by means of the antiperistaltic action of the alimentary tract to the stomach, œsophagus and thence into the respiratory tract. The most recent report of this phenomenon comes from the Kaiserliche Gesundheitsamt, which concludes that this antiperistaltic movement must be considered, not only in exper-

imental studies on tuberculosis, but also in the prophylaxis against infectious diseases; more especially in the disinfection in cases of cholera and typhoid fever, where the sputum may in this way be contaminated.

The experimental facts claimed are: When *Bacillus prodigiosus*, tubercle bacilli or other bacteria are suspended in from 10 to 20 c.c. of salt solution and are injected by rectum into an adult rabbit, they may be recovered by culture or animal inoculation an hour later from the small intestine, stomach, œsophagus, trachea, lungs and other organs. These results are interpreted as proving conclusively that these bacteria, after traversing the gastro-intestinal tract, have entered the trachea and lungs, and thence have been transported throughout the body.

The technique previously employed was, in brief, to keep the animal securely fastened following the injection, so that he could not lick himself, to kill him after a variable period, and then under the strictest asepsis to make numerous cultures from the contents of the alimentary tract, from the macerated organs, and from the heart's blood.

It appeared that the foregoing facts could, for the most part, be conceded, and nevertheless be open to quite a different interpretation. With this question in view I undertook the following series of experiments.

The technique which I made use of differs in two respects from that used by others: (a) Large amounts of blood obtained for examination were drawn from the ear vein or jugular vein, previous to pithing the animal; (b) care was taken to avoid contact with blood in the cultures made from the hollow viscera. In addition it was found necessary to introduce other experiments.

The following is a summary of my results:

Of four experiments in which the animals were killed within three hours of the rectal injection, in three bacteria were not present above the ileo-cæcal valve; in one they were obtained in the small intestine after seventy minutes; in no instance could they be cultivated from the stomach or œsophagus.

Furthermore of four other experiments where twenty-four hours was allowed to elapse before killing the animal, in one the tubercle bacillus was demonstrated by means of inoculation to be

present in the stomach. In the three others the injected bacteria were not found in the alimentary tract.

In the various experiments bacilli were recovered from the lungs, liver and kidneys, urine and mesenteric glands.

In three of four experiments *Bacillus prodigiosus* was cultivated from the blood within three hours of the rectal injection, and once twenty-four hours later. In two instances, where attempt was made tubercle bacilli were found in the blood twenty-four hours after they had been introduced into the rectum. Forty-five and fifty milligrams of a bovine culture had been injected, and 2 or 3 c.c. of blood was inoculated into each of six guinea pigs in both instances. In none of these experiments was the organism found in every blood culture, and in many of them the heart's blood tested proved to be sterile.

The result of these blood cultures suggested the injection of the bacilli directly into the circulation with an injury as to their subsequent distribution in the body. This work is still unfinished, but it may be of interest to note in this connection that one hour after injecting one forty-eight hour agar culture of *Bacillus prodigiosus*, this organism was found in the small intestine, and that three hours following the injection of 130 mg. of tubercle bacilli they were demonstrated in the stomach and small intestine. That these tubercle bacilli did not enter the alimentary tract by way of the lungs was shown by two experiments in which the pylorus was ligated previous to the intravenous inoculation and the bacteria were found in the small intestine. In these instances the bacteria either passed into the lumen of the stomach or intestine from without, or entered by means of the bile passages. Further experiments are being carried out to determine this question.

After it was shown that the bacteria entered the blood following introduction into the rectum, it seemed necessary to inquire whether they were excreted by the salivary glands and could possibly in this way enter the upper part of the alimentary tract. To this end three experiments were carried out on dogs. Rectal injections of *Bacillus prodigiosus* were given in the manner described and two or three hours later the secretion from the parotid gland was obtained by means of a capillary tube inserted in the opening of Stenson's duct. In most instances this is easy to carry

out and five to ten cubic centimeters of saliva can thus be obtained after giving the dog 1/100 gr. of pilocarpine subcutaneously. None of the cultures made from the saliva showed *Bacillus prodigiosus*; however, I do not believe that this route is absolutely excluded.

One clinical test was made. A "typhoid-carrier" who is known to have had typhoid bacilli in her stools for some years, at times almost in pure culture, but at present in the ratio of about ten per cent. of the total number of fæcal bacteria, was submitted to an examination. If the bacteria ascend from the intestine then typhoid bacilli should be found in her stomach. This patient was starved for eight hours; at the end of the period her mouth was washed with sterile salt solution, and the washings tested for typhoid bacilli. Her stomach, which was found to be empty after this period, was accordingly washed out and the washings, which were of neutral reaction, likewise plated on Conradi-Drigalski media. Neither of these fluids was found to contain typhoid bacilli, nor indeed colon bacilli.

From these experiments I conclude that bacteria injected by way of the rectum into rabbits are not carried in a viable state above the small intestine, and that they do not enter the respiratory tract by this route. In fact their presence in the small intestine may at times be due not to antiperistalsis, but to excretion from the blood or the bile. Furthermore; where experiment has showed them to be present in the lungs, the trachea and the œsophagus, they have entered these organs by way of the blood stream.

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### **The action of soaps on the pneumococcus.**

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The object of the study to be reported briefly is the ascertaining of the manner in which the pneumococcus is disposed of in the body of infected animals that recover. The animal experiments were made on full grown rats. A strain of pneumococcus fatal to them in 1/10,000 of a cubic centimeter of a twenty-four hour bouillon culture was employed. Strong solutions (1 to 5 per cent.)