PHYSIOLOGICAL AND PRACTICAL STUDIES.

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No. II.

ON THE EFFECTS OF THE HORIZONTAL POSITION OF THE BODY IN SYNCOPE; WITH OBSERVATIONS ON THE RELATIONSHIP THAT EXISTS BETWEEN THE BRAIN AND HEART.

PART II.

THE explanation about to be offered of the good effects that result from placing the body in the horizontal position during some kinds of syncope, appeals to mechanical principles, and rests on the supposition that the only stimulus to motion required by the heart is a due supply of normal blood.

I speak now of a healthy heart, and of a condition of the vascular system generally that admits of a free circulation. For when we begin to speak of failure of the heart's motion, it is necessary always to remember that neither the mere healthy state of the heart, nor even the actual presence of healthy blood, will suffice to keep the circulation going under all circumstances. It was shown, for example, in the last chapter, that an enfeebled state of the respiration, by causing in the first place a chemical derangement, and secondly, a mechanical obstruction of the blood in the pulmonic system, was alone sufficient to modify and lessen the heart's beat; and there can be but little doubt that a similar modification may take place from changes in the systemic circulation. In these cases, syncope is less directly relieved by the recumbent state than in cases where it arises from loss of blood or from diminished power in the heart itself.

In order to explain more clearly the mode in which syncope is produced, in instances where there is loss of blood or central failure of the circulation, and in which the recumbent position relieves, let me refer to the act of abstracting blood by the ordinary operation of phlebotomy. If blood be taken largely from the system—say from the arm—while the body is erect, the person operated on soon becomes faint. This, it may be fairly assumed, arises from the heart being robbed of a sufficiency of blood on which to act; and if the blood be allowed to flow on, the pulsating organ will soon be emptied, and will cease to act altogether. For this cessation to occur, however, it is not necessary for anything like half the real quantity of blood in the body to be withdrawn; and therefore it cannot be said that the heart ceases to act from there being no blood in the body, but from its failing to receive what there remains: and, at this point, a glance at the course of the circulating currents will render great assistance. Let these simple points only be remembered—that the arterial blood, on leaving the heart, whether destined for the upper or the lower part of the body, first *ascends*; that the venous currents from the upper part *descend*, while those from the lower parts *ascend*; and the difficulties are mainly removed.

The body thus constituted is placed in the erect position, and blood is withdrawn. The heart soon failing from abstraction of its stimulus, loses its power of throwing the current of blood along the ascending aorta; and the whole arterial circulation becomes consequently more or less active. The result is that, as the *vis à tergo* lessens, the blood in the lower half of the body (taking the heart as the centre) fails to return through the veins in opposition to gravity; so that the right side of the heart is merely supplied with stimulus from the descending veins above it; but as the blood they pour is forced at each pulsation after its arterialisation up the aorta with less and less power, eventually all of it that rises ceases to ascend through the carotids, innominate, and subclavians, and so either glides over the aortic arch into the lower half of the body, or falls back upon the tricuspid valve. The heart is thus finally left empty, and the vessels above it are empty also; but the veins of the lower half of the body are filled with blood, perhaps up to the mouth of the inferior cava, and want but force from behind to make them pour their contents into the right auricle.

The person is now in a state bordering on syncope; and as the brain is without its supply of blood, consciousness is necessarily absent, and voluntary movement and power fail universally. Death absolutely would indeed soon occur if the erect position of the body continued; for the heart would quickly cease to pulsate in the absence of its stimulus, and the blood in the veins below it would soon coagulate from remaining at rest. But before these results can take place, the body falls or is laid down in the horizontal position, and by this simple act the conditions previously existing are entirely changed. The inferior veins charged with blood pour their reserved supply into the right auricle, under the force of gravitation, and upon this the auricle contracts first, and the ventricle follows. A fresh stream of blood is thus sent through the pulmonic circuit, and returning arterialised to the left heart, is driven round the arterial system, and re-establishes the whole circulation.

Supposing, then, that the cause of the heart's failure should have been removed while the changes I have just described are going on, the recovery from the syncope is insured, and progresses favourably. The brain receiving a new draught of blood revives in its functions, and consciousness returns; and the skin receiving a new supply of the same vital agent has its sensation restored, and radiates again some sensible amount of heat; and, in short, in every part of the body the living action returns. But to not one of these parts is due the least credit for having restored the movement of the central organ of the circulation on which they all depend; to the brain no more than to the skin, or any structure in the organism.

In the illustration I have here given, I have shown what the results are when the body is placed erect, and made to lose blood from some vessel above the heart, as in an ordinary venesection. The explanation, however, extends to loss of blood in any other form, and from any part. If from the lower half of the erect body blood were freely abstracted, the chances of recovering are of course much lessened, because what was before a reservoir of blood would now be a running cistern; but the recumbent position would be equally valuable, since it would lead to a distribution of blood through the vessels superior to the heart, from which blood would not escape.

The effects of position of the body in modifying the duration of life, during loss of blood, are well illustrated in the act of killing a calf, as it is daily performed in our slaughter-houses. The object of the butcher is to make the flesh as white as possible, by draining the body of its blood to the fullest extent. He therefore first destroys sensation in the animal, and voluntary muscular motion, by a heavy blow on the back of the head; and then, suspending the body by the hind legs, he makes a free division in the vessels of the neck. He thus for a time secures a thorough drain of blood from all parts of the body; and, if the flow ceases sooner than he thinks proper, he lays the animal for a short time horizontally, by which he encourages the heart to throw a few more circuits of blood round the inferior half of the body, and also enables the brain to be emptied of its congested blood.

It would be difficult to adopt a more scientific proceeding than this, performed by the butcher, for the attainment of his object; and the physiologist, who is anxious to observe the effects of position during loss of blood, could scarcely devise or witness a better experiment.

To illustrate more clearly, however, the views I hold on the subject of the recumbent position, and to bring those views to the test of demonstration, I arranged in my mind, and ultimately performed, a series of experiments, of which the following are the condensed histories. I should add that each form of experiment was repeated several times, and with unvarying results.

EXPERIMENT I. A young kitten was slowly narcotised with the smoke of the lycoperdon giganteum; and, when rendered insensible, the ribs were removed over the heart, in such a manner that that organ was exposed, while the right pleural cavity remained entire. The animal was then sus-

pended perpendicularly, *i. e.* with the head upwards, and the arteria innominata was cut across. As blood flowed through this opening, the right auricle ceased to contract, and at last collapsed. At this stage the body was laid horizontally, with the hind parts slightly raised. The right auricle was instantly refilled with blood from the inferior venous trunks, and recommenced to contract powerfully; the play of the left ventricle also recommenced; the pulmonic circuit was re-established; and the action of the left side of the heart was also restored, as the restarting of jets of blood from the divided innominata obviously proved. This experiment I have repeated several times, with the same results.

EXPERIMENT II. Another young cat was thoroughly narcotised as before, with the smoke of the lycoperdon giganteum, and the heart was exposed by removing a portion of the left thoracic wall; the right pleura was uninjured. The heart continued beating strongly and rhythmically after its exposure; and the breathing continued. A long needle, armed with a strong twine ligature, was now passed under the trachea, and the ends of the ligature having been brought under that tube, were tied very firmly at the back of the neck; in this way the large vessels in the neck were to a great extent compressed, without there being any pressure on the trachea. By a quick incision through the neck above the ligature, the whole head, and two or three of the cervical vertebrae, were removed from the trunk. The heart still continued to beat, but the respiratory movements failed. A tube was therefore fixed in the trachea, and artificial respiration set up. The body was now suspended with the neck upwards, and as blood was being lost by the vertebral vessels and carotids, the heart speedily began to empty itself, and in proportion the right auricle and ventricle collapsed, and ceased to play. The body was then laid in the horizontal position: the auricle almost immediately became fully refilled with blood from the inferior cava, and, together with the ventricle, recommenced to contract so vigorously, that the pulmonic circuit was obviously made, since the left auricle also refilled and began to act. By raising the body a second and even a third time into the erect position, the right cavities once more collapsed; to become refilled and to recontract, on restoring the trunk to the horizontal line. At last, when the system was so emptied of blood that the auricle remained shrunken and quiet, even when the body was suspended by the hind extremities, I succeeded in refilling it, and in setting it in motion for a brief period, by compressing the abdomen firmly with a grasp of the hand, thus forcing a little remaining blood onwards toward the heart.

EXPERIMENT III. A full grown cat was rendered insensible as before. The heart was exposed, and the body was suspended by the head. The pulmonary artery was divided, and the auricle and ventricle were allowed to empty themselves, and become shrunken and at rest. The inferior vena cava was then closed near to the heart by a pair of spring forceps, and the position of the body was changed from the erect to the recumbent position. No filling of the auricle, and no reaction took place. After waiting four minutes, I removed the forceps: instantly there was a rush of blood into the auricle, which as soon recovered its contractile power. The ventricle likewise responded in due order, and continued to pour out its blood by the pulmonary artery, until the venous system below the heart became emptied of its fluid contents, when both cavities gradually sank and rested for good.

EXPERIMENT IV. A cat was again the subject. The first steps of the operation were the same as in the experiment preceding. After the heart was exposed, and the body placed with the head upwards, I carefully separated the heart from every attachment with all the surrounding parts, except the inferior and superior venae cavae, and laid it on a card. The right cavities continued to contract, pouring out blood by the pulmonary artery, until they became completely collapsed and at rest. Several minutes were now allowed to elapse, when the body was laid hori-

zontally. As in all the preceding instances, the cavities received a free draught of blood from the inferior cava, resumed play, and continued in quick and rhythmical action for nearly ten minutes, until, in truth, they had exhausted all the venous blood that could flow into them from the lower half of the body.

I have but little to add in the way of comment on these experiments. They must be judged of as they stand. As experiments they are easy to perform: and I feel sure that any physiologist who may take the trouble to perform them carefully for himself, will not be deceived in the results. They prove to demonstration, as I conceive, the complete independence of the heart of any power, force, or influence derived directly from the brain; and they show that the recumbent position of the body in syncope is useful, not because the head *per se* is laid low, but simply because it changes the direction of the circulating currents, and leads to the re-supplying of the empty heart with its one and only necessary stimulus, blood. By removing the head from the trunk, the heart was of course cut off from all communion with the brain; and by severing the heart from all its attachments at its base, except the two cavæ, it was of necessity removed from every kind of connection with the whole nervous system. Yet the recontraction of the circulatory organ was just as complete when blood was again poured into it, as in the cases where its union with the cerebro-spinal axis was preserved. Could any experiments illustrate more forcibly the truth of the position I have taken?*

I have treated as yet only of those cases of syncope in which the failure of the heart's action lies in the mere abstraction of its stimulus. It is proper, however, to refer to the other classes of cases, where the central failure is connected either with an overburthened condition of the pulsatory organ, with debility of its muscular walls, or with valvular obstruction. In these cases, the recumbent position, though also affording more or less of relief to the symptoms, acts in a manner different from that which I have described as occurring during syncope from hæmorrhage. I shall describe this difference in my next part.

[To be continued.]

Mortlake, August 1854.

PERFORATION OF THE DUODENUM: SUDDEN DEATH: WITH REMARKS.

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ON the 9th of June, 1849, at two P.M., I was requested to go instantly to see a man in an adjoining inn, whom I found dead on my arrival. On inquiry, I was informed that he entered the house about 12 o'clock, and was supplied with a glass of beer and porter mixed. He sat down and took up the newspaper; but soon complained of being unwell, and placed his hand over the epigastric region where he said he had pain. He sat there for some time (other persons being in the room), and about half-past one was noticed asleep, as the persons in the room thought; but as he continued so, and looked pale, they determined to awake him, when they found him cold and apparently lifeless. I was then sent for, and arrived in five minutes.

* In the experiments related, I used the smoke of the lycoperdon giganteum (common puff-ball) as an anæsthetic, in preference to chloroform; and I would recommend all experimentalists to do the same. First: because the lycoperdon is much less expensive than any other anæsthetic. Secondly: because, like Woorara, it exerts but little influence in paralysing the heart. Thirdly: because it is much more easily administered to animals of ordinary size, such as cats, dogs, and rabbits, than other similar. For the mode of using this substance, see my paper on the subject in the ASSOCIATION JOURNAL for June 3rd, 1853. The experiment of removing the encephalon was performed on the suggestion of Dr. Willis, to whom I am deeply indebted for much valuable aid in carrying out these and many other inquiries.