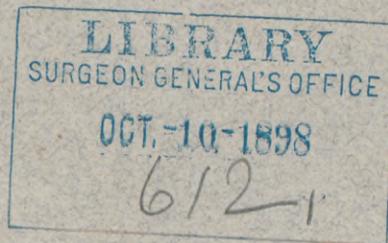


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MEDICUS

How soon do Bacteria which Enter the
Portal Vein become Disseminated
Throughout the System, and when
does their Elimination Commence?

BY

GUSTAV FÜTTERER, M.D.



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**HOW SOON DO BACTERIA WHICH ENTER THE PORTAL VEIN
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(First Paper.)

BY GUSTAV FÜTTERER, M.D.,

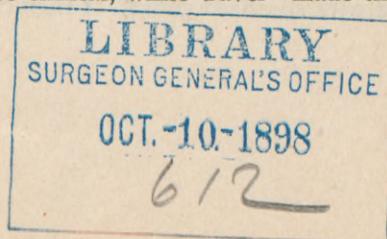
Professor of Medicine, Chicago Policlinic; Fellow of the Chicago Academy of Medicine, etc.

To gain information on this and some other questions, considerable experimenting was carried on during last winter. For years I have tried in vain to find a place where such work could be done under proper conditions, until Dr. Wm. L. Baum kindly gave me permission to work at the Post-Graduate Medical School. It gives me great pleasure to render my sincere thanks to Dr. Baum and to heartily thank Dr. Emil Ries for performing many of the operations for me and spending many days in the furtherance of my work. Certain results, as will be seen later, could not have been obtained without the help of a colleague so able and willing.

Although clinical observations must necessarily lead to the belief of bacterial absorption by the intestines, yet exact proof should be sought for such opinions. Kocher's reasonings in this respect have been of the greatest importance, and brought fruitful results.

Kocher,¹ who observed strumitis occurring after a simple intestinal catarrh, says: "In three of our cases of which we have kept an accurate record the strumitis came in immediate connection with an acute affection of the stomach. In two cases not only an acute inflammation developed, but with it signs of decomposition, gas, and putrefaction. None of those cases corresponded to the acute infectious gastritis or gastro-typhoid of Lebert, as an enteric affection was present, the sensorium being clear, and the course of the trouble short. The gastro-enteritis corresponded absolutely to those forms which occur after ingestion of decomposed substances." Kocher thinks that the only plausible explanation of such conditions is that common bacteria enter the blood and locate in predisposed places, in this instance causing a strumitis in an already changed thyroid gland. In cases of purulent inflammation of the thyroid gland following gastritis and enteritis he also believes in the metastasis of micro-organisms from the digestive tract, and he further says: "The acute metastatic strumitis accompanying acute infectious diseases is easily explained by an invasion of bacteria from the intestinal canal or other organs into the blood, and their deposition in the goitre."

Kocher's reasonings were clinical, while Tavel² made thorough



bacteriological examinations. He comes to the conclusion that strumitis is due to an infection from the blood. Tavel succeeded in culturing bacterium coli commune from a strumitis, thus corroborating the clinical statement of Kocher.

Conrad Brunner³ also confirms the above observations. He cultured bacterium coli commune from an abscess in a case of strumitis without finding other micro-organisms, and while he found no primary focus of purulent inflammation like Tavel's case of periproctitis, he believes he is justified in concluding that the bacterium came from the intestinal canal.

Sittmann⁴ found staphylococcus pyogenes albus and bacterium coli commune in the blood of a patient who suffered from, and later died of, diphtheritic inflammation of the colon ascendens, reaching all through the intestines and downward to the rectum.

Posner and Lewin⁵ closed the anus of rabbits entirely with clamps or sutures, or hardening dressings, and after eighteen to twenty-four hours found the whole system of the animal flooded with a bacterium which they considered to be the bacillus coli commune. Then they injected the bacillus prodigiosus into the rectum before ligating it and again obtained the same results. In these cases the walls of the intestine showed considerable tension, its blood-vessels were strongly congested, there were some hemorrhages present and sometimes peritonitis, but no perforations were visible.

Ferrio and Bosio⁶ opened the abdomen of guinea-pigs, ligated an intestinal convolution, and sometimes found bacterium coli in the urine; but as they did not find the bacterium regularly, they believed in a secondary invasion.

From all this we conclude that bacteria can pass through the walls of the intestinal canal, without grave lesions being present, and gain the general circulation. It seemed to me that some attention should be paid to their mode of traveling after they have passed through the intestinal wall into branches of the portal vein, and particularly to see if the liver would offer marked resistance to their reaching the general circulation. With this end in view the following experiments were made:

Experiment No. 1.—On January 16, 1897, I exposed both jugular veins in a dog, covered them with sterilized gauze, and injected a mixture of bacillus prodigiosus and bacillus pyocyaneus with physiological salt solution into the portal vein. After making this injection the abdominal wound was closed with a few sutures and covered with sterilized gauze. I then cleaned my hands thoroughly

with hot water, soft soap, and a brush, and disinfected them with a strong hot solution of carbolic acid. Five minutes after the injection had been made blood was taken from a jugular vein with a sterilized hypodermic syringe and transferred to an agar-agar tube. This was repeated every five minutes during the first hour, and during the second hour every ten minutes. The first inoculation, made five minutes after the injection, yielded large quantities of bacillus prodigiosus and bacillus pyocyaneus, which consequently had passed through the liver, the right heart, the lesser circulation and the head in five minutes. The second inoculation, after ten minutes, yielded mainly bacillus prodigiosus; the third, more pyocyaneus; the fourth one, nothing; the fifth one, after twenty-five minutes, mainly prodigiosus; and the sixth, after thirty minutes, mainly pyocyaneus. Later inoculations gave either no results or other micro-organisms. The fact that no micro-organisms grew in some of the tubes can probably be explained by thrombotic changes in the jugular veins, which thus yielded very little blood. The presence of other organisms than those injected was no doubt caused by contaminations from the air; they do not impair the value of this experiment, but it may here be mentioned that no such contaminations occurred in our later experiments.

Experiment No. 2.—On the 30th of January, 1898, I prepared a dog with all antiseptic care, in the same way, and again injected a similar mixture of bacillus prodigiosus and bacillus pyocyaneus into the portal vein, having the jugular veins covered with sterilized gauze. Specimens of blood taken in the way described gave exactly the same results as in the first experiment. The second experiment confirmed the result of the first, but the objection might be raised that the same hand which injected the germs into the portal vein also took the blood specimen, therefore I made Experiment No. 3, to eliminate this criticism.

Experiment No. 3 was conducted like the others, all possible care being taken to prevent contamination, and while I injected the germs into the portal vein, Dr. Emil Ries took the blood specimen from the jugular vein. As his hands were thoroughly prepared, he took the first blood specimen after three minutes, the second after five, and the others each five minutes apart, until half an hour had elapsed. They all yielded bacillus prodigiosus, the only germ injected.

Experiment No. 4 was conducted exactly like Experiment No. 3, but Dr. Ries took the first blood specimen one minute after injection into the portal vein, and others two, three, four, five, ten, and

fifteen minutes after the injection. This experiment not only confirmed the results of the others, but revealed the astonishing fact that *the injected micro-organisms had made their way from the portal to the jugular vein in one minute.* The surface of the diagonally solidified agar-agar was covered with the red cultures of bacillus prodigiosus. From the enormous quantity of prodigiosus present we may justly conclude *that the bacteria had reached the jugular vein in somewhat less than a minute.*

Experiment No. 5.—After injecting the germs into the portal vein and on withdrawing the hypodermic needle, a drop of blood will ooze out, even if during withdrawal of the needle, and for some time after, the point of injection is compressed and covered by a sponge of sterilized gauze. Therefore there might be some peritoneal absorption. Although the quantity of micro-organisms getting into the peritoneal cavity in this way would be very small indeed, and even if they had at once become absorbed, inoculation from the blood of the jugular vein would not yield such masses as we found. Nevertheless, I injected several syringefuls of the same mixture of prodigiosus and salt solution, which were used for injection into the portal vein, into the peritoneal cavity; then taking blood specimens from a jugular vein after one, three, five, ten, and fifteen minutes, all giving a negative result.

These experiments I think prove that micro-organisms may pass from the portal vein to the general circulation within a minute.

I then repeated the same experiments, using the bacillus tuberculosis on a monkey, a calf, and several rabbits, all experiments giving negative results. I see no reason why the tubercle bacillus should not pass into the general circulation as well as the bacillus prodigiosus, and therefore believe that the condition of my cultures is to be charged with this lack of success. The experiments will be repeated with other cultures of bacillus tuberculosis and other pathogenic micro-organisms.

As to the second question—When does the elimination of bacteria commence?—it can be said that it starts immediately. I have tied the left ureter of a dog, injected prodigiosus into one of the jugular veins, taken urine specimens from the pelvis of the left kidney, and found prodigiosus present two minutes after injecting it into the jugular vein. For five hours I have been able to culture prodigiosus from a dog whose left ureter had been cut behind the bladder, and into which a catheter had been introduced before prodigiosus was injected into the jugular vein, thus preventing contamination of the catheter with germs from the blood at the

stump of the ureter, which would surely have happened if the catheter had been introduced after making the injection. In another dog the common duct was laid open, a cannula was introduced, and prodigiosus injected into one of the jugular veins, and specimens of bile were used for inoculation on agar-agar, yielding a positive result after two minutes. This experiment was repeated, with the only difference that a catheter was introduced instead of a needle, making a contamination with blood less probable. Again prodigiosus was cultured after two minutes.

Conclusion.—The elimination of micro-organisms which have entered the portal vein is inaugurated at once by the kidneys and the liver.

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