To
A. H. G. Doran Esq:
with the writer's kind regards

13.

REMARKS

ON THE

FUNCTIONS OF THE LIVER

IN JAUNDICE.

BY

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THE FUNCTIONS OF THE LIVER IN JAUNDICE.

It is well known that, in the old system of physiology preserved to us by Galen, the liver, besides being the source of the movement of the blood, was likewise the centre of animal heat and of sanguification. Shortly after the discovery of the circulation by Harvey, the liver was robbed of all its functions save that of bile-making. Strange to say, in our time, the liver has been restored to all the functions, nay, more than all, that it possessed in the belief of Galen, and physiologists are now well assured that the liver is the centre of sanguification, of animal heat, of bile-making, as well as of certain other functions not dreamt of by the ancients.

To those who watch the flux and reflux, the Euripus of medical opinion, this return to ancient beliefs (if I may so use the word) is most interesting. Astrology, the influence of the planets upon human destiny, would, if discussed by the encyclopædists, have been set down among the grossest superstitions of ancient and mediæval writers ; yet now modern science acknowledges the great influence which the planets have upon the sun-spots, and these again influence many terrestrial phenomena, and consequently mankind. Again : the chemists tell us of the belief now gaining ground that the elements are not separated by the hard and fast line formerly supposed, but that it is highly probable that all the elements have some common source ; thus the theory of the philosopher's stone and the search after the transmutation of metals no longer appears to be the impossibility which fifty years ago it was believed to be.

To return to physiology. The most important function of the liver known to physiologists is its power of making glycogen, a discovery made not many years ago by Claude Bernard. Upon this function of the liver depend apparently sanguification, nutrition, and, indeed, ani-

mal heat; for Claude Bernard has found that the blood issuing from the hepatic vein is the warmest of all in the body, and is invariably of a higher temperature than that in the portal vein or arterial system. Another function greatly dependent upon the glycogenic function is the making of bile. A fourth function, according to Meissner, is the secretion of the greater part of the urea excreted by the kidneys. The object of this paper is to inquire what becomes of these functions in jaundice, whether they continue unchanged or are greatly or slightly impaired. It has, I think, been hitherto too readily assumed by pathologists, in their reasonings on the phenomena of jaundice, that the liver continues its functions just as in health.

First, as to the glycogenic function of the liver. Whether this were injured or not appeared to me so important a point to establish on a firm basis, that I made a large number of observations upon animals in order to decide it. After ligaturing the bile-duct, I found that, whether the animal died within a few hours or a few days, in all cases alike glycogen was absent from the liver. The absence of the glycogen was constant. It is not, therefore, merely the outcome of the temporary disturbance of the operation, but a permanent change in the function of the liver. The glycogen, however long the animal lived, in no case returned.

These observations have been confirmed by von Wittich; so that it may now be taken as an established fact that, in complete obstruction to the bile-duct, the glycogenic function of the liver is abolished. In like manner, puncture of the fourth ventricle after ligature of the duct causes no sugar to be present in the urine.

To one acquainted with the rudiments of physiology, it will be unnecessary to point out the importance of these results. They suggest a reason for the wasting often seen in jaundice, and which often occurs rapidly, and for the sense of weakness and inability to exert themselves of which some patients complain.

Another function of the liver is the preparation of bile. The three important constituents of the bile are the bile-acids, the bile-pigments, and cholestearine. Of these, the bile-acids are the greatest both in amount and in physiological value. Taking seventeen *grammes* as the very lowest estimated amount of dry bile which a man daily excretes, twelve *grammes* of this will be formed by bile-acid salts, about three by the bile-pigment and mucus, and the remainder by the cholestearine and inorganic residue. If the functions of the liver continue uninjured in jaundice, the whole of this should be excreted by the kid-

neys, as it is well known that none of the secretions but the urine contains either bile-pigment or bile-acids. It is true that the sweat may sometimes contain bile-pigment, but the amount lost in this fashion must be exceedingly small. What, however, is the real amount passed out of the body by the kidneys? If Schwanda's estimations may be trusted, the amount of bile-pigment passed by the urine in jaundice is very small. The highest figure which he gives is .015 *grm.* in the twenty-four hours. It has been seen that the amount secreted in health and passed into the duodenum is at the lowest reckoning two *grammes*. The same of the bile-acids. The smallness of their amount in the urine for a long time caused their presence altogether to be overlooked; but all observers are now agreed that the bile-acids, though in small quantity, are really present in the urine. The amount is very small. No one has found more than .3 *gramme* of bile-acids excreted in the twenty-four hours; yet, if the functions of the liver continue uninjured, at least twelve *grammes* should pass out of the system. This difficulty has been felt by physiological chemists, and Ernst Bischoff has proposed a theory to escape from it. He supposes that the bile-acids are oxidised in the blood; not all of them, but that they are only oxidised when their amount reaches a certain figure; just as a certain amount of sugar may be injected into the blood, part of it passing out by the kidneys, the remainder being oxidised in the blood. This theory is one to which assent can hardly be given, as the bile-acids have already attained a high degree of oxidisation, and it is well known how well they resist oxidising changes, as putrefaction, and chemical agents, as sulphuric acid. It seems more reasonable to suppose that very little indeed of the bile-acids is secreted. It is a widespread belief among physiologists that the albuminous principles of the food are split up in the liver into glycogen and bile-acids; the glycogen taking the carbon, hydrogen, and oxygen; the bile-acids the same elements combined with sulphur and nitrogen. Now, if the glycogenic function of the liver cease, what becomes more probable than that the bile-making function of the liver should cease or be greatly impaired? There is a well known example of the dependence of these two functions one upon another in the *limax flava*, first pointed out by Bernard. In this mollusc, the bile and glycogen are secreted alternately, one during digestion, the other after, and so on. So, on *à priori* grounds, it is very likely that, when once the glycogenic function of the liver is lost, the bile would cease to be secreted as well. Lately, several observers have noticed that as jaundice progresses the

bile-acids become less in quantity, and, as Golowin has found, even disappear from the urine altogether at the end of a long-continued jaundice.

The same reasoning may be applied to the bile-pigments; their source, however, is altogether different from that of the bile-acids, for it is probable that they are derived from the red corpuscles of the blood. There can be little doubt that the formation in the liver of bile-pigments must be decreased both from the small amount excreted by the kidneys and the slight staining of the tissues even in severe jaundice compared with what would take place were the whole of the bile-pigments formed in health again passed into the blood. The colour of the patient would then be an Ethiopian blackness. Clinical observation also shows that the colour of jaundiced patients decreases as death draws near.

A third important function is, that the liver produces a large amount of heat. Bernard, some years ago, pointed out that the temperature of the upper part of the vena cava inferior was higher than that of any other part of the body. This high temperature is, no doubt, due to the active chemical changes continually going on in the liver; and, if these changes cease, it must follow that the temperature itself would fall likewise. I have found, in some cases that I have examined, the temperature in the upper part of the vena cava inferior, forty-eight hours after ligature of the common duct, lowered to the temperature of the rectum. This lowering of the temperature is not, however, constant, and the investigation requires to be pushed farther than at present I have had the leisure to pursue it.

It has been long known that in jaundice the temperature of the body is below natural, provided the jaundice be not accompanied or caused by any disease which of necessity begets fever. The lowering of the temperature in the hepatic veins, if confirmed, would serve to explain the low temperature of the whole body so commonly seen in jaundice; for, if the liver be the great heat-giving centre of the body and it cease to give out heat, what sequence more natural than that the temperature of the whole body should be lowered?

Another revived Galenical function of the liver is its power of forming blood-corpuscles. It is well known that the blood of the hepatic vein contains a far greater number of both red and colourless corpuscles than that of the portal vein. The corpuscles of the portal vein show likewise under the microscope a more distorted shape than the blood-corpuscles of the general system; they are also richer in fat.

Now, in jaundice, if a number of old analyses may be trusted, the amount of blood-corpuscles is very greatly decreased. This has been explained by supposing that the bile-acids circulating in the blood destroy a large number of the red corpuscles. If, however, less than one *gramme* a day of bile-acids pass through the system, as I have endeavoured to show above may be the case, the bile-acids must be in so dilute a solution, that very little action upon the corpuscles can take place, in no way enough to account for the great diminution of the red corpuscles. If the liver be largely concerned, therefore, in the making of red blood-corpuscles, and its functions in jaundice be greatly impaired, it seems more probable that the anæmic state of the blood in jaundice may be due to the injury done to the liver. The general state of nutrition in jaundice should, however, be kept in mind, as there can be no doubt that the removal of the bile from the intestines causes a great disturbance in the phenomena of absorption.

The last function of the liver, the secretion of urea, rests upon a base by no means so well founded as the others. It is not a theory which, in the present state of knowledge, greatly commends itself to my mind, nor do the observations which I have made upon the urea in jaundice seem at all to confirm the theory. For, if most of the other functions of the liver known to us be greatly impaired or even entirely abolished, it would be strange if this alone should remain in unchanged vigour. And yet this is really the case; for, in a series of estimations which I have made, and published in a paper read in March last before the Royal Medical and Chirurgical Society, I did not find the urea so much diminished as on Meissner's theory might be looked for. The decreased amount could be readily accounted for either by the disease which caused the jaundice, the general health and food of the patient, rest in bed, and the like; while, in two cases in which the obstruction to the ducts was most complete, and in which no other disease save the obstruction was present, the amount of urea reached its highest point. These results do not dispose me to look with great favour on Meissner's theory.
