Thesis

On the Peculiarities of the Circulation within the Cranium.

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The peculiarities of the circulation within the cranium were first noticed by Professor Monro Secundus, about the year 1783.

The opinions held by that Physiologist on this subject were, that as the substance of the brain, like that of the other solids of our body, is nearly incompressible, the quantity of blood within the head must be the same, or nearly the same, at all times, whether in health or disease, in life or after death; those cases only excepted in which water or other matter is effused or secreted from the blood vessels; for in these cases a quantity of blood, equal in bulk to the effused matter, will be pressed out of the cranium.

Dr. Kellie of Leith advocated this theory, and performed numerous experiments in support of it.

The correctness of these opinions no one seems to have doubted until Dr. Burrows of London, disturbing the whole theory, and doubting the accuracy of Kellies experiments, repeated them with apparently different results. The opinions of Dr. Burrows are, that the contents of the cranium are subject to the same laws as other parts of the body, and that the quantity of blood circulating in the

brain may vary to the same extent as in other internal organs. The theory of Monro is now considered by many untenable, and not unlikely to lead to erroneous treatment of cerebral disease.

In investigating this subject, I propose I, to consider the structure of the cranium, the nature of its contents, the peculiar arrangement of its vascular system, and the effects such a structure is likely to produce on the blood circulating within this cavity; II, to endeavour, as far as possible, to verify by experiment the conclusions arrived at from the consideration of the structure; and III, to consider the arguments adduced in support of the opinions usually held on this subject.

The skull is of a spheroidal figure, and is composed of many distinct bones, most of which are closely united, and form a firm, unyielding structure. In a few instances, the margins of the bones are not united over their whole extent, spaces being left between them, and very frequently the bones themselves are perforated; by which means, fissures, foramina, and canals are formed, through which various important structures pass to and from the interior of the

head. These perforations, at least when of large size, are almost entirely limited to the inferior surface of the skull; and are all accurately filled by the soft parts. The foramina present on the superior and lateral surfaces are small, and the canals to which they lead invariably pass in an oblique direction through the bones.

The opening in the inner table is never exactly opposite the corresponding foramen in the external plate.

These canals are intended for the transmission of small vessels, arteries and veins, which have a longer or shorter course in the diploe of the bones through which they pass before entering the dura mater, or anastomosing with those in the interior of the head.

None of the numerous foramina in the base of the skull pass directly into the cavity, except the foramina, jugulare, spinosum, and the anterior foramen lacerum. The first of these transmits the jugular vein, and the three divisions of the eighth pair of nerves. The second transmits the middle meningeal artery; while the foramen lacerum is closed, inferiorly, by a thin

plate of cartilage. These foramina are, in the strictest sense of the term, situated in the base of the skull. The other foramina in this situation are invariably canals of greater or less extent; some no doubt extremely short, but still having a bony roof. The large vertebral foramen is doubtless an exception to this general rule; but as the cavity into which it opens might be proved subject to the same conditions as the cranial cavity, or at least as incapable of affecting the question I am now considering, I do not consider this really an exception.

The sphenoidal fissure and optic foramen, from their size and situation, deserve more special notice. They are large; not in the base of the skull, though nearly so; and, at first sight, apparently passing directly into the interior. They are both deeply placed at the back part of the orbital cavity; and, besides, have each a more or less perfect roof according to the development of the bones at this part. The solid mass of the eye ball fills up the orbital cavity, and on either side of this cavity presses on bones very obliquely placed,

until at the opening in the back part a mere slit remains forming the sphenoidal fissure, still further protected by its oblique direction. This arrangement, together with the pressure upwards and inwards through the spheno maxillary fossa on the soft parts filling that space, effectually provides against any apparent incompleteness in this situation. The pressure of such structures on the soft parts passing through openings so situated, and formed by unyielding bone, as the sphenoidal fissure and optic foramen are, presents as effectual an obstacle to the influence of external pressure on the parts within, as if the osseous case were complete throughout.

The skull being thus formed, and its foramina so arranged, and all clothed by the soft parts, the interior is completely removed from external atmospheric pressure.

The contents of the cranium are, the brain and its membanes, blood vessels and their contained fluid, and extravascular serum. The extravascular serum forms a very small proportion of the cranial contents. In a healthy state,

there is rarely more of this fluid than is sufficient to moisten the membranes, at least up to the middle period of life.

It is unnecessary to enter into any anatomical description of the contents of the cranium. There are, however, certain peculiarities in the vascular system of the brain which have an intimate bearing on the subject now under consideration. These peculiarities I shall shortly notice.

The arteries supplying the interior of the cranium pass through bony canals, and have a more or less tortuous course previous to their entering this cavity. The vessels on entering the skull divide and subdivide, ramifying and anastomosing freely, so as eventually to form a complete vascular net work. No vessel pierces the cortical substance of the brain until it has been reduced to a very minute size.

The structure of the venous canals within the cranium is altogether peculiar. They are composed of tough, inextensible dura mater, and many of them are bounded on one side by the

bony cranium. The walls of these canals resist any distending force that can be exerted on their interior, during life.

The last and most important point to be considered under this head is, are the contents of the cranium compressible or not, by any force that can be exerted by the heart on the interior of the blood vessels, during life?

The incompressibility of the cranial contents by any such force was assumed by Monro, and forms an essential element in the theory he has proposed on the subject I am now considering.

Without altogether denying the correctness of this assumption, the truth of it is called in question by Dr. Burrows, and those who hold his views on this subject.

The property of contraction or dilatation belongs to all bodies. Every substance, however dense or compact, can yet have its volume enlarged or diminished. This change of bulk is, in some instances, quite apparent, in

other cases, to render it visible, it is necessary to employ a vast amount of force, or use a measure of great delicacy.

In order to ascertain whether the brain is compressible or not on the application of any ordinary force, I performed the following experiment.

Having obtained a large and very strong glass tube, I fixed on the open end a brass cap, to which a top piece provided with a short tube and stop cock could be applied at pleasure. A powerful condensing syringe was accurately fitted to this tube.

I now obtained a fresh brain, and having filled the tube partially with water, inserted a large portion of the brain into it in successive pieces, agitating each with the water to remove any air that might be attached to their surface. The brass top piece was now applied, and the tube filled with water, as high as the stop cock. I now applied the condensing syringe with a force equal to at least one hundred pounds on the

square inch. After having applied this force, the stop cock was turned, and the syringe removed. The test of compression was, if any perceptible compression is effected on the mass of brain in the tube, a globule of air must be admitted to supply the vacant space, which will become apparent on reversing the tube.

On doing this, no such globule appeared. This experiment repeated, several times, in the presence of others.

It may be said, such could not have been the result, had this experiment been properly performed, as the water itself must have been compressed under such a force, a pressure of fifteen pounds on the square inch causing a diminution in the bulk of that fluid equal to $\frac{1}{21740}$ of the whole amount. There is no doubt both the brain and the water were compressed by the force employed, but to such an infinitely small extent as to be quite inappreciable by the naked eye.

We must next enquire, what is the amount of force which can be

exerted on the inner surface of the blood vessels, during life? This has been ascertained, by experiment, to be from 4 lbs. 3 oz. to 4 lbs. 6 oz., in the ordinary condition of the body. During very violent action of the heart, from whatever cause, the pressure on the inner surface of the blood vessels may amount, it is supposed, to ten or twelve pounds.

The conclusion to be arrived at, therefore, plainly is, as the brain cannot be visibly compressed by the large amount of force applied in the above experiment, that organ is absolutely incompressible by any force that can be exerted upon it through the blood vessels, during life.

Having now shewn that the interior of the cranium is removed from the influence of external atmospheric pressure, and that the cranial contents are incompressible under any ordinary amount of force, I will proceed to consider the probable effects of such conditions on the blood circulating within this cavity.

In considering the effects of such a structure, I shall describe the probable condition of the cerebral circulation in opposite states of the general circulatory system; first, under increased action of the heart; and secondly, under diminished action of that organ.

During increased action of the heart, more than the natural quantity of blood is propelled from the left ventricle to all parts of the body. The vessels leading to the head participate in the general fulness. The first obstacle which presents itself to the entrance of more blood, is the bony canals through which the vessels pass before entering the cranium. This bony encasement effectually prevents their dilatation, and the tubes must necessarily remain of their ordinary dimensions. Further, as the cranium is already full, there is no space for the entrance of more matter within the cavity, unless compression of some part of the contents is produced, or some portion be removed.

The compression of any portion of the cranial contents by any force that can be exerted on the inner surface of the blood vessels, during life, we have already shewn to be impossible; and this is the only possible source of pressure, as the brain is completely removed from the pressure of the external atmosphere. The first effect of this tendency to the entrance of more blood will be the expulsion of a greater quantity by the veins. The whole of the blood sent, however, is not required for the nourishment of the part; the change from arterial to venous blood will not fully take place; and the balance of the two systems will be destroyed, although the actual amount of blood continues the same.

When this derangement has taken place the functions of the brain are no doubt, in some measure, disturbed.

Symptoms, too, peculiar to this condition, though not yet ascertained, doubtless exist, and in a definite and

constant manner, give external evi-
-dence of the morbid change.

There is thus produced a state of the cerebral circulation, identical with active congestion in other parts; and as with this condition function is per-
-verted even in the least important parts, how much more must a sim-
-ilar change affect the actions of the most delicate and most important organ in the body? We cannot see the morbid change which takes place, but during a similar alteration of the circulation in the frogs foot, so far as there can be similarity in circum-
-stances so dissimilar, we can perceive, by the aid of the microscope, what the morbid change is.

When active congestion is brought on in the web of the frogs foot, by prick-
-ing or otherwise, the change from arterial to venous blood is interrupted in con-
-sequence of the increased activity of the capillary circulation. The coloured corpuscles of the blood retain their arterial

hue, even after reaching the veins; and, further, they shew a tendency to co-here, instead of flowing independently onwards. One of the natural functions of the web is the secretion of a kind of lymph, but this secretion is now suspended. In like manner and with equal certainty, though not capable of demonstration, are the functions of the brain more or less disordered.

This state of matters continuing or rather the morbid action increasing, a further change will take place. The extravascular fluid will gradually be in part removed; and though the quantity be small, it is still sufficient to permit a slight dilatation of the arteries and veins. The brain will now appear vascular and congested; and as the venous sinuses are inextensible, stagnation, to a greater or less degree, will ensue; some of the weaker vessels may give way; and the serious, it may be fatal consequences, of extravasation follow.

If these untoward consequences

do not take place, a state of passive con-
-gestion may result. The vessels in the
frogs foot, after the irritation has ceased,
do not recover their tone, at least for a
time, but remain passively loaded and
congested. In an unimportant part,
this is of little consequence, as the normal
condition of the vessels will be gradually
restored, and the tissue or organ res-
-ume its healthy function. The result
is far otherwise with the brain. While
such a condition exists, a fresh supp-
-ly of arterial blood is prevented enter-
-ing; and coma may be gradually, or
rather, speedily induced.

In this state of the brain,
not merely is the balance of the arterial
and venous systems destroyed, but blood
is present in increased quantity, and
the free circulation is seriously impaired.

There is, also, an important fluid,
in whole or in part, removed, the most
important, perhaps the only, purpose of
which is mechanical and supplement
-ary, there being great advantages in

having such a delicate organ as the brain surrounded by a fluid medium, while it also forms a most convenient substitute when the quantity of blood is in any way diminished.

The amount of blood is increased within the cranium to the extent only that the extravascular fluid has been diminished: the actual quantity of fluid within the cranium remains unaltered.

This increase in the propulsive force of the heart which we have been considering, besides destroying the balance of the arterial and venous circulation, and ultimately increasing the actual amount of blood within the cranium, exerts, from the first, a direct by mechanical influence on the cerebral mass.

The pressure exerted by the blood on the inner surface of the blood vessels, and through these tubes on the brain, is necessary to the healthy action of this organ. There is, however, frequently, as in the case now supposed, an increased

pressure on the walls of the cerebral vessels.

These tubes communicate this force, exerted on their walls, equally on all sides, to the surrounding substance; and as all the vessels, small as well as large, sustain the same amount of pressure on an equal extent of surface, an increased pressure is generally diffused throughout the brain. The brain being adapted with the utmost nicety to a certain degree of pressure, rejects equally any increase or diminution of its natural stimulus. This increased pressure may be exerted on the whole, or on a larger or smaller portion of the brain, according to circumstances. It has been already fully illustrated that no such pressure is capable of producing compression of the cerebral substance.

There is one condition of the body, depending neither on increased nor diminished action of the heart, the effects of which on the cerebral circulation it may be well to notice here.

The condition to which I refer, is obs-

-truction to the return of venous blood from the upper part of the body to the right side of the heart.

If there be any obstruction, from any cause, to the return of venous blood to the right side of the heart, an effect similar to that arising from too great a flow from the left side, will be produced on the cerebral circulation.

Blood will be sent, as usual, to the head through the different vess-els, but the circulation in the si-nuses must become interrupted. The veins of the brain, properly so called, will become engorged, while less arterial blood will enter it. The balance which exists in the healthy state between the arterial and venous systems is thus destroyed. The loss of balance between the two systems, arising from such obstruction will pro-bably produce more serious effects on the brain than that proceeding from increased action of the heart. Venous blood circulating in excess will prove

more speedily hurtful to the functions of the brain, than an increased supply of arterial blood. If the obstruction be not removed, venous congestion will increase, the extravascular fluid will gradually be removed, and the substance of the brain become vascular and congested. In this case, as in the former, the increase of blood is in a direct ratio to the diminution of extravascular fluid.

I shall next, as proposed, consider the state of the circulation within the head during diminished action of the heart.

If the action of the heart become suddenly less powerful than natural, from nervous shock or other cause, less than the usual quantity of blood will be sent to the brain.

The effect of this will be a diminished momentum in the arteries, and a consequent inability to force the blood through the veins and sinuses. The blood, however, remains

in its usual quantity: the vessels of the brain, unlike those in other parts of the body, not being diminished in calibre under these circumstances.

In virtue of their vital contractility, the vessels of the brain, did their circumstances permit it, would no doubt contract, as those in other parts of the body do, under a diminished momentum of blood. The sinuses, however, cannot relieve themselves, in this manner, of any part of their contents; and any force which may be exerted by the vital contractility of the arteries, assisted only by such diminished action of the heart, is unable to propel the blood through these sinuses. The effect of this impaired force of the circulation will, therefore, be venous congestion; and unless the hearts action be speedily restored, consequences very similar to those observed in the case of obstructed venous return must follow.

It must not be supposed, how-

-ever, that such similarity in the conse-
-quences of these two conditions, necessarily
induces a like similarity in their
symptoms. The functions of the brain
will probably suffer much in the same
manner; but, in other respects, the symptoms
presented are different. In the case of
obstructed venous return, the pulse, for a
time at least, may be full and strong; the
countenance is swollen and livid; the lips
of a dark purple colour; and the veins of
head, neck, and upper part of the body,
distended. When the action of the heart,
on the other hand, is suddenly dimin-
-ished, the pulse is small and weak;
the countenance pale; skin cold: in fact,
the ordinary symptoms of impending
syncope. The indications of treat-
-ment in either case are, also, plain and
distinctive. In the former case, the par-
-amount indication is removal of the obstruc-
-ting cause. We must, also, endeavour to re-
-lieve the already overloaded and congested
brain. This is accomplished by maintain-
-ing the erect posture, and freely

abstracting blood, locally, by cupping.

In the latter case, our object is to propel the blood with greater force towards the brain, thus restoring the activity of the circulation through the sinuses.

It is quite conceivable that, in some cases, an opposite condition might be the result of such diminished action of the heart, and that instead of venous congestion, there might only be a less amount of pressure on the blood within the cerebral vessels. A very slight and gradual diminution in the hearts action might lessen pressure on the blood, and consequently on the brain; but, still, not be sufficient to retard materially the expulsion of the venous blood.

If this sudden impairment of the hearts action proceed from hemorrhage, the appearance of the brain will vary, according to the rapidity of the bleeding and the posture of the body. If, for example, the hem-

-orrhage arises from an opening in one of the internal jugular veins, the system must speedily feel the loss, and the action of the heart be diminished. The blood first taken, will contain most of the red particles, and should the sufferer remain in the erect posture, the blood, continuing to ascend through the carotid and vertebral arteries, must do so with difficulty, against gravity, and under a greatly diminished impulse. The consequent effect must be that the blood, already unnaturally serous in all the vessels, will be still more so in these particular arteries; the red particles being the heaviest constituent of the blood.

The vessels of the brain containing this altered fluid, will appear pallid, and though well filled, might, on a superficial examination, be supposed almost exsanguined.

If, again, the bleeding proceeds from division of both carotid arteries,

death must ensue so speedily as scarcely to allow a fresh supply of the altered blood to be sent to the brain through the remaining vessels.

The blood found within the head after death, will be chiefly venous, and the substance of the brain may even appear darker than usual.

In the case first supposed, namely, opening of one of the internal jugular veins, should the position of the body be horizontal, there is then no greater obstacle to the red particles reaching the brain than any other part of the body.

The pallidity of the parts will, thus, be less marked.

If, on the other hand, the head be kept in a dependent position, the heaviest constituent of the blood must tend towards the lowest point, and the brain will appear congested.

Should the body be kept in the same position, after death, the coloured particles will become still further

aggregated in the most dependent part; and if coagulation be retarded, the smallest capillary may appear loaded with blood. In reality, the blood is altered only as regards the relative proportion of its component parts. The quantity within the vessels is not increased, although the colour is so much deeper than natural.

When death occurs from hemorrhage, and the erect posture is maintained, should life have been prolonged for any considerable time, the quantity of blood within the head will be diminished. This diminution in the quantity of blood is immediately atoned for by the effusion of extravascular serum.

The secretion of this compensatory fluid takes place with great rapidity.

The quantity of blood within the brain, however, cannot, consistent with the performance of its functions, be diminished to any considerable extent, although the plenitude of the cranium be maintained by effusion of this fluid.

The parts within the head, after death from the disease termed anemia, will differ materially in their appearance in different instances.

Anemia cannot, however, be properly termed a disease, it is rather the effect of disease, and that of various kinds.

Whatever tends to diminish the quantity, and alter the quality of the blood, produces, as a consequence, this state of the system.

The various wasting diseases to which the body is liable, Phthisis, Diabetes, Dysentery, Hemorrhoids, and, in fact, any morbid condition which prevents the entrance, digestion, or due assimilation of food, may give rise to the anemic state.

It is evident that anemia, produced by such a variety of causes, proving fatal in so many different ways, the diseases varying also in intensity and duration, must give rise to very different appearances in the system at large, and likewise in individual

parts. Again, it is well known that although a person be anemic in the last degree, and reduced to great weakness, local determinations and congestions of blood may take place. These occur in the most inexplicable manner, probably from some peculiar nervous influence exerted on the part.

The condition of the cranial contents will vary, as well as that of other parts of the system. Unless all the circumstances are fully considered, and an attentive examination made, a false condition of the parts may be described, and conclusions may be drawn from false premises.

If the disease prove speedily fatal, the only apparent change may be an unusual scarcity of the coloured corpuscles of the blood. There will, consequently, be great paleness of external and internal parts, and the appearance but merely that of a deficiency of blood in the cerebral vessels.

The functions of the nervous

system, however, are as easily perverted, and as completely suspended by alteration in the quality, as by derangement in the quantity, of the vital fluid.

Should the disease prove of a more lingering character, the blood will be altered in quantity, as well as in quality. Less blood than natural will be propelled towards the brain, as well as other parts of the body. Serous fluid will, consequently, be effused into the ventricles and other parts. In both cases there is a condition similar to that produced by slow hemorrhage.

If the disease be still further protracted, another and important change takes place.

The body is receiving, day after day, less and less nourishment. The diminution, however, is so gradual as not to produce, what may be called primary death. The brain, like other organs, becomes by degrees atrophied, and this, it is well known, may to a certain extent happen, without

necessary destruction of life.

According to the extent of this change in the substance of the brain and its nutrient fluid will be the amount of effusion of extravascular fluid.

The quality of the blood may be so altered that, after death, the vessels in some parts of the brain will seem hardly to exist, although actually full of this almost colourless fluid.

It has been already mentioned that congestions may occur in different parts of the body, even in the most reduced state of the system. No doubt, such a determination of blood may take place towards the parts within the cranium, as well as to other parts.

The patient, in such circumstances, must, from weakness, assume the horizontal posture, there will thus be no obstacle to the heavier particles of the blood passing towards the head.

Such a local determination will cause the blood to enter the head in larger quantity and with greater force than

formerly. The effect of this is, to expel the more serous part already in the cerebral vessels. This may even give the brain a vascular appearance, particularly if contrasted with the pallidity of other organs. It is possible the imm-ediate cause of death may even be similar in kind, and leaving traces in every respect analogous, to apoplexy.

The brain presenting such a variety of appearances after death, naturally leads to the conclusion, that the quantity of blood within the cranium may vary to the same extent as in other internal organs. This conclusion is, however, erroneous, and arises from want of attention to the peculiarities of the part.

It is shewn, I think, in the prec-ding pages, that the quantity of blood within the cranium can vary to a com-paratively small extent, and that the quantity of fluid is unalterable.

Having now considered, briefly, the first part of my subject, I proceed to shew, by the results of experim-

-ent, the correctness of the reasoning already brought forward in support of an invariable quantity of fluid existing within the cranium at all times, and in all circumstances.

The following experiments were performed on full grown rabbits.

They were easily and satisfactorily accomplished while the animals were under the influence of chloroform, the use of which could not interfere, in any manner, with the results.

This powerful drug has done, is doing, and will do much to alleviate human suffering, and, I think, where necessary cruelty, for cruelty most experiments certainly are, must be inflicted on any of the lower animals, whose sense of pain is probably as acute as our own, this anesthetic agent ought to be employed. Many experiments, doubtless, could not be performed satisfactorily under its influence, but many can, and, I am sure, where its administration is eligible, experiments on living

beings are, to the feeling mind, disarm-
-ed of half their horrors.

Exp. I. In this experiment, the ani-
-mal was strangled, and afterwards
allowed to hang by the hind legs for
twelve hours.

On dividing the parts exterior to
the cranium, every vessel seemed fully
injected. The soft parts were swollen, and
infiltrated with bloody serum.

On opening the cranium, a totally
different appearance presented itself. The
dura mater had no appearance of increased
vascularity. The longitudinal sinus was
darker than usual, but not the least
distended. The vessels of the pia mater
and surface of the brain were darker
than natural, but there was not the
slightest extravasation. On making
sections of the brain, I could perceive
nothing unusual. The choroid plex-
-uses were of a darker hue. In no part,
was there any serous effusion that I
could discover. The sinuses were well
filled with dark blood. The dura

mater lining the base of the skull, had no appearance of increased vascularity.

Exp. II. In this case, also, death was caused by strangulation.

The head was examined immediately after death. On dividing the external parts, all the tissues were loaded with blood, which flowed freely from the cut edges. The scalp was removed, the deep surface of which, as well as the surface of the bone, was stained with blood. On opening the skull and carefully examining every part, I could not discover the slightest alteration from a healthy brain. The dura mater, as in the former case, was unaltered. The colour of the fluid in the longitudinal sinus was, in this instance, quite natural.

The pia mater and surface of the brain were perfectly free from increased vascularity. Numerous sections of the brain were made, from the superior surface to the base, but I could not discover the slightest difference, in its appearance, from the normal condition.

The sinuses were well filled, but the blood was certainly not of such a dark colour as in the former experiment.

After the interior of the skull was carefully examined and the ligature removed, blood rushed into the cavity from both carotid arteries.

The difference in colour of the two brains in these experiments, as also the darker colour of the blood in the sinuses of the former, is easily explained.

The red particles, being the heaviest constituent of the blood, would naturally gravitate towards the lowest part while the animal continued hanging head downwards. The blood within the cranium would thus, have the relative proportion of its constituents altered, the coloured corpuscles greatly exceeding their normal proportion, while the liquor sanguinis would be proportionally diminished. In this way, vessels usually containing corpuscles in single file, may allow of an aggregation of these particles until no liquor sanguinis is

left to modify the colour.

Exp. III. Effect of hemorrhage.

In this experiment, I opened the jugular vein on one side, but the circulation being feeble, probably from the effects of the chloroform, the flow of blood was at first comparatively slow. I then opened the vein on the opposite side, and death speedily took place.

The neck was then secured, and the cranium immediately opened.

The integuments and parts external to the skull, on being cut across, shewed no appearance of the presence of blood. The scalp was removed, and every part was pale and exsanguine.

On removing the skull cap, the dura mater presented nothing unusual. There was no shrinking of any part. The longitudinal sinus appeared as full as natural, but the fluid it contained was paler in colour. Some of the smaller vessels seen on the surface of the brain, after death by strangulation, had appear-

-enthy disappeared. On close examina-
-tion, however, the course of such vessels
could, in many cases, be discovered. They
contained a colourless fluid.

The substance of the brain was paler
than natural, and a small quantity
of serous fluid was present in the ven-
-tricles. The sinuses contained blood
in the usual quantity; and from
its being contained in larger vessels,
the red colour was not so faint as in
some of the smaller vessels of the
brain. The absence of
coloured corpuscles in some of the ves-
-els is, like their aggregation in the
smaller vessels of the brain in the
first experiment, easily explained on
account of their greater specific grav-
-ity. This does not, however, operate, in any
great degree, in an animal like the rabbit,
the head being nearly on the same level
with the body.

Exp. IV. Effect of pasture.

In this experiment, I destroyed
life by causing the animal to inhale

chloroform for some minutes. These animals, after the first inhalation, seem to enjoy the sensation the vapour produces, continuing to breathe it vigourously. Immediately before life became extinct, the animal, although in a state of complete insensibility, gave two loud squeaks, exactly like one afraid or accidentally hurt. This curious circumstance might prove an interesting subject for reflection, which would be altogether out of place here.

During the whole period of inhalation, I kept the head elevated, thus giving every facility to the descent of blood from the head.

After death, I allowed the body to hang suspended by the ears for thirteen hours.

On cutting through the external parts, they appeared completely exsanguined. There was not so much as the colour of blood in any part of the scalp. The membranes of the brain were pale; the fluid in the longitudinal

sinus, almost serous. The surface of the brain was also pale, particularly the sides of the hemispheres. The contents of the vessels in the substance of the brain, were in some cases almost natural, in others entirely colourless. Serous effusion, though not in large quantity in any one spot, was general throughout the brain. The base of the brain was much more vascular than any other part; probably from the contrast, it even appeared more vascular than usual. Every vessel seemed full, and some of the larger ones were apparently distended. The blood in some of the sinuses was natural, in others more serous than usual, but in all it was present in good quantity.

I might greatly multiply experiments, and execute them in very various manners. I consider, however, those now detailed quite sufficient for my purpose, since all yield results exactly such as I had anticipated. A further destruction of life I should, therefore,

consider needless and unwarrantable.

The following conclusions as to the nature of the circulation within the cranium, may, I think, fairly be deduced from the nature of the parts and the results of experiment.

I. The quantity of fluid within the cranium is, in all circumstances, invariable while the solid contents remain unaltered.

II. The quantity of blood circulating within the cranium is, in health, always the same. The actual quantity is also unaltered during certain conditions of disease; the due balance of the arterial and venous systems alone being destroyed.

III. The quantity of blood within the cranium can only vary to a limited extent, even in disease, to the extent, namely, of increased or diminished extravascular effusion.

IV. The same symptoms accompany alterations of a totally different nature in the circulation

within the cranium; while changes in stricture apparently in all respects similar, produce effects, in different instances, of a totally opposite kind. Might not the apparent inconsistency of cause and effect last mentioned, arise from the state of the circulatory system, different in different instances, accompanying the structural lesion, and modifying its effects. Constitutional peculiarities or other attendant circumstances, in individual cases of the same lesion, might easily produce such alterations in the circulation.

It is not my intention to enter upon the consideration of any of the special diseases to which the brain is liable. This is not necessary for the elucidation of my subject; and, besides, my want of knowledge of the special pathology of the various cerebral diseases unfits me for the task. Many cerebral affections, however, terminate fatally, and leave no trace of any morbid lesion visible to the naked

eye, or even by the aid of the microscope, to account for the symptoms and death of the patient. These affections are often ascribed to irritation—a very indefinite term, and, in most cases, only a cloak for our ignorance.

Some of these at least, are, I think, attributable to derangement of the circulation within the head.

A case of this kind lately came under my notice, in the clinical wards of the Royal Infirmary, which I shall shortly relate, as I conceive it to have a peculiar bearing on the subject discussed in the preceding pages.

Wm Mc Donald, aged 38, was admitted into the Infirmary, late on the evening of Nov^r 22^nd 1852, suffering from fits of an epileptic character. Shortly after admission, he had an attack of this nature, during which he became paralytic on the left side of the body and right side of the face. The fits continued to recur at intervals of a few minutes. There was no stertor, no appearance of suffocation, nor any marked lividity of countenance. His consciousness

returned immediately after each fit was over, and he answered questions rationally almost before the convulsive action of the muscles had quite subsided. His pulse was 98 and full. Four leeches were applied to each temple, but produced no change in the symptoms. During the night he had 66 convulsive attacks. In the morning he was much in the same condition: his pulse 100, full and firm.

At 12 oclock the intervals between the fits were shorter, and the paroxysms longer. The pulse was now 120, strong and bounding, increasing in strength during the attack.

The cold douche was now applied to his head, during the administration of which the fits occurred more frequently and were of longer duration. I omitted to mention that in the morning he was cupped on the temples, and 12 ounces of blood taken.

At half past one he was bled from the arm, and 12 ounces more taken. The fits continued to recur as frequently as ever, and he now became quite unconscious during the intervals. His pulse was 148 and soft.

Strong aqua ammoniae was applied to the scalp. He now revived; consciousness returned; and the intervals between the two or three succeeding fits was much longer.

He was also able to swallow a little beef tea. He speedily relapsed into his former state.

At 4 oclock a little brandy was given, when slight consciousness returned, but only for a moment. The pulse gradually became weaker, and the fits less frequent. He died 3¼ hours after admission. The breathing was free of stertor, to the last.

On examination of the body after death, no lesion could be discovered, to account in any way for the extraordinary and violent symptoms shewn during life.

There was slight thickening of a small portion of the dura mater close to the crista galli. At this point also, a portion of the cerebral substance, about the size of half a crown, was adherent to the dura mater and slightly softened. Every other part was perfectly healthy, a most careful examination having been made microscopically.

In forming an opinion as to the

nature of this most interesting case, there are a few circumstances which require to be carefully attended to.

The condition of the pulse as noted in the report, it must be mentioned, refers only to the intervals between the fits.

The sudden changes of the pulse previous to, during, and immediately after a paroxysm, is of great importance. By attending to the pulse, without looking at the patient, the accession of a fit was easily predicted, as it invariably fell, both in force and frequency, before the attack. The subsultus tendinum was generally so strong during the convulsion that the pulse could not easily be felt. I succeeded in feeling it once or twice, and while the fit was subsiding, the force of the pulse increased. Immediately after the paroxysm the pulse was felt to beat much stronger; and this was very marked, so long as consciousness returned in the intervals.

The gradually increasing force of the pulse as the disease progressed, while consciousness returned during the intervals between the fits, is to

be accounted for by the continual recurrence of the morbid state, and the increasing amount of obstacle to be overcome. It is worthy of remark, that consciousness was present during the intervals only so long as the pulse continued full and strong; also, that the bleeding, instead of relieving, aggravated the symptoms. The partial returns of consciousness that took place after the bleeding, were in consequence of the action of powerful stimuli.

From these considerations I am led to the conclusion, that the symptoms and ultimate death, in this case, depended on a derangement in the cerebral circulation. The hearts action from some unexplained cause was peculiarly irregular, as evinced by the pulse.

Immediately before and during the first part of each paroxysm, less blood than natural was propelled to the brain and all parts of the body. When this change took place, the impulse of the heart was unable to force the blood through

the smaller vessels and venous sinuses within the head, producing a degree of stagnation there. In this manner the cerebral functions were deranged, and could only be restored by a restoration of the hearts impulse.

By the continual recurrence of this morbid condition, the functions of the brain were permanently deranged, and eventually brought to a stand.

Why derangement of the circulation should have produced in this instance such violent symptoms, I do not pretend to explain. Neither can we explain, however, why sudden emotions, as fear, joy, anger, &c., which affect most persons slightly, some scarcely at all, should, in a few exceptional cases, produce serious or even fatal consequences.

I must now proceed to the last part of my subject; but I fear that I may here incur the charge of presumption by offering any remarks on the opinions of men of talent and experience, who have already considered the inter-

-esting subject now under discussion.

Many of these opinions, however, I conceive to be inconsistent with reason. The very experiments adduced in support of them, when carefully considered, prove them to be erroneous.

At the commencement of this essay I stated shortly the views generally held regarding the nature of the circulation within the cranium.

After a careful investigation of the whole subject, I fully coincide with the views originally brought forward by Monro, and ably advocated by Kelly.

I shall, therefore, in what follows, confine myself chiefly to the consideration of Dr. Burrows views regarding the cerebral circulation, which differ apparently, in many points, from those of Monro. Still, I think I shall be able to shew, that when Burrows writings on this subject are closely considered, they only tend to strengthen the doctrine he has endeavoured to overthrow. Several of the statements of Dr. Burrows appear to me very contradictory.

This will be seen as we proceed.

The deductions Dr. Burrows draws from some post mortem appearances presented by the human brain, and from experiments made on animals, are evidently unwarranted by the actual facts.

Partly on this account, partly from misunderstanding Dr. Kelly, in part also from unsound reasoning on the structure of the cranium, Dr. Burrows believes that he has established a new doctrine.

With what justice Dr. Burrows claims this honour I shall endeavour to shew, merely stating in passing that at present his claims are acknowledged by men of high standing in medical literature.

I cannot help thinking that these men have accepted Burrows views without studying those of Kelly; and in the work of the former, the opinions of the latter, in many points, are certainly, though unintentionally, misinterpreted.

It is only in the English schools, and among English authors, that the work

of Dr Burrows has received unqualified approbation, while the opinions originally promulgated by Monro & Dr Kelly, are considered erroneous, and as leading to dangerous errors in practice.

The following quotations from standard works will shew the views held by the London school regarding this subject. In a work on physiological anatomy and physiology by Todd & Bowman, the following paragraph occurs; "Notwithstanding these facts,"—the merits or demerits of which I do not here enter upon—"a doctrine has received very general assent, and the support of men of high reputation, which affirms that the absolute quantity of blood in the brain cannot vary, because that organ is incompressible, and is enclosed in a spheroidal case of bone by which it is completely exempted from the pressure of the atmosphere".

In the same work, at the close of one of the chapters on the brain, among the references to the writings of other authors, there appears the following; "The subject of the

circulation in the brain has been treated with great acuteness and learning by Dr George Burrows". There is no reference made to the iritings of either Monro or Kelly.

Again, in Watsons lectures on the prac-tice of medicine, after quoting the experiments and reasoning of Burrows, the author says; "By this refutation of a prevalent error, not unlikely to warp or mislead our practice in some cerebral disorders, Dr Burrows has done the science of medicine an essential ser-vice. The theory which he has demolished involved probably more than one erroneous assumption". Dr Watson makes some fur-ther remarks, but these are sufficient for our purpose.

It is quite unnecessary to enter into a lengthened criticism on the work of Dr Burrows This task has been already most ably accomplished by the late lamented and talented Dr John Reid, of St Andrews, whose name will be mention-ed with respect and regret while phys-iological science continues the study, and its results the wonder and admir-

-ation of man. I shall, however, make a few quotations from this work bearing directly on the theories advanced in the foregoing pages, taking the liberty at the same time, of making a few remarks.

After mentioning the previous views held regarding the cerebral circulation, and hastily quoting a few of Dr. Kellys experiments, Dr. Burrows says; "The summary of these observations is thus stated—that though we cannot entirely or nearly empty the vessels of the brain, as we can the vessels of the other parts of the body, it is yet possible by profuse hemorrhage, to drain it of a sensible portion of its red blood. If instead of bleeding animals usque ad mortem, we were to bleed animals more sparingly but repeatedly, there is no doubt that we should succeed in draining the brain of a much larger quantity of red blood, although serous effusion would be increased".

It may then appear surprising that Dr. Kelly has been so often quoted as asserting the brain cannot be depleted by blood

letting, when we find him stating that his experiments satisfactorily proved that these brains had really been depleted by bleeding, and their vessels drained of a very sensible proportion of the blood usually contained in them. But, in opposition to the conclusions drawn from these experiments, we find, in a subsequent communication to the Medico Chirurgical society of Edinr, Dr Kelly affirming "that, in the ordinary state of the parts, we cannot lessen, to any considerable extent, the quantity of blood within the cranium by arteriotomy or venesection; whereas, if the skull of an animal be trephined, then hemorrhage will leave very little blood in the brain".

There is certainly no contradiction in these statements of Dr Kelly, although Dr Burrows seems to think so. In the one case, we have "it is yet possible to drain it of a sensible portion of its red blood"; also, "by bleeding more sparingly but repeatedly we no doubt should succeed in draining the brain of a much larger

quantity of red blood, &c.". In the other case, we have the statement, "we cannot lessen to any considerable extent the quantity of blood &c.".

There may be a very sensible amount of blood withdrawn, and a much larger quantity than merely sensible, and yet not be considerable as compared with the whole amount in the brain. From Dr Kellys expression, red blood, it is also evident he foresaw an increased proportion of serum in the vessels, besides increased extravascular effusion.

Taking the parts bearing on the point at issue, as far as possible, in order as they occur, we next find Dr Burrows stating; "Hence it is not a fallacy, as some suppose, to assert that bleeding diminishes the actual quantity of blood in the cerebral vessels. By abstraction of blood we not only diminish the momentum of blood and the quantity supplied to the brain in a given time, but we actually diminish the quantity of

blood in those vessels". This was understood and clearly set down by Dr Kelly in the summary of his observations already quoted. "Whether the vacated space is replaced by serum, or resiliency of the cerebral substance under diminished pressure, is another question into which I do not now enter". We find an answer to this question, however, in another part of Dr Burrows work, in the following terms: "This extravascular serum appears to me to be supplemental to the other contents of the cranium; at one time, giving place to an increased quantity of blood in the cranium; at another, making up for a deficiency of blood in the vessels of the head". This is, in fact, the whole point at issue: increase of blood is permitted, and decrease compensated for, by a corresponding alteration in the quantity of serous fluid, but not by any resiliency of the cerebral substance.

The slight pulsating movement observed in the brain when a small portion of the skull has been removed, might

seem to countenance the idea of resiliency of of the cerebral substance. This movement, however, is due to the admission of atmos-pheric pressure to its external surface, which brings the vessels of the brain under the same conditions as those of other parts of the body. The cranial contents are no longer, at all times, necessarily a constant quantity. Were this move-ment due to resiliency, it must be caused by compression of the brain under atmos-pheric pressure. Elasticity alone could not cause it, there being no room for the brain to expand in any other dir-ection. Such compression, I need not again say, cannot take place.

When the cranium is entire there cannot be any such movement. The momen-tum of the blood within the head, as well as in other parts of the body, is increa-sed during each systole of the heart, and diminished during the diastole. The absolute quantity, however, is unaltered.

There is thus an alternation of press-ure, but the cerebral mass under ordin-

-ary circumstances, is in contact with the skull at every point, and at all times.

As far as regards the plen-itude of the cranium I might now con-clude. There are still, however, some observations of Dr Burrows that must be alluded to, and they are those which have evidently given a wrong impress-ion of the original theory.

I shall simply make a few quot-ations from Dr Burrows work, which, according to him, are the statements of Dr Kelly, but which are so modified and altered as to cause wrong impressions of that authors views on this subject. He says; "it is maintained that when hemorrhage takes place from the gen-eral system, it does not affect the quan-tity of blood in the brain. The exper-iments I have performed lead me to the opposite conclusion".

Had this statement been made with respect to the ultra views of Dr Clutter-buck, who says that no additional quantity of blood can be admitted

into the brain, and no abstraction can diminish that quantity, it would have been a correct one. Dr Burrows should then have had some claim to the honour of demolishing an unsound and dangerous theory. But, how unlike Kellys statement! who, after performing actual and comparative experiments in the most careful manner, says; "these affording most satisfactory proof that the brain had really been depleted by bleeding, and the vessels drained of a very sensible portion of red blood. Dr". Again, Dr B says; "Those who have maintained this doctrine of the quantity of blood within the cranium being always the same, have not, I believe, taken into due consideration that large proportion of the contents of the cranium which consists of extra-vascular serum". Here again we have the obnoxious term "constant quantity".

Once more; "in accordance with the variations in the quantity of extravascular serum, there must be fluctuations in the

quantity of intra-vascular fluid, the blood. From this consideration alone, it seems that the blood may be increased or diminished in quantity within the cranium". I might bring forward many more passages to the like purpose, but these are sufficient; and to say the least, quotations of this kind are tedious and uninteresting.

I shall now endeavour to prove certain conclusions of Dr Burrows erroneous, as I believe they are, and shew in what way these errors have originated. I shall also answer one or two questions put by Dr Burrows.

Before proceeding, however, I shall notice one statement made by Dr B., which he does not attempt to support either by reason, observation, or experiment.

He, Dr Burrows, says; "Those who maintain that the absolute quantity of blood" (absolute quantity again) "in the cerebral vessels does not vary, admit a disturbance in the balance of the arterial and venous systems. I admit, with Dr Abercrombie and others, the probability of an occasional

disturbance in the equilibrium between the quantities of blood in the arterial and venous systems within the cranium, and that such disturbance is productive of many serious cerebral symptoms. But in such cases, I presume, there is also a change in the absolute quantity of blood within the cranium, and not a mere change in the relative quantities in the two systems of vessels". Perhaps it may be allowed me to say, that I think it is shewn in the foregoing pages there may be an altered equilibrium in the balance of the arterial and venous systems, without a change in the absolute quantity of blood in the brain. I have also endeavoured to shew some of the ways in which such altered balance may occur.

With this digression, I proceed, as proposed, to prove certain conclusions of Dr. Burrows erroneous, and shew the way in which these errors have originated. First then, as to the effect of posture on the brain — He, Dr. Burrows,

says: "My experiments shew that posture has a most striking influence on the quantity of blood in the cerebral vessels".

These experiments were the suspension of two rabbits, after death; the one by the hind legs, the other by the ears.

In the former, he found great congestion of the external and internal parts of the head; staining of the tissues; and extravasation of blood into the membranes; also the substance of the brain uniformly dark, and congested in a remarkable degree.

In the latter, he found the external parts, of course, pallid and bloodless; of those within the cranium the membranes and substance of the brain were pallid, sinuses and other vessels exsanguined; altogether anaemic.

From these experiments, and the appearance presented by the brain of a gentleman, who was found dead with his head in a pool of water and in a dependent position, he concludes that "the encephalon is not exempt from this law in physics, the gravitation of the fluids

to the lowest parts of the corpse.

The description of the first experiment, from what I have myself seen, I should consider exaggerated; as also the second in some points, and even false in one particular, namely, "sinuses and other vessels exsanguined". He has completely overlooked, in these comparative experiments, the relative weight of the coloured corpuscles and colourless constituents of the blood; and has hastily concluded the vessels distended, because dark, and empty, because colourless. In the conclusion eventually arrived at he commits a further error, and forgets the universal nature of the law alluded to, gravitation. The heaviest particles in a fluid entirely removed from atmospheric pressure, will gradually descend, while the lighter particles take their place at the surface. Hence the superior surface of the brain in the first experiment, and also in the case of the gentleman found dead, would be the darkest part. But as no blood was lost in either case, the whole brain

must necessarily have appeared con-
-gested; since depth of colour and con-
-gestion are, in medical language, conver-
-tible terms. I have no doubt as to the
true condition of the vessels in the second
experiment. Instead of being exsanguined,
by which I understand empty, they
contained a colourless fluid. My own
experiment of a similar kind satisfies
me on this point.

In support of the great depleting effects of hemorrhage on the brain, Dr. Burrows quotes the post mortem appearances of the brain met with in 72 insane patients. "In 53 out of the 72 cases," he says, "the vessels of the brain were found congested; sometimes they were turgid; at other times extremely turgid; and upon one occasion, Mr. Laurence reported that he had never seen the blood vessels of the brain and its membranes more injected with blood". Among the whole number, there was only one case in which the vessels were unusually empty, and here a femoral

aneurism had burst three days before which was the cause of death. He here places in vivid contrast the congestion in the 53 cases, and the exsanguined condition of the one. There is thus, he thinks, clearly demonstrated that great increase in the quantity of blood within the cranium is permitted in some cases, and large abstraction, indeed complete drainage, in others. How are we to account for these post mortem appearances? The explanation, I think, is very simple. First, as to the congestions — It is well known, that in many insane persons, and especially in insanity from intemperance, the brain becomes atrophied in different degrees, according to the extent of the malady. This atrophy may probably occur, in something like the proportion here mentioned, 53 in 72. According to our theory, this diminution in the solids will be supplied by blood and extravascular fluid. The vessels will become distended as far as their texture and the healthy performance of function will permit, thus giving

rise to a considerable increase in the quantity of blood. The remainder will be atoned for by serous effusion. It must be remembered that the nearly invariable quantity originally held by Monro as existing within the cranium, was on the supposition that the solids remained unaltered. The exsanguine state of the vessels described in the single exceptional case, depended on the previous hemorrhages having drained the blood of a large proportion of its colored particles. It is, I think, from such errors as these that Dr Burrows arrives at the conclusion, that "the quantity of blood within the cranium is extremely variable at different times, and under different circumstances.

I come next to the questions put by Dr Burrows to those who advocate the opinions of Dr Kelly. After coming to the conclusion that the quantity of blood within the cranium is extremely variable, Dr Burrows asks; "How shall we account for these variations in the quantity of

blood within the head, if the cranium be a complete sphere, as it has been described by some physiologists"?

The answer to this question is simply, as we have already said more than once, that when the blood is by any means diminished in quantity, the solids remaining the same, an equivalent is substituted by effusion of extravascular serum.

Dr. Burrows goes on to say that he does not regard the cranium as a complete sphere. If he does not do so, he elsewhere makes a curious statement, namely, "the whole contents of the cranium, that is, the brain, the blood, and extravascular serum, together, must be at all times nearly a constant quantity". What else, Gash, except removal from external atmospheric pressure, would necessitate this constant quantity? Do we find this constant quantity present in any other organ of the body? Assuredly not - enlargements on the one hand, and shrinking on the other, are of every day occurrence. If it were not for this exemp-

-tion, we should therefore expect to find, if not the former, at least the latter taking place within the cranium under certain circumstances, and no compensation made for the loss in bulk by fluid or otherwise.

Again Dr. Burrows asks; "If in the natural state of the parts the brain is defended from atmospheric pressure, should we not find the functions of that organ disturbed in some way, when part of the walls of this sphere is wanting"? Certain-ly not. The brain while the cranium is entire is subject to internal atmospheric pressure, if I may so speak, through the blood everywhere circulating through it; and in children with open fontanelles, and in those who have lost part of the bones of the cranium, it is also subject, like other organs of the body, to exter-nal atmospheric pressure. The press-ure from within exactly balancing that from without, there can be no dis-turbance. If this be the case, what, it may be asked, is the use of this protection

from external atmospheric pressure?

The benefits are many: I shall only mention one or two of them. This beautiful provision in nature might form a subject for a separate essay.

Were the brain not protected in this manner, congestions of blood might take place to almost any extent; and who does not perceive the evils, nay the fatal consequences, that would follow enlargement of the brain, such as we find taking place in the liver or spleen? It is generally believed that mere alteration in the molecular arrangement of its particles gives rise to derangement in the functions of the brain. If this were permitted by the unopposed enlargement of the organ, such a condition would be very frequent and, at times, excessive. Again, when blood is supplied in deficient quantity to any part of the body, it shrinks and becomes smaller in bulk. I do not now speak of genuine atrophy. Were the brain similarly circumstanced, such

would be the case with it also. An organ such as the liver or spleen, however, recovers its size and function on the circulation being restored. Such a change in the brain, however temporary, would produce dangerous, perhaps fatal consequences. I have no doubt many of the sudden attacks of convulsions, and other obscure cerebral affections in children are due to this very cause.

Further, hemorrhage may occur to such an extent as to leave the body almost exsanguine, and yet the powers of the system struggle on, and ultimately replenish the loss. If the brain were, at the same time, so depleted, which it would be, were it subject to atmospheric pressure, recovery would be impossible.

The brief consideration of the criticism of Dr Burrows on the views of Dr Bennet regarding the pathology of syncope, forms a fitting conclusion to this essay.

The morbid condition usually termed syncope, though not originating within the head, may yet be considered, in an

especial manner, the connecting link between the physiology and pathology of the circulating system within the cranium. This subject has also a direct bearing upon the views brought forward in a former part of this essay.

Dr. Burrows, after stating his own opinions respecting syncope, says; "a very different opinion has been advanced in a recent work, in which it is asserted that syncope differs from apoplexy only in the extreme feebleness of the hearts action, but the cause producing loss of consciousness, sensation, and motion, is stated to be the same in both affections. In either case, this author says, 'pressure is exerted on the brain; and that this is produced by over distension of its vessels, in the one case of its arteries, in the other of its veins'.

"Now, I believe", writes Dr. B, "so far from syncope being occasioned by pressure on the brain, it will be found that every method of diminishing vascular pressure on the brain to any great extent, from whatever cause, will almost certainly

induce syncope" Again, Dr Burrows says, "if syncope be produced by venous congestion causing pressure on the brain, would any practitioner of experience attempt to overcome syncope by the use of those remedies most likely to diminish venous congestion of the brain and the consequent pressure on that organ? Would he be bold enough to place his fainting patient in the erect posture, or draw blood from the jugular veins?

The appearances presented by the brain, after death from any cause obstructing venous return from that organ, and from diminished action of the heart, I have already said, are in many cases the same. The cause of this morbid condition, and the manner of its production, are, however, very different. The symptoms characteristic of syncope, I am confident, are, as Dr Bennet says, due in many cases to pressure on the brain from venous congestion. The same affection may, however, as I have already endeavoured to shew, be produced from a different cause, namely,

diminished pressure. The blood may exist in normal quantity and due proportion within the cranium, but from diminished momentum the pressure on it, and consequently on the brain, be less than natural.

Again, from the same cause, the blood may not only have its momentum diminished, but there may be less than the natural quantity sent to the brain, its place being supplied by extravascular serum.

Here also, the pressure on the brain is less than natural, and diminished pressure is, again, the cause of syncope.

In each of the three cases, the primary cause of the diseased condition is the same, an enfeebled condition of the heart unfitting it for its constant and ever necessary task.

Why the same cause should in different instances produce in an individual organ different pathological results, is a question I do not pretend to solve. It may arise in this instance from a healthier tone in the cerebral vessels, resisting distension, and propelling their contents, for a time, independently of diminished vis a tergo. The

treatment of this affection is in all cases the same, and is directed to the origin of the evil. There are two plain indications to be fulfilled; first, to place the patient in the horizontal posture, thus favouring the flow of blood towards the head; and secondly, to stimulate the heart to increased action. Although this is the rational treatment, and which under the circumstances is invariably practised, it may be a question, whether it is always had recourse to on rational principles, or if it is not, in many cases, practised merely as the result of experience. In the form of syncope first mentioned, Dr. Burrows, denying this form altogether, tauntingly asks; "would any practitioner of experience be bold enough to place his patient in the erect posture &c?" If he did, he certainly would take the means worst fitted, in the circumstances, to diminish venous congestion; as bleeding would only tend to lower the hearts action still further. From the structure of the cranium and the peculiarities of the circulation

there, he could not, while no blood entered by the arteries, remove any by the veins.

In this case the modus operandi is, removing pressure by applying pressure: In other words, forcing the blood through the veins by increasing the force of the circulation through the arteries, and thus restoring the natural stimulus to its transit through the veins.

I might proceed to illustrate this subject more fully, and deduce many important conclusions from the doctrine supported in this thesis; but this would be out of place in an exercise of this nature.

David H. Stirling.