lation of the nerves of the splanchnic area, the urine causes a fall in pressure.

From these observations it is concluded that the urine lowers pressure through its paralyzing effect on the endings of the vasomotor nerves.

Dog's urine in doses of three cubic centimeters given intravenously may be used in physiological and pharmacological experiments to produce an abrupt and marked but transient fall in pressure with no secondary effect, in the same way that adrenalin is used to produce a corresponding rise in pressure.

The physiological antagonism between urine and adrenalin, which evidently act on the same anatomical structures, suggests the possibility that the depressor substance of urine represents a body which previous to its elimination may have a regulatory influence on the circulation directly opposed to that of the secretion of the adrenal gland.

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On the elimination of bacteria from the blood through the wall of the intestine.

By **ALFRED F. HESS, M.D.**

Last year in a paper presented before this Society on, "Antiperistalsis in its relation to tubercle bacilli and other bacteria in the alimentary tract," I noted that bacteria which are injected into the blood current of rabbits could be recovered by culture from the contents of the small intestine. Since then I have followed this problem further, investigating the path by which the bacteria enter the alimentary tract, and, although the work is not completed, I have arrived at certain definite conclusions.

It has been shown by previous workers that some soluble poisons, notably morphine and snake venom, are excreted from the blood through the stomach. It has likewise been demonstrated that various salts, mainly soluble salts, such as strontium or lithium chloride, may be found in the intestine following intravenous injection. It is most probable that the authors of these experiments are correct in deducing that these salts have traversed the wall of the intestine; however, it should be noted, that in none of these

experiments was the common bile duct or pancreatic duct ligated, and entrance to the gut by this route excluded.

For almost all our experiments rabbits were employed. The test bacterium was *Bacillus prodigiosus*, which unless otherwise stated, was suspended in 0.8 per cent. salt solution and inoculated into the ear vein. After two experiments had shown that the injected bacteria were to be found in the small intestine, further experiments were undertaken to discover their portal of entry. Four routes seemed possible: (1) the bacteria may enter the lung and then gain access to the gastro-intestinal tract; (2) they may enter the intestine through the common bile duct or (3) through the pancreatic duct, or (4) traverse the wall of the intestine. Experiments were undertaken to discover whether this last route was possible, and to this end the other paths were one by one excluded.

In two experiments the pylorus was ligated in order to exclude the possibility of bacteria descending from the respiratory tract. As in all the experiments the inoculation of test bacteria was not made until the animal had recovered from the shock of the operation, which interval was generally one to two hours. After the inoculation the animal was killed in from one to three hours. Cultures were then made from different levels of the gut, under the precautions as to sterility which I have mentioned in my previous paper. Varying amounts of the contents of the intestine were used for culture, from one platinum loop of 4 mm. diameter to 1 c.c.; this was transferred to large tubes of broth, from which in turn agar plates were made. In some instances forty to fifty broth tubes were inoculated. In these preliminary experiments, in which the pylorus was ligated, it was proved that if three loops of agar culture of *Bacillus prodigiosus* were inoculated, this bacillus could be recovered from the small intestine two and one half hours later.

Of three experiments in which the common bile duct was ligated, two gave positive results. The smallest amount of culture employed was two platinum loops. *Bacillus prodigiosus* could not be recovered from the stomach, but was present in large numbers in the bile. In one of these experiments rabbits' serum was used as a menstruum instead of salt solution.

In five experiments the pancreatic duct as well as the com-

mon bile duct was ligated or also incised. In rabbits this is very easy to carry out, as the pancreatic duct enters the intestine separately and many inches below the bile duct. All five experiments gave positive results. The smallest amount injected was one loop of culture, which was recovered after the animal had lived for one hour.

In order to prevent the damming back of the bile, consequent to ligation of the common duct, two experiments, in which the duct was not obstructed, were undertaken. In these the duodenum was ligated and divided in its upper part, so that the bile flowed freely into its upper segment and no stagnation ensued. In addition the pancreatic duct was ligated. In one of these experiments in which one loop of culture was inoculated, *Bacillus prodigiosus* was recovered from the lower duodenum and the ileum.

Finally a dog was experimented upon. A duodenal fistula was made, the upper segment of gut including the openings of the pancreatic and the bile ducts. After the upper end of the duodenum was closed off, four loops of culture suspended in 4 c.c. of salt solution were injected into the jugular vein, the animal having been starved previously for twenty-four hours. Two hours later *Bacillus prodigiosus* was recovered from the lower segment of the small intestine, the gall bladder, and the urine, but not from the cecum or large intestine.

In some of this series of experiments the small intestine was ligated so as to divide it into sections, to see whether we could determine whether there was any difference as regards the permeability of the various segments of the gut. We found, however, that all parts of the small intestine acted alike in this respect.

It is very difficult to estimate even approximately the number of bacteria that may traverse the intestinal wall in this way. In general it may be said that in rabbits using an inoculation of one to three loops of culture material, not a very large number of organisms seem to be excreted by this route, as they could not be cultivated regularly from each tube, even though one half to one cubic centimeter of the intestinal contents was used for culture purpose. In the small intestine and especially in the duodenum the living bacteria are normally so few that large amounts of the fecal contents can be used for culture without danger of losing

sight of the test organism. It was found that the bacteria were excreted in large numbers by the bile. They were also found to a less degree in the urine; however, no extended quantitative estimations were made in this regard.

We have not been able to demonstrate the way by which the bacteria pass from the blood or lymph through the intestinal mucosa; whether unaided or with the help of the leucocytes. The experiments are being continued in this direction.

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A report on the production of tabardillo, or Mexican typhus fever, in monkeys.

By **JOHN F. ANDERSON**, *Director Hygienic Laboratory, and* **JOSEPH GOLDBERGER**, *Passed Assistant Surgeon, U. S. Public Health and Marine-Hospital Service, Washington, D. C.*

It has been found that at least two species of monkeys, the *Macacus rhesus* and *Cebus capuchinus*, are susceptible to infection with tabardillo or Mexican typhus fever by direct inoculation with blood from human cases of this disease.[1] An attack of the disease in the monkey, produced by blood inoculation directly from man, induces a definite immunity to a subsequent inoculation with virulent blood.[2] Two monkeys, one a *rhesus* and the other a *capuchinus*, which were tested for their immunity 23 and 30 days respectively after the subsidence of their fever, were found to be immune to inoculation with large doses of virulent blood. Some of the same blood inoculated into two untreated monkeys produced, after an incubation period of eight days, a febrile curve similar to that of human cases of tabardillo. Blood taken from one of these animals on the sixth day of the fever and used for passage into another monkey, caused, after an incubation period of seven days, a similar febrile curve.

The blood of a *Macacus rhesus* infected from a human case

[1] Anderson, John F., and Goldberger, Joseph, A note on the etiology of "tabardillo," the typhus fever of Mexico. Public Health Reports, Dec. 24, 1909, XXIV, 1941.

[2] Anderson, John F., and Goldberger, Joseph, On the infectivity of tabardillo, or Mexican typhus, for monkeys and studies on its mode of transmission. Public Health Reports, Feb. 18, 1910, XXV.