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DISSERTATIONS

ON

CYNANCHE TRACHEALIS

Or Croup;

AND ON

THE FUNCTIONS OF THE

EXTREME CAPILLARY VESSELS

IN

Health and Disease;

TO WHICH WERE AWARDED THE BOYLSTON PREMIUMS

FOR THE YEARS 1820 AND 1823.

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On Cynanche Trachealis.

Cynanche Trachealis has been believed by some medical writers to be a disease of late origin; it appears to me, however, that even a very partial examination into the medical works of the ancients will prove to us that this, or certainly a complaint bearing its characteristic marks, existed long ago. I do not mean to be understood that there are any accurate or clear accounts of it in the writings of the older physicians; this we could hardly expect, had the disease been common, so little were the complaints of children formerly regarded.

Hippocrates, and others who wrote not far from his period, divided quinsy into two species; in the one there was no tumour, nor any manifest disease of the fauces and parts within view; in the other, disease here was evident to the senses. The former species they universally described as being most fatal. Aretæus, as Van Swieten states, believed it so fatal that he compared it to the mortiferous vapours, which, exhaling from damp pits or caverns in a moment, suffocate people.* In relation to it, Hippocrates remarks, "there arises an orthopnæa with a great dryness, and

* Van Swieten's Commentaries on Boerhaave's Aphorisms.

the parts within view are slender or without swelling. Likewise the posterior tendons of the neck are contracted and seem to be stretched as in tetanus. The voice likewise is disturbed or broken, the respiration is small, and there arises a frequent and violent drawing in of the breath." He likewise states that this species of quinsy often induces suffocation on the very day of its attack, and also on the second, third, and fourth. The older writers do not speak of it as being peculiar to children, which affords reason for believing that the Cynanche Laryngea might, in their time, have existed and been confounded, as it has been among ourselves until very lately, with croup.

Boerhaave describes a species of quinsy where there is no tumour, nor any manifest disease about the fauces, and which he supposes to have its seat in the trachea. His description of its symptoms corresponds very well with those which are now known to occur in croup. He likewise speaks of it as affecting the upper part of the larynx particularly, and his commentator enumerates its diagnostic marks when affecting this part, and when especially confined to the trachea. We have no reason for believing that the early writers in medicine had any idea of the false membrane so frequently witnessed in those who die of croup. Their limited knowledge, however, of morbid anatomy will sufficiently account for their ignorance on this point.

Whether the Cynanche Trachealis is of more frequent occurrence now than formerly, cannot with certainty be decided. Many more cases have been recorded of late years, but whether this is owing to

the disease being more common, or to its having excited more attention, we do not know, though we should rather be inclined to attribute it to the former cause. In some situations there can be no doubt but that of late it has become more frequent, whilst in others it may perhaps be more rare in its occurrence. In the report of the diseases of Edinburgh for December 1807, it is stated that croup at one time was a very common disease there, but that lately it had almost entirely disappeared.

Martin Ghisi, an Italian physician, appears to have been the first who gave any thing like a regular history of croup. This was written in 1749. During the same year Doctor Starr, of Great Britain, published a paper on the same complaint, in which its symptoms were pretty accurately described. He also gave the drawing of a membrane, which had been expectorated in this disease, and which seemed from its shape to have lined the trachea, and some branches of the bronchiæ. But the notions of these gentlemen in regard to the nature of the disease were quite vague and unsatisfactory, so that the treatise by Dr Home, of Edinburgh, which appeared in 1767, is now generally considered as having given the first clear account of it. In 1798, Michaelis, of Gottingen, published a paper, *De angina Polyposa sive Membranacea*, in which he gave a full and pretty accurate history of all that was then known of the disease. Since the publication of this last treatise, the complaint has excited a good deal of attention; much too has been written about it, a considerable part of which rather serves to confuse, than give us any clear notions of its nature.

Even at present we are not entirely agreed in its pathology, many physicians still believing it to be a spasmodic affection.

The disease of which we are treating is peculiar to children, who appear to be most subject to its attacks from about the time of weaning until their sixth or seventh year. It does, however, occur both earlier and later than these periods. Dr Ferriar observes that he has seen children affected with it almost at all ages under nine;* and we have well authenticated instances of its occurrence even still later in life than this. It attacks, though not indiscriminately, children of very different habits; we see it both in the healthy and robust, in the sickly and delicate. Cheyne thinks it occurs most commonly in children of very robust constitutions. Others have believed it to be more peculiar to those of a scrofulous disposition. I have heard a medical gentleman of high eminence state, that he has noticed it to occur most frequently in children of a fair complexion, and light hair, who have large heads, short necks, and naturally full round faces.† Both sexes seem equally liable to it.

After children have once been affected with croup, the parts on which it has its seat seem more ready, perhaps, as some believe, from the influence of habit,

* Medical Observations and Inquiries.

† This remark is made in his Lectures by Dr James Jackson, Professor of the Theory and Practice of Physic in Harvard University. In the four last cases of this disease which have fallen under my observation, two of very recent occurrence, these physical characters in the individuals were very strongly marked.

again to take on this diseased action; and it has been noticed that after having had frequent attacks of it, they will often after a little exposure be affected with cough, having the peculiar sound of this complaint, and slight wheezing during respiration, which symptoms soon go off, either without any remedies at all, or by the use of the common family ones. It is a very common opinion that the after attacks of the croup are more mild than the first, the danger from the disease seeming to diminish almost in the direct ratio of the frequency of its occurrence. This opinion is, no doubt, correct to a certain extent, but not universally. Parents, too, after their children have once been afflicted with the disease, detect it more readily, and being aware of its dangerous nature, call in assistance at its very onset, which seasonable attention may both shorten and mitigate it in its course.

Some instances are adduced by European writers to show that croup does at times prevail as an epidemic; but I am incapable of deciding what reliance is to be placed upon them. We certainly have no well authenticated account of its having prevailed epidemically in our own country. Some have asserted it to be contagious, but observation seems by no means to support this assertion. There occasionally appears to exist in some families a predisposition to the disease, so that at times, we find it attacking successively the different children of a whole family. In such instances there may perhaps be an hereditary weakness of the parts on which this affection has its seat.

Cynanche Trachealis occurs in almost every climate, but it is by far the most prevalent in cold cli-

mates, having a moist atmosphere, and which are liable to great and sudden alterations. In our own it occurs most frequently in the spring and autumn, those seasons during which the weather is most variable. In the winter months it is less frequent, and we hardly ever witness it in the summer. Its exciting causes, therefore, appear to be the same as those which give rise to other iuflammatory diseases in organs above the diaphragm; as catarrh, pneumonia, &c. and it has been by some observed to occur most commonly when such diseases have been most prevalent.

It was the belief of Dr Home, and many other physicians have since held to the same opinion, that this complaint was peculiar to maritime places; there is abundant evidence, however, to show that it is also common in inland situations. It has likewise been stated to prevail most in the neighbourhood of large bodies of water, and near marshy grounds. In Cheyne's Essay we find the following note—"This disease, we are informed by Dr Crawford, prevailed in the Carse of Gowrie, a plain in Perthshire, bounded by the river Tay;" but he adds, "Hæc planities vero nuper desiccata fuit, et varius occurritur morbus." The more frequent occurrence of this, as well as of other inflammatory affections in such situations, may be accounted for from the greater exposure to their exciting causes.

Croup, in some instances, appears to follow as a consequence of certain other diseases, for which reason some have divided it into symptomatic and idiopathic. It will sometimes succeed to catarrh, cynanche tonsillaris, and cynanche maligna. Dr

Ferriar observes he has seen it occur in two cases of ulcerated sore throat, and that he has seen pneumonic inflammation converted into it. In some instances it will follow measles; I have witnessed one case, which proved fatal, where it occurred in this disease. Immediately on the appearance of the symptoms of croup, the eruption disappeared, nor could it afterwards, by any means, be restored. The lungs also, were from the very first, much affected. Dr Rush says he has known it follow small pox, measles, scarlet fever and apthous sore throat. I recollect to have seen it some where recorded to have occurred in a case of yellow fever.

The proximate cause of croup is now pretty generally agreed to be an inflammation, especially seated on the mucous membrane of the larynx and trachea, but also extending into the bronchiæ, and sometimes even into the air cells of the lungs. The usual consequence of this inflammation, when continued long enough, is an effusion of coagulating lymph, which often puts on the appearance of a membrane lining a part of the air passages, for which reason it is called *false membrane*. Sometimes it is seen commencing at the upper portion of the larynx and extending even into the minute branches of the bronchiæ. It also commences at the upper part of the trachea and extends not even so far as its division. It is generally observed to be thinner in the larynx than in the trachea; but sometimes through its whole extent it is found to be quite thick, and at others very thin. Some writers have recorded instances of its being dry and even hard. It now and then has such consistence that it

may be removed entire, when it will be found to correspond in shape with the organs to which it was attached. More frequently, however, it is too soft and tender to be removed except in small portions at a time. It usually is of a whitish, or yellowish white appearance, and it has been compared to thin chamois leather. There are some anomalous instances on record in which it was dark coloured, and even quite black, also where it appeared spotted.

The adhesion of the false membrane to the mucous coat of the air passages is generally but slight, and in some instances it is partially or almost entirely detached by an effusion of purulent matter under it, which sometimes nearly fills the trachea and bronchiæ. The mucous coat of the larynx and glottis is often found to be greatly inflamed, and quite tumid, so much so as to close up the rima glottidis. Sometimes this opening is seen to be shut up by an adhesion of the lips of the glottis.

With regard to the nature of the membrane formed in croup, a variety of opinions have existed. It has been believed to be an organized substance, also to possess a fibrous structure. But the most common opinion entertained by the earlier writers on the complaint made it to be merely inspissated mucus. This seems to have been the belief both of Home and Michaelis, as well as of many others who have since treated of it. I recollect having seen in a periodical publication a similar opinion advanced by a celebrated physician in our own country. It was that the natural secretion of the parts in consequence of the inflammation, became increased, and growing inspissated from

the evaporation of its more volatile parts, the child had not sufficient strength to expectorate it. The reason offered for the disease showing itself in children rather than adults was that they possessed less power to expectorate this secretion, so that what in an adult would be only catarrh, in children would often become croup. It seems now, however, to be pretty well agreed by the best writers on the complaint, that the effused matter is coagulating lymph. But why this is poured out instead of mucus or pus, which are usually secreted on an inflamed mucous membrane, we know not. Mr Hunter thought that when inflammation of the mucous membrane of internal canals was unusually severe, this membrane took on the adhesive inflammation and poured out coagulating lymph. The inflammation does generally seem to diminish in severity as it extends down in the air passages, and the consistence of the membrane seems also to become less, and to partake more of the nature of a purulent mucus; in fact as it extends, it is often found to be gradually without any distinct line of demarkation, converted into the same matter as is secreted in catarrh; the inflammation in the lower portions of the air passages appearing, according to the above theory of Mr Hunter, to be reduced down to the catarrhal.

The false membrane we have been speaking of, is not formed in all cases of the disease. Sometimes portions of coagulated lymph only, having none of the characters of a membrane, are seen. At other times no effusion at all takes place. "In two cases," observes Dr Ferriar, "where dissection was per-

mitted, I found the internal surface of the trachea, near the larynx, affected with the most violent inflammation. The membrane so much talked of by the first writers on this disease, appeared in both of these dissections, to be nothing more than inflammatory exudation." Ghisi, Home, Bard, and others who have wrote since, relate cases of this disease which proved fatal, where the false membrane was not formed. In the New England Medical Journal, Dr Jackson has related four well marked cases of croup, all of which proved fatal, but on examination after death no membrane could be detected. The inner coat of the larynx and trachea were found inflamed and smeared over with mucus. The three first patients all died in less than forty eight hours from their attack, but the last lived sixty hours. It is made plain by the concluding observations of this paper that the rapid progress of the cases, certainly of the last, will not account for the absence of the effusion.* In the majority of cases, however, and of those in a special manner, which run their course most perfectly, the false membrane is formed.

In Cynanche Trachealis we find no disease in the fauces; the pharynx and œsophagus have also a healthy appearance. The epiglottis is occasionally a little inflamed and somewhat rigid, and sometimes there is a partial swelling about the glands of the throat. The viscera of the thorax are found in a healthy state, more especially if the complaint has been very rapid in its progress. The lungs, however,

* N. E. Journal of Med. and Surg. vol. i. p. 383.

in many cases, are much diseased. Sometimes a serous effusion is discovered in the bag of the pleura; this membrane is also at times found partially inflamed, and here and there coagulated lymph effused upon it. In the lungs themselves there is often the appearance of great congestion, and likewise of considerable inflammation; they have a solid feel, and do not recede as usual on opening the thorax. There is occasionally discovered a serous effusion in the reticular substance of these organs. In the bronchial tubes and air cells there is generally found a large quantity of purulent matter, often combined with mucus. The heart is usually healthy in its appearance; instances, however, have been recorded of considerable serous effusion in the pericardium. The viscera of the abdomen have commonly their natural look; if the disease, however, lasts long, they may from sympathy become affected. Dr Farre, in a volume of the Med. Chirurg. Trans. relates the history of a rapid and fatal case of croup, in which, on dissection, the stomach was found to be extensively acted upon by the gastric fluid, and in many places in a state of dissolution.

Death in croup may be induced in various ways. It may occur in the stage of inflammation, even before any effusion has taken place, from the violence of the constitutional sympathy either completely exhausting the living powers, or bringing on convulsions in which the child expires. It may also take place from asphyxia, induced by the inflammatory swelling of the lips of the glottis closing up the rima glottidis. Death is probably brought on in this way in most of those fatal cases of the disease where, on examination, no

effusion can be seen. In the last stage, or that following effusion, the child often dies from exhaustion, which takes place in consequence of blood, that has undergone only a partial change in the lungs, being circulated through the system, as well as from the great efforts made to carry on respiration. The rima glottidis may also in this stage be closed by the effusion on, or swelling of the lips of the glottis. In the first case, there is sometimes perfect adhesion. Sometimes life is destroyed by an accompanying pulmonary affection, even after the difficulty in the larynx and trachea has been removed. Disease in the lungs will always aid much the other causes of dissolution. When much effusion takes place in the bronchiæ and air cells of the lungs, it is plain that air cannot be received so as to effect the necessary change in the blood, the consequence of which must be asphyxia.

The false membrane may, in some instances, so completely close the air passages as to prevent the admission of air to the lungs, but this I conceive is not common. The aspect of the corpse will, for the most part, show whether the child died from suffocation. If death were thus induced, the face will be livid and swoln, the eyes protruded, the muscles rigid, and the whole appearance exhibit marks of violent struggling. "I once," observes Dr Ferriar, "attended the inspection of a fine boy, who had died of the croup, and I observed his struggles had been so violent, that the corpse rested in a great measure on the hind head and heels."

Symptoms. The Cynanche Trachealis sometimes makes its attack very suddenly, there having been no

previous symptoms of illness. More frequently, however, the child seems unwell for some days before; he is uneasy, fretful, and his countenance becomes changed from its wonted healthy look. There is occasionally a slight cough, with some dyspnæa, also loss of appetite, thirst, drowsiness, and often more heat on the surface than natural. These appearances very commonly last for some days, when the symptoms of croup suddenly show themselves. Sometimes the disease comes on after a catarrh, even of some weeks standing; and, as has been before stated, it will at times succeed to, or be combined with other complaints.

To aid us in describing the symptoms of this affection, we shall—following Dr Hosack—divide it into three stages; the first, or forming, stage, where the affection is merely local; the second, or inflammatory, where the constitution sympathises with the local affection; the third, or post-febrile, in which effusion has taken place.

In the first, or forming stage, the complaint, to an inexperienced observer, would not generally appear to be very serious, and might easily be mistaken for a slight catarrh only. Even the countenance of the child is not much altered, and sometimes its expression is indicative of perfect health. During this stage, often in the morning and fore part of the day there takes place an evident remission of the symptoms, at which times the little patient frequently becomes playful, and sometimes even morbidly exhilirated, so that the physician is very apt to be deceived in regard to the nature of the complaint. These remissions, however,

do not last long, but the symptoms soon return, and generally with increased violence.

In this stage the heat on the surface is but little, and sometime scarcely at all increased, and the pulse are but slightly accelerated. The appetite, too, often remains unimpaired. There is a manifest difficulty, however, in the respiratory function; we observe an effort, on the part of the patient, to carry on respiration, accompanied by an unnatural sound. It is difficult to describe this sound so as to give any clear idea of it, yet it is so peculiar that it is seldom mistaken after having been once heard. Writers on the disease have compared it to the noise made by air passing through a brazen tube, and through muslin. It appears to be produced by air rushing with uncommon velocity through the air tube, which, in consequence of the inflammation, has become narrowed, and unusually rigid. It is most evident during inspiration.

The voice also becomes much changed, and as the disease progresses, this change grows more and more evident. It is shrill, hoarse, or squeaking, approaching in its sound, as was remarked of it by the ancients, in the worst species of quincy, to the noise made by singers when they try to raise their notes beyond the compass of their voice. Some have likened it to the crowing of a cock. It certainly partakes, in a considerable measure, of the sound of the respiration. At times, especially when the disease is much advanced, the child cannot raise his voice above a whisper. The alteration in it is probably owing to the swelling and rigidity of the lips of the glottis.

A cough also comes on in this stage, the sound of which has been compared to the barking and yelping of young puppies. It resembles much the sound of the respiration and voice. During the act of coughing, there is commonly expectorated in small quantity, a transparent, glairy mucus. Sometimes the cough is almost perfectly dry. This stage will occasionally continue even for a day or more, but usually in a shorter period the symptoms of general inflammation came on, which, as we should naturally suppose from the disease being seated on parts so essential to life, are greatly disproportioned to the local affection.

In the second stage of croup all the symptoms become more aggravated, and the constitutional affection is now very evident. The respiration grows more difficult, is performed at shorter intervals, and its peculiar sound, together with that of the voice and cough, are more strongly marked. The pulse are more accelerated, and usually full and hard. The skin is hot and dry, the face flushed, often partially swollen, and has a livid appearance. The eyes seem protruded, as if starting from their sockets; are suffused with blood, and have a glaring brightness, and the whole countenance exhibits marks of extreme suffering. If the child is capable of expressing his sensations, he will often complain of heat, and a painful feeling in the larynx, or its immediate neighbourhood. This pain is increased by pressure, and is sometimes felt only when the larynx is pressed upon. Occasionally there is a sense of uneasiness about the affected parts, seemingly not confined, or even referrible to any particular spot. The fauces, if they

can be examined, will almost always appear healthy, and deglutition is not accompanied with any uneasiness. There is generally a thin white or yellowish coat on the tongue; commonly great thirst, and total loss of appetite. The urine is passed in small quantities, is limpid, and high-coloured. The bowels are, for the most part, costive, and when discharges do take place, unless provoked by medicine, they are generally small in quantity, and exhibit an unnatural appearance.

Occasionally slight delirium manifests itself in this stage, yet it hardly ever lasts long, the patient here, as in the other acute inflammatory affections of the respiratory organs, generally retaining his mental powers, and at times, even in their full vigour, to the last. Pain is frequently felt in the head, and there occurs, now and then, a spontaneous vomiting of offensive matter from the stomach, often affording some temporary relief.

As this stage continues, the symptoms go on increasing in severity. The breathing grows still more difficult, and the cough becomes more frequent and distressing. The patient tries to assist respiration by assuming different postures, and calling into action all the different muscles that can aid this function. During his struggles for breath, he throws back his head, thus in some degree, probably, by lengthening out the trachea, increasing its capacity for air. In the excess of his agony there is scarcely any position that he does not assume to get relief; from the lap he goes to the cradle, and from the cradle to the lap, but no position satisfies him, for none affords relief to his sufferings. Sometimes, if old enough, he will start

suddenly, and run, or attempt to run towards the door, or some other part of the room, seeming hurried, and to be anxious to attain something, but what, he does not himself appear to be perfectly aware. It is air of which he is in search. Frequently, from the severity of the constitutional sympathy, and probably also from blood partly venous circulating through the brain, the little patient becomes drowsy, but if he chances to doze, he suddenly starts from his slumber, apparently almost suffocated, gazes wildly about, stretches out his arms, and in a manner the most pitiful and trying to our feelings, seems to implore assistance. At such times the sweat, from the severity of suffering, will often stand in drops about the face, which exhibits an apoplectic appearance. Remissions in this stage are not common, and when they do occur, are very imperfect, and short in their duration. Symptoms of general inflammation continue for the most part unabated till effusion takes place, after which the third stage may be said to have commenced.

In the third and last stage of Cynanche Trachealis, the inflammatory symptoms subside, and those of irritation come on, combined however occasionally, with signs of inflammation. The pulse almost always become smaller and more feeble, the heat on the surface is also diminished, and a moisture often breaks out here. At the commencement of this stage, respiration is frequently performed with more ease, but this relief is of short duration, the difficulty soon returning with all its former violence. The patient still continues to make all the exertion of which he is capable to carry on respiration, but the living powers are now much

exhausted, consequently his efforts are more feeble, and there is a longer interval between them, seemingly to give time for the accumulation of sufficient vital energy for a new effort to respire. The lips in this stage become quite purple, and a livid paleness overspreads the whole countenance. The cough continues, and often with such severity as nearly to exhaust the little strength remaining. In some instances a substance has been expectorated, in small portions, resembling coagulated lymph ; this expectoration, however, is not common. Sometimes there is apparent difficulty in deglutition, owing, probably, to the delay this action produces in the performance of respiration. The urine becomes increased in quantity, and a copious sediment is deposited from it. As the stage advances, jactitation comes on, the child also becomes comatose, and at times a low muttering delirium manifests itself, during which he appears hurried, but from this state he can generally be aroused. The tongue and whole mouth are often much coated, quite foul, and the breath fetid. A diarrhæa, and profuse sweats sometimes make their appearance, soon closing the scene.

The patient seldom holds out long after this stage has commenced, and the younger he is, other things being equal, the sooner is death induced. As the fatal termination approaches, the countenance has a deathly hue, or is hippocratic, the pulse increase in frequency, are small and fluttering, the respiration is irregular, and performed at still longer intervals, a cold, clammy moisture breaks out over the body, the extremities grow cold, and the little sufferer expires. Death may

take place at any period of this stage from suffocation, when the child is carried off in violent struggles. Frequently before death the cough will wholly cease, the respiration also will seem to be performed with more ease, and without the peculiar sound which before accompanied it; but the livid paleness of the countenance, the small, frequent, fluttering pulse, and the coldness of the extremities, show us too plainly the fallaciousness of these symptoms.

Sometimes in this stage of the disease, the child will be suddenly relieved, respiration will be performed with much comparative ease, and it is said that in some instances he even becomes playful, but on a sudden the difficulty returns with increased severity, and he dies with every symptom of suffocation. This has been explained by supposing a portion of the false membrane to become detached, and after a certain time to be forced by the air into such a situation as, like a valve, to close up the air passage.

It is stated by writers on the disease, that the stage of effusion does occasionally last for days, or even weeks, the patient every little while expectorating portions of the false membrane, and ultimately recovering. Sometimes through the whole disease, great insensibility to the action of medicines is witnessed. In the 29th vol. of the London Medical and Physical Journal, there is recorded a case, in which, in the space of forty eight hours, a boy of two years old took forty-nine grains of antimonial powder, and in less than three days, forty-seven grains of calomel, and the bowels were never opened more than twice any day

during the disease, the salivary glands not at all affected, and the breath not in the least tainted.

On the prognosis in croup little needs be said. If we see the patient in the first stage, there will be a pretty good chance of effecting a cure, and the earlier we are called to him in this stage, the greater will the probability be of our success. If the physician is not called in until the second stage, the cure becomes quite doubtful, and the longer it has continued, the smaller is the chance of success. There are instances, however, recorded, where the disease had continued, so long as two days, and still a cure was effected, and apparently by resolution. We must be greatly influenced at any period, in forming our prognosis, by the severity of the symptoms.

Though when effusion has taken place, we can scarcely hope for a recovery, yet, in some rare instances, the effused matter, or false membrane, has been expectorated, and a perfect restoration to health followed. Some instances are recorded where the membrane was expectorated entire, but it has been oftener coughed up in small portions at a time. Recovery does by no means always follow its expectoration, for it is plain that when the disease is extensive, and the lungs much affected, this can do but little good. The disease too may have so exhausted the living powers, that even should the cause of the disorder be removed, its effects on the system could not be recovered from. Cheyne, in his Essay on the complaint under consideration, gives a case in which the membrane completely formed, was coughed up twice, and still the child died. In this last stage, as well as through the

whole course of the disease, we must be much governed in forming our prognosis, by the respiration, pulse, and general powers of the patient.

Diagnosis. In the first place we will attempt to point out the distinctive characters between croup and cynanche laryngea. It was not until very lately that a line of distinction was drawn between these two diseases; the ancients probably described them both under that species of quinsy, *sine apparente tumore.* Boerhaave and his commentator both remark, that a quinsy from inflammation of the windpipe is attended with the greatest danger when the seat of it is especially about the larynx and its muscles. In such cases, too, they also notice that there is great pain and difficulty during the act of deglutition, which symptom is not mentioned by them as occurring when the disease, in their belief, principally affects the trachea.

Within a few years cynanche laryngea has excited in Europe a good deal of interest, much of which was at first owing to the circumstance of two distinguished physicians* having died of it at about the same period. Instances of it have also occurred in our own country, and the two first on record, in individuals whose names are intimately connected with the history of our country.†

Late dissections have shown that the cynanche laryngea differs considerably from croup. Many of its symptoms, too, are different, as well as the subjects whom it attacks.

* Dr David Pitcairn, and Sir John Macnamara Hayes.

† George Washington and Samuel Dexter.

Cynanche laryngea attacks, so far as observation has extended, only adults, and it has generally made its appearance in persons somewhat advanced in life. Cynanche trachealis attacks children only, or those under the age of puberty, and we have no well marked case on record of its occurrence in the adult. Both these affections appear to be produced by the same, or nearly the same exciting causes, and they are both attended with great danger to life. Many symptoms, too, are common to them both.

Some have asserted that in cynanche laryngea there is pain felt in a small spot about the larynx, but that in croup there is rather a diffused sense of uneasiness, or the pain is more extensive. Little dependence, however, can be placed on this diagnostic mark, for in the former affection there is generally rather a sense of uneasiness about the larynx than acute pain, and in the latter, when there is pain in the affected parts, it is most usually referred to the larynx or its immediate neighbourhood. As in cynanche laryngea the inflammation about the parts which are immediately concerned in forming the voice, is generally more severe than in croup, the disease being more concentrated in the larynx, we should infer, *a priori*, that the voice would be more uniformly, and in a greater degree affected. In some of the few cases recorded, we find it noticed that the patient was unable to raise his voice above a whisper, and in all that great pain accompanied efforts to articulate, so that the patient endeavoured to avoid speaking as much as possible.

The sound of the respiration differs somewhat in this disease from that in croup; nor is the breathing so difficult at its commencement, but it goes on increasing in difficulty, even with greater rapidity than in the last mentioned disease. In all the cases of cynanche laryngea which have been given to the public, difficulty of deglutition accompanied the other symptoms, owing to an inflammation and swelling of the fauces.

Different morbid appearances are exhibited in these diseases after death. In cynanche laryngea, the fauces are somewhat inflamed and swollen. The uvula, and velum palati, are often found œdematous, and at times, the tonsils likewise. The upper and fore part of the pharynx are inflamed, and this inflammation is found extending on the mucous membrane common to these parts, to the epiglottis, glottis, upper part of the larynx, and sometimes, though with abated severity, to the trachea and bronchiæ. It would seem that the inflammation commences in the pharynx, because difficulty of deglutition is noticed as one of the first symptoms, showing itself before the respiration becomes manifestly affected.

In those who have died of cynanche laryngea, serous effusion has generally been found in the cellular membrane behind the larynx, and also under the mucous membrane of the glottis and upper part of the larynx. The epiglottis, too, is occasionally œdematous. Sometimes coagulable lymph is effused on the mucous membrane of the glottis. Now in croup, as may be seen by referring to its proximate cause, there is no disease of the fauces or pharynx, there is

no serous effusion, or certainly it is more rare in the cellular membrane of the affected parts. The inflammation is more extensive, and likewise more severe in the trachea, where is usually found a false membrane, and generally more purulent effusion in it and in the bronchiæ, than in cynanche laryngea. The lungs, too, so far as observation has extended, are more frequently affected in croup.

In cynanche laryngea, death from suffocation is more common than in cynanche trachealis, the rima glottidis becoming so closed, either in consequence of the inflammatory swelling of its mucous membrane, of the œdematous tumour, or from adhesion following the effusion of coagulable lymph, as to obstruct the passage of air to the lungs. From the accounts we have had of cynanche laryngea, it would seem that, for the most part, it runs its course more rapidly, and is more fatal than croup.

There are two other species of cynanche with which croup may possibly be confounded; they are the cynanche tonsillaris, and cynanche maligna.

First, *Cynanche Tonsillaris.* The seat of this disease is in the fauces, but when severe it extends, also, to the pharynx, and even to the œsophagus. On inspecting the fauces, the tonsils will be seen swollen, and of a more florid red than usual; sometimes one only is affected, at others both. All the parts about the fauces look inflamed and somewhat tumid, and often have portions of coagulable lymph effused on them, exhibiting the appearance of ulcerations. The tongue, too, at times, becomes much swollen. In some instances in which the disease is very severe, the tongue and

fauces are so much swelled that it is with much difficulty that the air can pass to the larynx, and even suffocation may be induced from this cause. In the external fauces considerable tumour is usually manifest to the feel. Now in cynanche trachealis none of these phenomena are exhibited, but as in young children we cannot always examine the fauces, we are often under the necessity of distinguishing the diseases by their symptoms only.

In mild cases of cynanche tonsillaris the respiration and voice are but very slightly affected; as the disease, however, increases in severity, the affection of these becomes more strongly manifested. But the respiration is never accompanied by that peculiar wheezing noise which is the attendant of croup; the voice also is hoarser, and has not the shrill sound of this last disease. It has been remarked that in cynanche tonsillaris the patient speaks and breathes as if there was some foreign substance in the mouth, partially obstructing the air in its passage through it, and giving it a direction through the nasal passages, thus the patient often seems to speak, as is commonly expressed, through his nose. The peculiar cough of croup is also absent in this species of cynanche. Great difficulty and pain attend deglutition, especially when the patient attempts to swallow his saliva, or foreign liquids, so that much distortion of the countenance is frequently witnessed during this act. This difficulty is increased when the individual lies on his back. In croup, deglutition is not attended with any difficulty until a late period of the disease, and then the difficulty arises from a cause altogether different.

In common cases of cynanche tonsillaris, the constitutional affection is quite mild, and the symptoms of general inflammation are hardly ever so violent as they are in croup. When the inflammation of the fauces extends to the larynx and trachea, as sometimes happens, symptoms of croup, of course, show themselves.

Second, *Cynanche Maligna.* Nearly the same marks distinguish this as the former disease, from cynanche trachealis. The fauces are inflamed and swollen, in addition to which, there is ulceration and sloughing of these parts, giving rise to a disagreeable fetor of the breath. The stomach also is much disordered, and the tongue and mouth very foul. The powers of the system are more prostrated, and delirium is more frequent than in croup. The cynanche maligna often prevails as an epidemic, and at such times is much more severe than when sporadic, so that there is hardly a possibility of mistaking it for croup. The inflammation in this disease may also extend to the larynx and trachea, inducing symptoms of cynanche trachealis. "In the unfortunate circumstance," observes Dr Ferriar, "of the croup's supervening to the ulcerated sore throat, from the extension of inflammation to the trachea, it is extremely difficult to direct our practice, and if the symptoms of croup run high, it becomes scarcely possible to save the patient. To discontinue the bark, while the ulcerations are gaining ground, would be to devote the patient to certain death, and general bleeding is expressly prohibited by the same circumstance. Large blisters to the throat, leeches and repeated emetics, are the only means of

relief reserved to us; and I must own, that I have found these ineffectual, in this perplexing coincidence."

Acute spasmodic Asthma of Children. This disease seems to have been very commonly confounded with croup, and in fact, until very lately, there appears to have been no accurate line of distinction drawn between them; which may in part account for the division of croup into a spasmodic and inflammatory species, so frequently met with. Many physicians even now do not seem fully aware of the different nature of the two affections. Dr Rush at one time thought them to be the same disease; he afterwards, however, treated of them as distinct. The diagnosis here, is unquestionably difficult, yet a careful attention to the different symptoms of each, will in a great measure do away this difficulty.

Acute spasmodic asthma and croup affect children at about the same age, and they are not unfrequently produced by similar exciting causes. Dr Rush, and some others, state that this species of asthma, like croup, most usually makes its attack in the night. It generally, however, comes on more suddenly than croup, at times the symptoms appearing almost instantaneously. The difficulty of respiration, which is for the most part very great, seems almost at once to arrive at its height, whereas in croup it is at first slight, and goes on in a more gradual manner to increase. The respiration, also, is more rapid, certainly, than at the commencement of the last mentioned disease. The breathing is often accompanied by a wheezing noise, but it is not usually so loud as

in croup nor has it the peculiar shrill, clangorous sound of that disease. Occasionally a cough is present, but it differs somewhat in its sound from that of croup, so that it may be readily distinguished by one accustomed to witness the two diseases. The voice is described as being dull and hoarse, rather than shrill. The patient also breathes better in the sitting posture with the head bent forward, but in cynanche trachealis the head is generally thrown back to get relief. The remissions, too, or perhaps they may with more propriety be called intermissions, are generally more perfect, frequent, and regular.

The constitutional affection in acute spasmodic asthma is by no means so constant, nor so violent as in croup; neither is any pain induced by pressure upon the larynx.

The entire relief often given in this disease by a spontaneous vomiting of undigested food, and the immediate good effects following the action of emetics, would lead us to infer that it originates in many instances from a disordered state of the digestive organs. According to the observation of some authors, it now and then takes a chronic form, continuing for weeks, or more, with frequent and well marked intermissions. In some instances it appears like a family complaint, the younger members being very subject to its attacks, especially from any irregularity of diet, or undue exposure; in such cases, however, the diagnosis becomes much less difficult. It is pretty generally allowed, that there is no false membrane formed in it. Dr Rush, in the first volume of his Medical Observations and Inquiries, gives the dissection of a

case, in which the larynx, trachea, and lungs were found perfectly healthy.

Catarrh. The proximate cause of this disease is an inflammation of the mucous membrane of the nasal passages, extending back into the fauces; and if severe, into the larynx, trachea, bronchiæ, and even air cells of the lungs. The same parts then, which are affected in croup, here take on diseased action, and they are both inflammatory complaints. In catarrh, however, the inflammation is usually quite mild, and it also goes through different processes. We observe in it only the ordinary phenomena consequent to inflammation of a mucous membrane; an increase of the natural secretion of the parts, or a secretion of pus. But in croup the inflammation seems to diminish or check the natural secretions, and in their stead a new matter, or coagulating lymph, is commonly poured out. As the complaints differ in their proximate cause, so do they in their symptoms. In catarrh, except when it prevails as an epidemic, the constitutional affection is quite mild, and even in its epidemic form, it is seldom, if ever, so severe as in well marked cases of croup. An attention, however, to the respiration, voice, and cough will enable us most readily to distinguish it from this latter disease.

Though in catarrh a wheezing often accompanies the respiration, yet it differs from the respiration of croup; it is neither so hard nor shrill, but rather gives the idea of loose matter, partially obstructing the passage of air. The increased secretion of mucus, also, about the nasal passages does not admit the air to pass freely through them, from which cause the peculiar

noise which we call snuffling, arises. Sometimes they seem almost entirely obstructed, more especially after the patient has been asleep, the mucus then having become accumulated and inspissated. Now in cynanche trachealis there is no obstruction to the air above the larynx.

In catarrh the respiration is less rapid than in croup, and there is often a sense of fulness or oppression about the pulmonary organs, but no symptoms of any mechanical obstruction to their functions. When the larynx is affected, the voice becomes dull and hoarse, but not shrill as in croup. The cough when present differs from the hard, barking cough of this latter disease, it being attended with a rattling noise. There is also expectorated a proper mucus, or a purulent mucus, and in large quantity, whereas, in croup, a thin, glairy mucus is coughed up, and in very small quantity.

Pneumonic Inflammation. In inflammation of the lungs there is pain, and a feeling of oppression in the chest, accompanied, also, by a manifest difficulty in the respiratory function. These symptoms are often much augmented by certain postures of the body; thus they will generally be more severe when the body is horizontal, than when the head and shoulders are so raised that the chest forms an inclined plane. Sometimes the breathing is easiest in the erect position. In some cases the patient can only lie on one side with any kind of ease, in others only on the back. In croup the child throws himself into almost every position without obtaining any relief; at least no farther

than as one may favour the action of more muscles in aiding respiration.

In pneumonic inflammation, the breathing is shorter and more rapid than in croup, and the sound accompanying it is altogether different, approaching that which often follows a sudden blow on the chest, or epigastric region. There seems to be no mechanical obstruction to the air in its passage to the lungs, as in the latter disease; the effort on the part of the patient to carry on respiration is apparently but slight, yet by observing him attentively, we perceive that he breathes short, and with a degree of timidity, seeming afraid to take a full breath; and if at any time the attempt is made, checks himself suddenly as if from acute pain.

The cough, also, differs from that of croup. As coughing produces considerable pain, the patient makes evident attempts to avoid, or check it, and during a paroxism, exhibits signs of much suffering. Its sound, too, is very different, having none of that peculiar shrillness attending the cough of croup.

There are instances recorded of polypi forming both in the larynx and trachea. They are distinguished from croup by the gradual manner in which their symptoms come on, and the comparative mildness of the constitutional sympathy. The peculiar sound, too, attending the respiration, voice, and cough in croup, is here absent. It has been observed, likewise, that the breathing is free at certain times and difficult at others, and that occasionally after an expiration the patient seems to be suffocating, but becomes immediately relieved by an inspiration.

Foreign substances received through the mouth, into the larynx and trachea, may give rise to symptoms analogous to some which occur in croup, so that an inexperienced observer, not aware of the accident, might, in some instances, be led by them into a serious, and even fatal error. Michaelis thought the diagnosis here to be attended with much difficulty, and Dr Home mentions an instance related to him of a foreign body received into the trachea, which, from the similarity of the voice, was mistaken for croup.

When an extraneous substance is received into the air passage, the symptoms are more or less urgent, and varied, according to its nature, size, and situation. But we may, in almost every instance, distinguish such a case from cynanche trachealis by the following marks. The symptoms make their appearance in a very sudden manner, the respiration at once becoming extremely difficult, and at the same time there is a violent convulsive cough. The repiration and cough, however, both differ from croup, being usually attended by a kind of hissing and rattling in the throat. The voice generally becomes hoarse, but is less shrill than in the last mentioned disease, and sometimes it entirely fails. There is difficulty, too, in deglutition, this act often producing great distress. We occasionally observe, after the foreign body has remained some time in the air tube, an emphysematous tumour above the clavicle. I do not know that this appearance is ever witnessed in croup. If the substance is loose in the trachea, it will often be felt by the patient to change its situation; the seat of the pain, too, will become altered, and at times the symp-

toms have evident remissions, the cough and difficulty of respiration occurring at intervals only.

Dr James Jackson speaks, in his lectures, of a peculiar affection, of which he had witnessed two cases, attacking children, and almost exactly resembling croup. In both of these, the symptoms were so similar to those of croup as to deceive him with regard to the nature of the disease. The patients continued sick for some weeks, but finally recovered. The diagnosis of such cases must of course be difficult or almost impossible.

Dr Ferriar has distinguished the genuiue from what he calls the spurious croup. "Children," says he, "who are subject to attacks of the croup, are sometimes seized with the deep, barking cough, which will increase to such a degree as to create much alarm about the usual time of the dangerous exacerbation, yet it will decrease again, and at length go entirely off, without any other remedies than common demulcents." Such cases as these are supposed by him to have been described as genuine croup, and to have been the occasion of the use of trifling remedies in the disease. The diagnosis is to be drawn from the following circumstances. The cough in this spurious kind of croup, is different; it has not the shrill whining sound of the genuine disease, but is hoarser, and has longer intervals. There is less difficulty also manifested in the respiration, and it has not the sound peculiar to croup, the affection of it seeming more like a common dyspnæa. "The spurious croup is not attended with restlessness, trembling, and palpitation of the arteries, which characterize the other. I must

observe, however, that these distinctions are only to be learned, from much attention to the different cases of the disease; for the sound of the cough is so similar in both, as to inspire even the most experienced with some degree of doubt. I have sat by the child's bedside repeatedly, watching for the moment of danger, while the cough was increasing in violence; and have been only undeceived, by finding that no tremor or palpitation came on towards midnight, that the restlessness abated, and that sleep seemed to become more composed."*

Some writers have thought it necessary to point out the distinguishing characters between croup and some other diseases which we have not noticed, among which are hooping cough, hydrophobia, and hysteria; but the line is so distinctly drawn here, that it would seem almost impossible for any physician having a tolerable acquaintance with his profession to mistake these for croup.†

* Medical Histories and Reflections.

† In the Med. Chirurg. Trans. vol. 12th, part 1st, Dr Marshall Hall has published four cases of an affection which was produced in children by their attempting to drink through the spout of a tea-kettle containing boiling water, having symptoms similar to those which occur in croup. Out of the four cases recorded by him, one only recovered. Bronchotomy was performed in one instance, and gave immediate, and very manifest relief. The patient died, however, in about thirty four hours after the operation, exhausted, as was thought, by the irritation from the primary affection. On dissection of this case, the epiglottis was discovered to be swollen, blistered and corrugated, and the internal mouth, tongue, and fauces affected in the same way. A little mucus was seen in the larynx, but no morbid condition of the stomach or œsophagus. The trachea was not at all inflamed.

Treatment. The pattralogy of croup which has been given by the latest and most distinguished medical writers, and of which we have already spoken, shows it to be a disease of inflammation in the strictest sense of the term. Our indications of cure then are strictly antiphlogistic.

I feel persuaded that serious errors in the management of this complaint have often arisen from the belief in its spasmodic nature, and that Dr Ferriar does not err from truth when he says, "many valuable lives have been sacrificed to the imaginary powers of assafœtida, or small repeated doses of antimonials, from unfounded theories of spasmodic constriction attending the disease." He believes croup to be as strictly an inflammatory complaint as pleurisy, or peripneumony, and to be equally free from spasm. Many physicians, undoubtedly, who have viewed croup as a spasmodic affection, have, from not duly attending to its diagnostic marks, confounded it with the acute spasmodic asthma of children, a disease, as has been already shown, very different in its nature. But even admitting its pathology to be doubtful, it would be much the safer way to treat it as an inflammatory disease, since it is well known that our antiphlogistic remedies act powerfully as antispasmodics; but the reverse of this is not true, for the greater number of antispasmodic medicines in common use, not only

In an appendix to this article, Edward Stanley Esq. relates two more cases of this affection, each of which exhibited the symptoms of croup. They both proved fatal. In one, the interior of the mouth, the fauces, pharynx, and the œsophagus, to within a short distance of the cardiac orifice of the stomach, manifested the common appearances of a scald.

do no good, but their employment is attended with much danger in inflammatory affections.

The disease of which we are treating has its seat on organs in the highest degree essential to life, and its whole force is generally concentrated in a very small space. It runs its course, too, with great rapidity. Our remedies, therefore, should be prompt and powerful; the delay even of a few hours may be attended with the most fatal consequences, and to tamper with inefficient remedies is sure death. The words of Hippocrates, "*Ad extremos morbos, extrema exquisite remedia optima esse,*" may be well applied to this disease.

General Bloodletting. To effect a cure in croup the course of the inflammation must be checked; and what remedy have we so likely to do this, as general bloodletting? This then should generally be our first remedy employed, for we are seldom called to the child so early in the complaint that it can safely be dispensed with; ignorant and officious friends too frequently tampering with common family medicines until the inflammatory symptoms appear with all their violence. Under such circumstances, bleeding is most urgently demanded, and is the remedy upon which we are to place our chief reliance.

The ancient writers on medicine, in treating of that species of quinsy which corresponds with our definition of croup, have agreed almost universally, that bloodletting is the sole remedy upon which we can rely for a cure. Hippocrates and Galen, both strongly urge its employment. Aretæus advises that the blood be taken from a larger orifice than usual, and in such

quantity as nearly to produce fainting. Among the medical writers who come nearer our own period, we find Boerhaave strongly insisting on this practice. In Aph. 809, referring to this kind of quinsy, he observes, "In the first place a speedy, large, and repeated blood-letting, must be put in practice, until the weakness, paleness, coldness, and collapsion of the vessels, denote that the remaining strength is not able to increase the tumour and turgescence, or rigidity of the vessels." "That kind of inflammatory quinsy," observes Van Swieten, "which is seated either in the windpipe itself, or about the larynx, is of all the worst and most suddenly fatal, and requires the most efficacious remedies to be applied at one and the same time." Among the first and principal of which, he ranks bloodletting. He recommends the blood to be drawn until the patient faints, and if the threatening symptoms return, again to have immediate recourse to it, the disease admitting of no delay; since, as he remarks, "It is much better for the patient to languish some time by a loss of blood, than to be unhappily suffocated." Home, Cullen, Michaelis, and many others of note who have written on the disease we are treating, speak most decidedly in favour of this remedy. If, then, we are called to the patient at any period previous to the last stage of the disease—perhaps with the exception of the early part of the first stage—we should begin our treatment with general bloodletting.

In relation to the quantity of blood to be taken, it is impossible to state any certain and invariable rule, as this must be varied according to the age of the patient, his habit of body, the severity of the symp-

toms, and length of time they have lasted. In a child from two to six years of age, a quantity of blood varying from five to eight ounces, taken at once, would be a pretty free bleeding.

In the first stage of croup it will not often be requisite to employ bloodletting to the same extent, as when symptoms of general inflammation are present. But even in this stage, especially if the child is robust and plethoric, and the difficulty of respiration considerable, we should let blood pretty freely. When the patient is not seen until the sympathetic inflammation has occurred, more especially if it has continued for any length of time, runs high, and is attended with great difficulty of breathing, we ought to bleed even till fainting is induced, as under such circumstances the child's safety seems to depend in a special manner on the result of this remedy. It is almost universally allowed that in acute inflammations, more particularly where it is so important to produce a speedy effect on the disease, that the blood should be drawn from a large vessel and from a large orifice.

It is not unusual to meet with considerable difficulty in obtaining blood from young children in sufficient quantity to be of service in this disease, their veins being small, and, for the most part, lying deeply imbedded in adipose substance. "In the case of young children," says Dr Ferriar, "we must almost despair, for it is extremely difficult to procure any blood from them by the lancet." Generally, however, we may obtain considerable blood from the veins on the back of the hand, if we immerse it in warm water, but still more reliance can be placed on the jugular

vein. There are, in fact, several reasons which should, on a general principle, induce us to give the preference to this last. It is the most prominent of the superficial veins, and can consequently be opened with the greatest facility. Commonly, too, from its greater size, the blood may be drawn more rapidly, and in larger quantity than from any other. And perhaps there may be some advantage in taking this fluid from the immediate neighbourhood of the diseased organs. To be sure there have been objections urged against it. The operation has been thought hazardous in consequence of the extreme restlessness of the patient in this disease. It has been urged, too, that we cannot always ascertain the exact quantity of blood taken, it being difficult from the situation of the vein to receive it all as it flows. There has been supposed, likewise, to be constant danger of the orifice made in the vein being opened afresh by the child's continued motion and violent fits of coughing. And finally it has been opposed on account of the unpleasant effect it produces on the by-standers. But there seems to be little force in these objections. It can be no very difficult matter for one or two attendants to keep the child quiet for so short a time as the operation will occupy, and the vein is so large and prominent that it may readily be opened by any one possessing a common share of surgical skill. The blood, as it flows, may be received in a sponge, or in small vessels, as teaspoons, or teacups, so that the quantity may be pretty accurately ascertained; and by bringing the lips of the orifice together, with common adhesive or court plaster, they very soon became united so as to

be out of all danger of being forced open; or if they are, the bleeding may be very easily checked by slight pressure over the opening. The effect the operation may have on the feelings of the by-standers, when compared with the welfare of the individual, scarcely deserves any consideration; still this may be much lessened by doing the operation neatly, having a care to receive all the blood as it flows, so that it may make as little show as possible.

Sometimes after one full bleeding, all the dangerous symptoms subside, and the little patient, who, a short time before, seemed every moment about to suffocate, now breathes easily, and appears nearly restored to health. Still he is far from being secure, as the symptoms, in spite of these propitious signs, not unfrequently reappear, and sometimes even with increased violence. If the threatening symptoms subside in a considerable degree after the first bleeding, it will not be requisite to repeat it, unless they return; still it ought to be followed by other remedies about to be mentioned, which should be continued as long as we conceive there is any danger of a recurrence of the disease.

If by the first bleeding in combination with the other remedies, the symptoms are not mitigated, but remain the same, continue to increase in violence, or even should they subside only in a slight degree, it ought to be repeated, in fact even to the third and fourth time, if the urgency of the symptoms require it and the strength of the patient will admit. A knowledge of the rapidity of the disease makes it plain to us, that to gain benefit from this remedy, it must be

repeated at short intervals, as of six or seven hours, or oftener if the violence of the symptoms demand. Of course we cannot safely continue to take so large quantities of blood as at the commencement of the treatment; the physician, however, must be guided here by the general powers of the child, and the urgency of the symptoms.

Local Bloodletting. In cynanche trachealis, this is a remedy of great value, especially as the strength of the child may become so exhausted from the violence of the constitutional sympathy, and from the first general bleeding, as to render the repetition of this dangerous, although the inflammatory symptoms continue; under such circumstances we must rely principally on local bleeding. A small quantity of blood, drawn from the capillary vessels in the immediate neighbourhood of an inflamed part, will not unfrequently have as great an influence on the disease as even a much larger quantity when taken from the general circulation. The effects, however, are not so immediate; the blood is obtained more slowly, and in much less quantity; consequently, in the disease under consideration, local is to be considered as merely an auxiliary to general bloodletting, where the latter can be safely resorted to. Instances may sometimes occur in which all the veins, even the jugular, lie so deeply imbedded in the adipose substance, that it becomes almost impossible to open them with the lancet; here local bleeding must be immediately resorted to, and carried to the greatest possible extent.

Very soon, then, after blood has been taken from a large vein, unless the symptoms are so much alle-

viated, as in our judgment to make it unnecessary, topical bleeding ought to be employed, which not unfrequently will prevent the necessity of repeating the general bleeding. This is usually effected by means of leeches applied to the external fauces; and to produce the desired effect, they ought to be applied in considerable number, as from a dozen to twenty. This is generally a very convenient mode of obtaining blood, and is productive of but little pain to the patient. It has also been thought to unite, to a certain extent, the advantages of general bloodletting and blistering; the blood drawn by a considerable number of these animals being sufficient to affect the whole circulation, whilst their bites keep up a counter-irritation. The flow of blood may generally be kept up for some time from the orifices made by the leeches, by bathing the part with warm water; in this way considerable blood may often be obtained.*

* It is of much importance to acquaint ourselves with the proper method of managing leeches, since they do not always bite so readily as we could wish; at times, in fact, we find it extremely difficult to make a sufficient number of these animals take hold.

"In order that leeches may bite readily and suck well, they should be made to *fast* for a few hours before they are applied—that is, they should be taken out of the water, and put into a cup, tied over with linen, for four or five hours in winter, and three or four in summer. They are then to be put into a dry and fine napkin, and gently rubbed, which irritates them, and makes them bite keener. If it be winter, they are the better to be breathed upon, for a minute or two, before application, the warmth of the breath making them more lively; or the vessel in which they are kept may be placed near a fire for a short time, so as to raise the temperature of the water a little, a great

Emetics.—Almost all writers on croup attach great value to emetics; in fact there are but few remedies concerning which we are so well agreed, as in the use of these in the complaint under consideration. They have, however, met with a little opposition, and Dr Home was averse to their employment. Our experience, however, still continues to give them their deserved rank in the disease.

Emetics, in addition to the benefit arising from their evacuation of offensive matter often contained in the stomach, have a powerful influence in restoring to the inflamed organs their natural secretions, and also in promoting expectoration, which is here of great importance. They aid, also, to allay the inflammation by diminishing the action of the heart, and by their tendency to restore to the extreme vessels their natural functions. The system also feels a peculiar shock from their operation, which seems in many cases to destroy morbid catenation, and to excite a new and healthy set of actions in the constitution.

When an emetic is employed at the very onset of the disease, that is, within the first few hours of the attack, it will not unfrequently restore to the diseased parts their healthy actions, and without the aid of any other remedy, effect a perfect cure; but even if the

degree of cold rendering them torpid." *Paper on the use of Lavemens and Leeches; extracted from the Med. Chir. Jour. into No.* 1, *vol.* xi, *of the New Eng. Med. Jour.*

The part where leeches are to be applied ought to be first wet with milk and water, or sweetened water; or it may be rubbed with a piece of fresh meat.

success is not entire, we lay a foundation for the cure, the disease being almost always more manageable afterwards. According to Dr Crawford, in a certain part of Scotland where croup is prevalent, it is a common practice as soon as any of its symptoms show themselves, to give an emetic, which practice is generally attended with success. It certainly, however, may be made a question, whether it would not be the safer practice, if the symptoms are well marked, and the child robust, to begin the treatment of this disease with bloodletting.

Immediately after general and local bleeding, or general, if local is not thought requisite, or when circumstances prevent the immediate employment of it, an emetic ought to be administered. Ipecacuanha, generally speaking, is more certain in its operation than the tartarized antimony, though for the most part not so effectual; it is generally better to combine the two, adding calomel to move the bowels. The antimony when used separately, should be administered in small repeated doses until its full effect is induced. We must by all means produce full vomiting. Should there, owing to the insensibility of the stomach, be any difficulty in producing the emetic effect by means of the substances mentioned, we may resort for aid to the sulphate of zinc, or copper. After our first emetic has operated freely, we should continue during the first and second stages, to give small doses of emetic substances, sufficient to keep up a pretty constant nausea, and to produce occasional full vomiting. For this purpose preference ought to be given to the antimony, as it exerts a very powerful influence in

diminishing the action of the heart. It likewise has a very marked influence on the capillary system, equalizing and diminishing the action of its vessels, and consequently its circulation, and, what is of special importance in the disease we are treating, these effects very soon follow its exhibition. It seems in fact peculiarly calculated for acute inflammatory affections. Small doses of ipecacuanha have frequently been recommended either alone, or combined with other articles, as in the formula of Dover's powder; opium, however, ought not be employed, and I feel persuaded that the antimony should supersede any form in which the ipecacuanha may be combined.

The best way of administering the antimony is in the watery solution, and the doses ought to be repeated at short intervals, especially where the symptoms are urgent. Sometimes, on account of the great insensibility of the stomach, we are compelled to give it in quite large doses before it will produce any obvious effect.

Cathartics.—These operate to allay inflammation, and in a way similar to bloodletting, that is, by producing a positive diminution in the circulating fluids; but their effects are much less speedy, certain, and powerful. Our only intention then in their use, should be to evacuate the bowels of their contents, and to keep up in them a regular excitement.

It is always proper at the commencement of this disease, and more particularly if the bowels are constipated, to evacuate them freely by injections; and thus our other remedies will generally be more certain and effectual in their operation.

Since the bowels in croup are very liable to be constipated, particularly during the first stages, we must occasionally, as the case requires, administer cathartic medicines, so as to prevent them from becoming loaded with fecal matter. Calomel answers our purpose very well, it being a very effectual cathartic, particularly in children. At times there is great torpor in the action of the bowels, so that it becomes requisite to administer quite powerful cathartics, and to aid their operation by the use of frequent injections.

Vesication.—This is a remedy in very common use, and unquestionably a valuable one in this disease. It was formerly the common practice to blister the throat, but it is now by many thought better to leave this uncovered, it being the situation where the leeches are to be applied. It will always, however, be proper to blister the upper part of the chest, and, where the symptoms are urgent, the back of the neck. Vesication should be kept up certainly whilst the inflammatory symptoms continue. In one instance where I could not obtain leeches, I applied a large blister on the fore part of the neck, extending to the upper part of the sternum, and as soon as this began to draw, the respiration became manifestly relieved, and perfect recovery followed. In some acute and dangerous diseases where it is necessary that our remedies should be sudden in their operation, as in inflammations of the heart and pericardium, blistering by means of hot water is advised, and I am much disposed to think that it would be very beneficial in croup. In this way the throat might be vesicated in so short a time as not to interfere much with local bleeding. I have

never practised this mode of blistering, but intend it in the next urgent case which occurs to me.

The Warm Bath.—This, as an auxiliary to the remedies mentioned, may, in some instances, be serviceable. I have certainly witnessed considerable temporary relief in the respiration, from it. Dr Philip, in speaking of croup, observes, "It is common with nurses in many parts of Scotland where the disease is frequent, to immerse the whole body in warm water as soon as the disease shews itself, which sometimes, it is said, wholly removes it."*

This remedy is doubtless worthy of trial, when it can be conveniently employed, and without interfering with our other remedies; but if it is likely to produce much delay in the use of these, it certainly ought to be dispensed with. The feet, however, may almost always, and without inconvenience, be immersed in warm water, which it has been thought may act beneficially by promoting a determination of blood to these parts. Sinapisms and garlic may also be applied to the feet with the same view.

We have now brought into view the remedies upon which our chief reliance is to be placed for the cure of croup, a disease ever rapid in its course, and dangerous in its consequences. If under their assiduous use, the symptoms do not abate, but go on increasing in severity, we can hope but little from art, as effusion must soon follow.

During the first stages of croup, the patient's drink should be mild and mucilaginous, and his food, if he

* Treatise on Febrile Diseases.

require any, of the lightest kind, as gruel, barley-water, or arrow-root. Some have thought it better, if the disease runs it course rapidly, to abstain altogether in these stages from any kind of nourishment.

In the last stage of cynanche trachealis our indications are changed; since the only chance of recovery remaining to the child, is from the dislodgement and expectoration of the effused matter. Now to effect this, great efforts are required on the part of the patient; we must therefore endeavour to support the vital powers, that they may not sink under the exertions necessary to dislodge this matter. Mild cordials, therefore, and light nourishment ought to be administered.

To aid the efforts of the child to get rid of the effused mater, emetics should be employed, since from the powerful mechanical action induced by them, they seem especially fitted to effect the detachment and expectoration of the membrane, or of any matter obstructing the air passages. Emetics of the sulphate of zinc, or copper, are generally to be preferred to ipecacuanha, or antimony, since the mechanical action resulting from their operation is equally great, and is followed by less exhaustion. Emetics in this stage ought not to be administered at very short intervals, since the strength of the patient would in this way soon become wasted. No invariable rule can be stated in relation to the frequency of their employment, as we must be so much influenced by the circumstances of the case. We ought seldom, however, to repeat them oftener than once in seven or eight hours. During these intervals, we should endeavour, by means of

cordials and light nourishment, to raise the energies of the system, so as to prepare them for a new exertion. We may now and then, also, give expectorants; those of a cordial nature are best. We cannot, however, expect much from this class of medicines.

Sometimes in the last stage of croup, a diarrhœa comes on; this we must immediately attempt to check, or the patient will soon sink under it. But we ought not to do it by opiates, since they are apt to allay the cough, upon which we principally depend for the expectoration of the effused matter. The common chalk mixture often answers a good purpose. But other cordial and astringent medicines, for which physicians are not generally at a loss, may be advantageously employed.

Occasionally the bowels are quite constipated, when it becomes necessary to evacuate them; for this purpose, mild injections ought to be used.

We should endeavour in this stage to maintain the vital heat on the surface by the application of stimulating substances. Sinapisms and garlic should also be applied to the feet. Every thing in fact ought to be done, which will be likely to delay the exhaustion of the living powers. As the lungs are so frequently affected, particularly in this stage of the disease, it will generally be advisable to continue the vesication on the chest.

It now and then happens, even when effusion has occurred, that the inflammatory symptoms still continue, so that local bleeding may become necessary. Still if the strength is much prostrated, it must be sup-

ported, so far as is consistent with a regard to the symptoms of inflammation, by the means already advised. If the child, however, is robust, and the strength holds out well, it may sometimes become necessary to pursue the same treatment that has been recommended in the first stages, not even omitting general bloodletting. We certainly cannot employ these means to the same extent as in the other stages, but the discretion of the practitioner must show how far they may with safety be carried. It is rare, however, that this practice is admissible in the last stage of croup.

Such, then, should be the treatment of the disease when effusion has taken place; yet, though our duty prompts us, while life continues, to persevere in our exertions for the preservation of the patient, still the melancholy reflection remains to us, that success can hardly be hoped for.

There is a number of other remedies, which, at various periods have acquired a reputation in the disease we are considering, a few of which we will cursorily notice.

Calomel at one period was believed to be almost a specific in croup, and Dr Rush, and other noted physicians, relied much on its virtues. Its use seems to have been confined to no particular stage of the complaint. There are many successful cases recorded to show the efficacy of this remedy; some of them, however, do not appear to be well marked cases of the disease; and in others, many other remedies, as bloodletting and emetics, were employed in combination with it, to the effects of which we, at least, have

equally good reasons for attributing the cure. Calomel, as is well known, produces its effects on the system in a gradual manner, and this is more particularly the case in children; for which reason it does not seem well adapted to the cure of a disease so rapid and violent as croup. I am much disposed to believe that the advantage derived from it in this complaint, is principally owing to its cathartic qualities. In the last stage of the disease the vital powers are generally at too low an ebb to admit of its employment.

The greater number of our latest and most accurate observers of the disease have placed but little reliance on the virtues of calomel. Dr Cheyne observes that he has used it in the second stage of croup without any benefit. Should the disease take on a chronic form, more might be expected of it, as there might then be time for the system to become affected by it. When used in this disease with a view to affect the system, it should be exhibited in large doses, and at short intervals.

The polygala seneka, or rattlesnake-root, at one time acquired considerable reputation in croup, and some physicians now hold it in much esteem. It was first, I believe, introduced to public notice by Dr John Archer of Maryland, who seems to have placed great confidence in it. He considered it the most powerful remedy, and one to be depended upon in preference to all others for the cure of this disease. In short he remarks that he would not give an ounce of it, as a chance in the cure of croup, for all the emetic tartar, mercury, and cantharides in the United States. He gave it in the form of decoction, half an ounce of the

seneka, in coarse powder, being added to eight ounces of water, and boiled until half of it is evaporated. A teaspoonful of this was administered every half hour, or hour, according to the urgency of the symptoms, and occasionally a few drops to keep up the stimulus, until it acts either as an emetic or cathartic. It is then repeated in smaller quantities, so as to keep up a constant action from it in the mouth and throat. Experience, however,—the proper test of all remedies—has not established the seneka in the rank which Dr Archer believed it to hold, for it has been repeatedly employed without any manifest advantage. The use of this medicine does not appear to have been confined to any particular period of the disease. Now in the first stages of croup, from its stimulating qualities, there would be danger of its aggravating the inflammatory symptoms. It is now only employed in the last stage of the disease, and with a view to its expectorant powers, as the irritation it produces in the throat excites coughing, and thus aids in dislodging loose matter from the trachea; in this way, I have witnessed some temporary relief from it. When given to considerable extent, it will sometimes produce vomiting; we cannot, however, depend upon this effect from it, for which reason, though it may be given to assist the operation of our emetics, it should never supersede their use.

Digitalis was at one period introduced into practice in this disease, and some physicians have believed it to be an effectual remedy. To prove its efficacy, a number of successful cases of croup, in which it was employed, are recorded. It has not, however, stood

the test of experience, having now, among the better class of practitioners, wholly fallen into disuse. From the comparative tardiness and uncertainty with which its effects on the system are induced, we could hardly look for benefit from it in a disease which progresses with such rapidity.

The cicuta has also been recommended in croup, but I believe we have no well attested instance in which it appeared to be of service.

It has been thought that benefit might arise in this disease from breathing air containing less than its natural proportion of oxygen, but I am uncertain whether it has ever been practised. I cannot conceive that any good could arise from it. It seems in fact necessary that a certain proportion of this principle of atmospheric air should be received into the lungs to effect the necessary change on the blood as it circulates through these organs. But in this disease it is only by the most powerful efforts that a sufficient supply can be obtained from air in its natural state. The consequence, therefore, of diminishing the oxygen of the air would seem to be, either that the child must make more powerful exertions to respire, or be sooner suffocated. Certainly the use of this remedy would be attended with considerable difficulty, and be likely to produce much delay in the employment of other means; and as an antiphlogistic remedy it is undoubtedly inferior to bloodletting.

Many of the different expectorants are used, and by some in every stage of the disease. Many of them, however, would be injurious in the first stages, as they possess stimulating properties; in the last stage they

may aid somewhat in promoting expectoration. But they ought to be administered with caution.

The inhalation of vapour arising from heated vinegar, and from various medicated substances, is a common and very old remedy in quinsies; and it is especially recommended by the ancient writers in that kind which was thought to have its seat in the larynx and trachea. Hippocrates advises it in the worst species of quinsy. He ordered nitre, origany, and the seeds of cresses, to be enclosed in an earthen vessel, with equal parts of vinegar and water, and exposed to heat, and the vapour which arose was to be inhaled by the patient through a hollow reed. That the throat may not be scalded, it is advised by Ætius that a small egg-shell, perforated at each end, be held in the mouth, and the end of the reed fixed in it, the vapour thus being received into the cavity of the egg-shell before coming into contact with the patient's fauces.

This remedy, though it cannot be expected to aid much in effecting a cure, still may be productive of some temporary relief. It will therefore be very proper to employ it when it can be done without much inconvenience. The vapours should be mild in the first stages, and in the last stage more stimulating. Vinegar, either clear or diluted, is most commonly employed.

Various fermentations and stimulating substances have been recommended to be applied to the throat externally, but when it is allowable to cover this, blisters are by far the best application.

The last remedy we propose to notice in croup is bronchotomy or tracheotomy. For the most part, this

has been considered as a last resort; for which reason it has seldom been employed until near the fatal termination of the disease.

This remedy was long ago advised to prevent suffocation in quinsies of the worst kind. Hippocrates recommends, when symptoms of suffocation are present, a practice somewhat similar in its effects—"*Fistulas in fauces ad maxillas intrudendas esse, quo spiritus in pulmonem trahatur.*" Asclepiades, I believe, is the first recorded to have practised opening the trachea to give relief in the most fatal kind of quinsy, and a good deal of reliance appears to have been placed upon it by him. Aurelianus, and Aretæus both notice the operation in quinsies. The former condemns it altogether, whereas the latter objects to it only on account of the danger supposed to attend its performance.

Boerhaave, having described the common remedies to be employed in inflammatory quinsies, goes on to say—"If all these means are neglected, used too late, or not followed with a due effect, the disease being very recent and suffocating, and the seat of the disorder being above the place where the incisions ought to be made, and attended with the worst symptoms, but as yet no signs of gangrene appearing; in this case after a severe and doubtful prognostic, bronchotomy must be immediately performed."* Dr Home recommends the operation as a last resort in croup. Michaelis advises that it be performed early in the disease, that is, as soon as it can be ascertained that other remedies are unavailable.

Of late years, there has been considerable said in

* Aph. 812.

relation to the expediency of employing bronchotomy in croup, but it has been mostly agreed among physicians that the chance which it offers of effecting a cure is quite small. Within a few years the attention of some medical gentlemen in Europe has been particularly directed to it as a remedy in cynanche laryngea, and in a few instances it has been successfully performed.* From the seat of this disease, the operation would seem to promise more than in cynanche trachealis.

Bronchotomy has also succeeded in croup. There is a case in the third volume of the Med. Chirurg. Trans., taken from the Inaugural Dissertation of Dr Thomas White, published at Leyden in 1786, in which it had a happy result. And there is another given in the same work, by Thomas Chevalier, Esq. Mr Chevalier observes, that since this case occurred, he has seen the operation done with great relief to the child, the breathing becoming quite free and easy after it; death, however, soon followed, which is supposed by him to have been occasioned from the debility previously induced by the disease, being too great to be surmounted. In almost all the cases recorded in which this operation was performed, the patients have received some temporary relief from it.

When the inflammation of croup extends into the lungs, the chance of benefit from the operation is of

* There have been two cases recorded very lately in which this operation was performed with success in cynanche laryngea. One may be found in the ninth vol. of the Med. Chirurg. Trans.; the other was published in the Lond. Med. Intel., and has since been extracted into the New Eng. Med. Jour. vol. ix, pp. 106, 107.

course much diminished, since the disease produced in these organs may alone be sufficient to destroy life. "When," says Dr Farre, "the cynanche trachealis is combined with pneumonic inflammation of whatever kind, then the operation cannot avail. In proportion as the inflammation is extensive, it is less intense in the larynx, and I think it is not difficult to discriminate between the cases, at the period when the operation is required, by the manner in which the respiration is conducted. In the one the difficulty of breathing is evidently that of impending strangulation ; in the other, that of deep seated, and extensive oppression." These remarks are illustrated by a history of two cases of croup, in one of which there was pulmonary affection, in the other none.*

Our special view in performing tracheotomy is, that air may be received into the lungs in larger quantities, and with less effort on the part of the patient, than it can be through the natural opening in the trachea; thus the blood in its passage through these organs undergoes its requisite change more perfectly, and the rapid waste of the vital powers so commonly witnessed in this disease may consequently be delayed. We shall in this way then, give the organs more time to recover from their diseased actions, and a better chance for the membrane, when formed, to become detached, and expectorated. Sometimes the operation may be required to prevent immediately impending suffocation.

When the operation is once determined upon, we must be particularly careful not to delay it too long,

* Med. Chirurg. Trans. for 1812.

as the violent efforts made by the child to continue respiration, and the blood in its circulation through the system having but partially received its vital change, will very soon so exhaust the living powers, that, should the respiration be ever so much relieved by it, the effects of the disease could not be recovered from. The early employment of the operation may possibly prevent, in some degree, the extension of the disease, for if the energies of the system are raised by it, the restorative powers will be more successfully exerted. Would it not then be oftener successful, if physicians, instead of considering it a last and almost hopeless resort, had recourse to it earlier in the complaint, before the fatal symptoms manifested themselves?

Van Swieten insists much on the necessity of performing bronchotomy early in those quinsies which have their seat in the larynx and trachea. Having spoken of some other remedies he proceeds—"but when these remedies have not been used, or else applied when the disease has become too violent, or if they have all been tried without any abatement of the symptoms, nothing remains, but the patient must be either delivered up to certain death, or else a passage must be made by art for the air to enter into the lungs." "But that an incision may be made through the windpipe with hopes of success, it is necessary that the disease be recent or not of long standing, for when it has continued any considerable time, there is reason to fear lest the pulmonary arteries have already been stuffed up by impervious blood;" &c. &c. "The most important point," says Mr Lawrence, speaking of it in cynanche laryngea, "is the time at which the oper-

ation ought to be performed, and this should be as soon as the symptoms enable us to determine the nature of the disease. In no case is delay more dangerous; the patient is constantly exposed to the risk of suffocation, which sometimes comes on very suddenly; the difficulty of breathing certainly produces so much constitutional disturbance, and the circulation of venous blood through the brain and other organs, causes so rapid an exhaustion of the vital powers, as are of themselves extremely dangerous."* Many other physicians have strongly urged the necessity of performing bronchotomy early in the disease, before the symptoms evince a fatal close to be at hand. Some have even said that it ought to be the first remedy employed in well marked cases of croup. To do the operation then with any hopes of success, I feel persuaded that it ought to be done early, that is, as soon as our other remedies have been proved to be unavailable.

Though experience will not warrant me in offering an opinion in relation to the expediency of this remedy in croup, still, from the authorities already adduced, and from many others which might be cited in its favour, I am disposed to consider its employment as not only justifiable, but even proper, where the symptoms do not yield to other remedies, and where there are not evident marks of considerable pulmonary disease. It must not be inferred, however, that much dependence is to be placed on the operation; on the contrary, I conceive the chance of its success to be extremely small, yet there is a chance, because it has succeeded; and allowing it be ever so small, ought it not

* Med. Chirurg. Trans. vol. vi.

to be offered to the individual? Especially as the operation is neither very difficult nor hazardous, nor would the child be likely to feel much pain from it, his attention being so wholly engrossed by the extreme suffering from the disease.

DISSERTATION II.

ON THE FUNCTIONS OF THE EXTREME CAPILLARY VESSELS IN HEALTH AND DISEASE.

The capillary system is the seat of so many of the vital functions, and has so intimate a connexion with all the actions carried on in other parts of the economy, and must consequently be so influenced by them, more especially in disease, that to go into a full and minute consideration of the subject before us, much investigation, much physiological and pathological research would be required. There is scarcely a disease to which animate beings are liable, scarcely a function goes on in the living machine, but we may trace in it either a direct or indirect connexion with the capillary system. In a paper however of this kind, limited as it must of necessity be, written too by one whose experience has not admitted of that thorough investigation into the phenomena of life, as exhibited in health and disease, which this subject requires, only some general views of the functions of this system can be expected; an outline, if I may so say, of the picture, whose shades and colouring must be given by the hands of abler and more experienced masters.

In treating the subject before us, we mean to attempt only a history of some of the phenomena which are exhibited in the system of capillaries; facts which

may be deduced from the rigid laws of induction. Too much time has already been spent by physiologists in attempting to discover what is beyond the reach of the human faculties; they have started from that goal which they ought to have considered as the boundary of their progress. The mode of action of the nervous system has, I believe I may say for ages, called forth the labours of human intellect; and what have these labours effected? We cannot arrive at a knowledge of the intimate laws of our economy. We know that inert matter is received into the body, which, after having undergone particular changes, becomes impressed with vital properties; but what these changes are, which are so necessary to adapt this matter to its new destination or the mode in which they are effected, we know not. Animal heat seems in many instances to be extricated in the capillary system; but we have no clue to discover by what kind of action it is given out there, nor the peculiar laws to which its distribution is subjected.

The mind of man is ever anxious to pry into the secrets of nature, ever on the alert to discover what she has been pleased to conceal from his view. It is this curiosity, inherent in our minds, which gives rise to the thousand disputes that are constantly going on in relation to ultimate facts. One philosopher tells you every thing is the result of the operations of matter, that all the phenomena of mind arise out of the action of the brain. Another says, mind is the main spring that gives motion and life to our machine, that every thing is to be referred to an immaterial principle. Such speculations serve to exercise our reasoning faculties, but nothing more.

In the physical sciences it is the same as in the science of life; we can only study general results. We can no more define gravity than vitality, nor do we know any more why the minute particles of bodies are chymically, than why they are vitally attracted. It has with much truth been observed that principles are only general results from first causes; we are obliged therefore to suppose such causes, and to reason only of their effect; when we attempt more than this we lose ourselves in error. Nature, like an *ignis fatuus*, if we endeavour to find her hiding-place, leads us into so many by-paths, that it becomes difficult to regain the road from which we strayed.

At the termination of the arteries there is a network of fine vessels into which all the blood is poured, and from which it passes into the veins. From this network the secretories and exhalants take their rise. It in truth appears to form a reservoir of materials for the supply, not only of the veins, but of those minute vessels which perform the most important functions in the animal frame, functions upon which our wellbeing and the continuance of our existence are in close dependence. It is this reservoir, if we may so call it, which, strictly speaking, is meant by the capillary system; but so intimately are all the extreme vessels connected in their functions, so immediately dependant are they upon each other, that it will be impossible for us to treat separately of this system. The exhalants, including those of nutrition, the secretories, the excretories, and even absorbents, though we by no means intend giving a distinct description of each, may all be considered as extreme capillary vessels.

This system pervades every part of the body, even such as have no arteries supplying them, and which in their state of health receive no blood. The cartilages, the tendons, the hair, &c. are of this class. When any of these become inflamed, even the hair, as witnessed in plica polonica, blood enters and makes their vessels manifest. Capillary vessels seem to enter into the very structure of our organs, so that their number is beyond calculation, and the size of a large proportion of them too minute to be estimated by our senses. Boerhaave computed that the largest of them were no thicker than the tenth part of a hair, and that there was an incredible difference of size between the largest and smallest. This estimate will go well beside that of Lewenhoec, who computes that 125,000 of the exhaling vessels which transmit the Sanctorian perspiration, open in a surface equal only to that of a single grain of sand. No dependence however can be placed upon computations of this kind, nor do I know of any advantage which would result from them if they could be relied upon.

The capillary vessels anastomose generally with each other thus establishing a universal communication. These anastomoses are especially necessary to guard against the thousand causes of obstruction to which their size, as well as changes in their vital properties, constantly expose them. They become less necessary in the large vessels of the body, the liability to obstruction being diminished in proportion as their size is increased. Hence these vessels anastomose less frequently as their capacity becomes greater, and the larger trunks not at all.

The capillaries of certain systems in their healthy state circulate only white fluids; the same is the case with the most external capillaries of the surface. Irritate the skin at any point, and its apparent vascularity becomes greatly increased by the entrance of blood into vessels which, in a natural state, admit only such fluids as are destitute of colour.

In different parts of the body the capillary vessels are differently developed. The degree of their development in an organ seems to be nearly in the direct ratio of the sum of labour allotted to it in the economy. The more functions a part has to perform, as was observed by Hunter, the more abundantly is it supplied with vessels. Hence growing parts and those recovering from disease, as in granulations, have their vascular system so fully evolved. Those textures, which injections show to possess the smallest number of capillaries, have only nutrition going on in them, as in the muscles, cartilages, and bones; but those which are more largely supplied, have other functions, as secretion and exhalation, to perform. We have proof of this in the skin, the serous and cellular membranes, glands, &c. all of which injections show to be extremely vascular. These latter systems seem for the most part to take on diseased actions more readily, and to go more rapidly through the processes of recovery. It has been remarked, that as those parts which are most vascular are especially disposed to congestions of blood, inflammations, &c. nature has provided them with a structure which tends to obviate and relieve disease. It consists in the addition of exhalants and secretory vessels; these supply neccessary fluids in

health, and answer the purpose of evacuating the part when disease requires it.*

The appearance of the face, and the great facility with which its extreme vessels receive blood, would lead to the supposition that the capillary system is more developed here than on other parts of the surface. An irritation which would have little or no effect on the skin generally, will often fill the face with blood. How quickly too it becomes flushed under the operation of some of the passions, or from irritation in an internal organ! In violent deaths also we notice it to be especially swollen and livid ; and during life it has generally a floridness not common to other parts of the surface. But there are other causes beside the number of capillaries to which these appearances may be attributed. The great facility with which the face becomes coloured by injections is considered as a proof that the communication of its capillary vessels with the arteries of the chorion is more free than in other parts. The sensibility too seems to be greater here than on the rest of the surface. It is this susceptibility of the face to receive blood to which its great liability to cutaneous diseases is to be attributed.

We notice a difference in the development of the capillary system at the different periods of life. Its vessels are as numerous, or even more so, in the fœtus than in the adult. Now this great proportional vascularity in the fœtal state is undoubtedly demanded for the purposes of growth. Hunter remarks that the growth of an animal is in proportion to the number of

*Parry's Elements of Pathology.

its capillary vessels. Their number does not increase in proportion to the growth of the rest of the body, and very probably many of them not being needed, are obliterated.*

In youth the capillary vessels of the surface especially appear evidently to be more numerous and active than in old age. As man declines in life, he loses for the most part the rosy complexion of youth; his skin becomes dry and shrivelled, his hair, from not receiving its colouring and nutritious fluids, grows white and then falls off. The period however at which the hair changes its colour is by no means constant; there are a thousand moral and physical causes which may prematurely bring on this change. In some individuals it happens very late in life, in others early; and there are many instances of persons living to an advanced age without any alteration taking place in it. It is to the diminution in the number and activity of the capillary vessels of the surface that we are to attribute the

* "The whole of these differences between the fœtus and the adult must be intended for the purposes of growth; and indeed we may discern the necessity of it: for if a child was not more vascular in proportion to its size, than the adult, its growth, we might conceive, would only be in proportion to the number of its vessels; which would be twelve times less than they are; for a new-born child is only one twelfth in size to that of an adult. A child would therefore grow faster and faster every year; for instance, in proportion to its size, as the vessels would become numerous in that proportion.

"But this is not really the case, for children grow less and less every year in proportion to the size; only adding its first year's growth to itself every succeeding year; though, perhaps, not quite so much, as the vessels rather decrease in number."

HUNTER on the Blood &c.

comparative unfrequency of cutaneous diseases in the aged, and the sluggishness, when they do occur, with which they go through their morbid or curative processes. The capillaries in other parts of the body are less active in the old man ; callus is much more slowly formed, and all injuries are more tardily and with more difficulty recovered from. The capillary vessels, however, of the internal organs do not generally seem to be diminished in their number or activity, as it regards their healthy functions, certainly not in the same proportion. The glands, as may be seen in the liver, kidneys, &c. preserve their red colour and vascularity ; their functions too as well as those of the other internal organs, continue to go on with activity. This perfection in the internal functions of the old man is often witnessed even when his animal existence has nearly ceased its manifestations. The blood then first seems to desert the external parts and becomes comparatively more concentrated in the internal organs, from which loss of balance between the surface and viscera, it arises that congestions and inflammations in the latter are more frequent as we advance in life.

At the last period of our being, then, the energies of the system obviously become concentrated in the internal man, and the internal glandular life seems especially to be most slowly extinguished. Man dies naturally from the circumference towards the centre. Those ties which connect us with external objects, and from which is derived all the anxiety we feel for existence, are first broken, nature destroys or weakens the desire for life, and next life itself. Our animal being ceases, we vegetate, then die.

The capillary system is not manifested alike in every individual. May not the different temperaments be intimately connected with its state? Many circumstances would lead to the belief that it is the most fully evolved and active in the sanguine, as their external appearance; their greater liability, other things being equal, to those diseases in which this system seems in a special manner to be concerned; also the rapidity with which diseased or restorative actions, generally speaking, go on in them. Our habits of life too affect the state of this system. Those engaged in pursuits which require much physical exertion, probably have it more perfectly and equably developed than the sedentary and inactive, for it is a law of our economy that parts should become vascular, in a degree, certainly, in proportion to the action required of them.

The capillary vessels of the skin appear to be more numerous in warm than in cold climates, heat increasing the action of this organ. The greater rarity of the air too, has an influence in determining the blood to the surface. This is proved by the accounts of travellers who have ascended high mountains; for they tell us that as the pressure of the atmosphere on their bodies was diminished, the skin especially of the face became red and bloated; and in such as have ascended to very great heights, blood has even been forced out of the exhalants of the surface, and of the mucous membrane of the lungs. In warm climates cutaneous diseases are by far more frequent than they are in cold. The converse of what has been stated of the skin, happens as it regards the internal organs. It was remarked even by Hippocrates, that the viscera were warmer, and digest-

ed more powerfully in cold than in warm seasons. Cold, as it diminishes the action on the surface, according to a law of our economy, increases the energies of the internal life. It is well known that the quantity of urine secreted in the kidneys is in the inverse ratio of the secretion by the skin. The glands of the nose, of the mucous membrane of the lungs, &c. pour out more matter in cold than in warm weather.

Bichat considers the rete muscosum to be a network of capillary vessels, and calls it a general capillary system. He describes it as having two sets of vessels. One of them contains fluids which impart to the different races of men their respective colour; these are not believed to circulate, but to remain stationary until they are displaced by others of the same kind. The nature of this colouring substance is not pretended to be known; it is foreign both to the chorion and epidermis, and when once destroyed is not readily reproduced. Light and heat combined, act upon it so as to alter much its colour. The other set of capillaries belonging to this body, under their ordinary state of excitement, circulate white fluids. They are situated immediately under the epidermis, and give rise to those exhalants which pour out the sweat. They are the seat of erisipelas, and of the other cutaneous eruptions foreign to the chorion.

The hairs have an internal arrangement of capillaries analogous to that of the reticular body. They possess two sorts of vessels; one contains the colouring subtance, which remains stagnant until displaced by other matter of the same kind; the other contains fluids which afford support to this system, and which under-

go a kind of circulation. It is thought that there may be some analogy between the colouring matter of the hair, and that of the skin, since black hair is found among the dark races of men. Persons too, who have red hair, are very liable to have freckles spread about their skin, which are proved to be seated in the reticular body.*

Having now described, so far as is consistent with our plan, the general capillary system, it will perhaps be proper to say a few words on that which is peculiar to the lungs.

The capillary system of the lungs receives its supply from the pulmonary artery, and the pulmonary veins alone go out from it. Here then the blood passes directly from the pulmonary artery to the pulmonary vein without serving any other function. There are no exhalant or secretory vessels to divert it from its straight forward course; it follows uniformly one direction, whereas in the general capillary system it is ever varying in its motion according to the demand made for it by the different sets of vessels it is destined to supply.

In this system it is that the venous blood is again fitted for its use in the economy, either by receiving new principles, or, as late experiments have shown to be more probable, by parting with such as are deleterious. Here then the blood enters venous and goes out arterial, the converse of which happens in the capillary system of the body; for into that, red blood enters, and black goes out.

On taking a superficial view of the pulmonary

* Bichat's General Anatomy, translated by Dr Hayward. Vol. 3d.

capillary system, the following difficulty very naturally presents itself. How can a due balance be kept up between it and the general capillary system, this latter necessarily containing the greater quantity of blood? The chyle, too, and other fluids returned by the absorbents, are obliged first to pass the pulmonary capillaries. Much of this difficulty however will vanish on a closer consideration of the subject. The excess of the blood in the greater over the lesser circulation is not so large as, on a *primâ facie* view, we should be led to suppose. A large number of the vessels of the general capillary system contain and give motion to fluids differing from blood; in many parts, too, much of this fluid seems to be combined with the organs as their colouring matter. In some it is at times very sluggish in its motions or nearly stagnant, as in what are called the cancellated or erectile textures. But there remains still an excess in the general capillary system to be accounted for. The distance between the heart and pulmonary capillary system is less than between this organ and the general system of capillaries; so that, the velocity of the blood being given, the time required for its passage through these systems would be in the direct ratio of their distance from the source of circulation. Now the velocity of the blood is probably nearly the same in each. Supposing therefore the distance between the heart and general capillary system to be double what is between this organ and the capillaries of the lungs, and these last vessels to be but half as numerous as they are in the body, an equal quantity of blood would be returned to the heart in the same period of time in the one case as in

the other. It is plain, therefore, that the excess in the general capillary circulation is compensated by the much shorter time which the pulmonary takes up in its course. Hence, as Bichat has remarked, is the reason why the lungs are placed at the side of the heart in all animals whose pulmonary is in opposition to the general circulation.

The liver has a set of capillary vessels analogous in one point to those of which we have just been speaking; they are supplied with black blood. This fluid returned from its circulation in the stomach, intestines, pancreas, and spleen, is poured into the vena portæ and undergoes another circulation in the liver. For what purpose blood of such a character is sent to this gland particularly, we have not as yet ascertained. The most commonly received opinion is, that it serves for the secretion of bile, whilst that conveyed by the hepatic artery nourishes the organ. Possibly the blood of the vena portæ may differ in its intimate nature from other venous blood. The functions of the abdominal viscera being so different from what they are in other parts of the body, may, for any thing we know to the contrary, produce a different influence on the blood that passes them. At present much obscurity hangs over the functions of the liver. Perhaps this organ, as has been elsewhere suggested, may be subservient to some other use in the economy besides the secretion of bile. Its great size in the fœtus is certainly a strong argument in support of this supposition. It is not impossible, therefore, that, at some future period, the blood circulated in the vena

portæ may be discovered to answer important purposes in the system, of which we are now wholly ignorant.

Of the structure of the capillary vessels we know but little. They were thought by Boerhaave to possess only a mucous coat. Hunter believed them to be almost entirely muscular. Ruysh demonstrated that these vessels exhibited a variety in their arrangement and texture according to the different organs they supplied. The circumstance that ossification never occurs in this system induced Bichat to believe that the common membrane of the arteries does not extend to these vessels, but that it changes gradually to a different texture. We can know nothing with certainty of the structure of these vessels. They probably partake of the nature of the organs they supply; hence the variety of diseased actions which have their seat in the capillaries of the different organs, it has been thought, may be owing to the peculiar modifications of the vital properties of these vessels arising out of their difference of structure.

Some organs, as the corpus cavernosum of the penis; also the clitoris, the nipple, nymphæ, and urethra, exhibit textures in which the blood does not always move with the same regularity as in the capillary vessels of other parts, apparently often becoming stagnant. These textures have been called erectile. The lips, even, have been thought to possess a structure of this kind, something analogous to an erection appearing at times to take place in them. The spleen

also has a cancellated texture, in which the blood appears often to stagnate.*

Let us now speak more particularly of the functions of the capillary system; and we would, in the first place, observe, that it is by far the most important of the two circulatory systems. In the lowest classes of animals it alone answers all the purposes required for carrying on the vital phenomena. The zoophytes have no great circulatory system, yet the functions of life go on in them, they are nourished and have their peculiar temperature. Their vital actions, to be sure, are comparatively but little complicated, corresponding with the greater simplicity of their organization. Nor can we look upon animals of this simple construction as without their importance in creation, if we reflect upon the great and almost incredible changes which our globe is undergoing by their means.†

* Beclard supposes the erectile texture to be "formed of small arteries and veins interlaced like the capillary network," and "that here the venous branches are more developed and dilated in a particular manner. These enlargements," he remarks, "are so unlike cells that they are only continued with the veins, and the internal membrane of these vessels is found in them." Beclard's Additions to Bichat. Translated by Dr Hayward. pp. 117, 118.

† What vast additions have been made to the earth by the labours of the coral worms! It is ascertained that nearly all the islands lying south of the equator, between New Holland and the Western coast of America, derive almost, or perhaps the whole of their formation from these minute and simply constructed animals. Nor have they ceased their work, but are now constantly laying the foundation of territories which in the lapse of time are probably to become the habitations of man, and the seats of civilized life.

Vegetables live with only a capillary system, their functions seeming subjected to the same vital laws as those of animals. The different sets of vessels belonging to them are endowed each with their peculiar vital properties, fitting them to act upon their respective fluids, which they circulate or change according as the economy of the plant may demand. No confusion is observed in the performance of their various functions; like those of animals, they are under the immediate direction and control of vital laws. In the very lowest of the vegetable creation, even in the mosses, vital functions, as nutrition, absorption, &c., are exhibited. In fact, life is said to be continued in more than one half of organized nature by means of a capillary system alone.

The capillaries, then, are the most essential vessels. They are the ultimate agents throughout the whole chain of organized beings, in the highest of animals, as well as in the meanest vegetable, upon which every vital phenomenon depends. The heart, the stomach, &c. in the more perfect animals, perform, as is well known, the great functions of life; but they are ultimately dependant upon their capillaries for this capacity. Destroy the functions of these, and all the great functions inevitably cease. Alter the state of these vessels in an organ, and the state of the organ itself becomes altered. The organs of the general circulation, as the arteries and veins, are only subservient to these—they act as carriers for them—they bring them materials to work, and take away their refuse. All that the capillary system requires they convey to it; when it increases its demand for mate-

rials, they proportionally increase their supply. When the functions of the capillary vessels of an organ are active, arterial action increases; when we exercise much, there is a proportional waste in the system, to supply which the capillaries must augment their labour, and work up more materials; for which reason the action in the great circulatory system becomes more vigorous. The same thing happens in relation to the digestive organs. When the demand of the nutritive vessels is increased, as after fevers, labour, &c. the stomach appears to feel for them, and increases its action. It would seem as if the organs which perform the great functions were constantly on the watch that the capillaries might not want materials with which to perform their labour.

We will here occupy a few moments in speaking of the circulation in the capillary vessels. It appears to be but indirectly dependant upon that of the large vessels, and life may even continue here for some time after it has ceased in the general circulation. In sudden deaths this phenomenon may frequently be noticed. It has been observed, too, that injections pass with difficulty into the capillary vessels of animals recently dead, owing to a resistance offered by the continuance of the properties of life in them. This never happens when the animal has been dead for any length of time.

The circulation seems to be carried on in these vessels by means of a power existing within themselves, to which Bichat has given the name of *insensible organic contractility*. The capillaries then probably conduct the blood from the arteries to the veins by

means of a motion resulting from their own powers. This opinion seems more rational, and has many more facts for its support, than that which attributes the whole circulation to the influence of the heart alone. There is enough to show that the capillaries may act after the great circulation has ceased, and that their actions may be increased in a part, whilst the heart moves with its wonted regularity. I conceive then that the blood receives an impulse in the capillary system distinct from that of the heart, which not only drives it on to the veins, but is also instrumental in returning it through them to its source. Bichat thinks it necessary to bring in other causes to contribute their aid to the capillary system in effecting the venous circulation. He believes that the coats of the veins have some power of contraction, and that there are mechanical causes from without which aid the blood in its passage to the right auricle of the heart. It seems, however, not unreasonable to suppose that the capillaries may be the principal, or even sole agents in returning the blood from the extremities. And we may easily conceive them adequate to this object when we consider that, if added together, their power would more than equal that of the heart. On this supposition then, the veins, like the arteries, would be only recipients and transmitters of the blood; the capillary system producing a similar effect by acting on the former at various points, to that which the heart produces by acting on the latter at one point.

The motion of fluids in all the extreme vessels seems to depend upon an action resulting from their vital properties. The capillaries are endowed with

a peculiar faculty which enables them to resist the entrance of some fluids, and to admit others. The different sets of these vessels have each their appropriate fluids with which their vitality is in relation; these, in their natural state, they exclusively admit. Some circulate only white fluids, others blood. Boerhaave, and those of his time, supposed that those vessels which circulated colourless fluids were too small to admit the red globules of the blood. They believed the capillary vessels to be only strainers, the larger of them admitting blood, the smaller only the more subtile principles of this fluid. Bichat, however, has sufficiently shown that the size of these vessels has nothing to do with the kind of fluids they contain. They all are of sufficient size to admit blood, which they actually do when disease alters their vital properties.

All the different fluids in the capillary system are kept distinct by means of this *vital elective power*, nor during life, though there are so many passages constantly open to them, do any escape, as happens after death. Whilst life continues, the vitality of the capillaries places them in relation only with this or that fluid; but when it ceases, their different relations cease of course, and they lose all power of contraction. It is remarked that in attempting to inject living animals there is always a resistance opposed to the injected fluids in the capillary system, which phenomenon never takes place when life has ceased.

On this principle of *vital elective affinity*, if we may so call it, the different phenomena of the system we are treating of may be explained. The glands

secrete their peculiar fluids, because their secreting vessels are exclusively in relation with them ; hence the liver never secretes urine, nor the kidneys bile. The exhalants, in their healthy state, admit only such substances as are adapted to their nature. The various fluids then in the capillary system are all kept distinct by means of vital laws alone. In the heart and large vessels, mechanical obstacles become necessary, for reasons which will be obvious to every one, to effect this purpose ; but in the capillaries such apparatus are not required.

In the capillary system the blood undergoes its change from arterial to venous. Of the nature of this change, and of the mode in which it is effected, we are ignorant. It seems to result from the functions it performs here ; but whether it receives new principles, or parts with old, or both, has not been ascertained. The change is apparently the same whatever be the function performed ; the qualities of venous blood being, so far as we have been enabled to discover, always alike. Whether the change may not be different in the blood sent to the abdominal contents, admits of a question ; their functions, as before remarked, are very different, and the blood returned from them seems to be applied to uses in the economy different from those of other venous blood. On this subject, however, we as yet know nothing certain.

Let us now occupy a few moments in speaking of nutrition, it being without doubt a function of the capillary vessels.

The different substances taken into the body for its support, undergo a continued and gradual change

by means of vital operations, until they finally constitute a part of the animal machine; throwing off by degrees their physical character, they take to themselves living properties. The nutritive matter continues, apparently, to accumulate vitality until it arrives at its ultimate destination in the body. The chyle, as experiments upon it show, is endowed with more vital properties than the chyme; and the blood possesses a still higher degree of life, yet inferior to what it has, after having entered into and made part of our organs. Here it receives its finishing stroke, and becomes impressed with the most exalted degree of vitality.

In nutrition there are two distinct actions taking place; one, which we call *composition*, conveys nutritive matter to the different organs; the other takes it from them, to which we give the name of *decomposition*. The first is performed by the nutritient vessels, which Hunter calls *workers* or *labourers* in the machine; the second is effected by the absorbents. *Composition* and *decomposition* then are constantly taking place in all parts of the body.* It is a fixed law of nature that our material organization should be ever changing, so that could man drink of the fabled waters of Lethe, he would in truth exchange his being; it is consciousness alone continues us what we are.

The various organs of our bodies receive their nourishment directly from the capillary system; some

* The ancients believed that the body became renewed once in seven years. What reason they had for this supposition, I have been unable to learn.

from the blood, and others from the white fluids. The calcareous matter of the bones is proved to be formed by the red vessels, whilst the white supply the gelatine. The former substance is alternately furnished and taken away, as is shown by the well known experiment with madder, which has no effect on the bones in their cartilaginous state.

Nutrition, like other functions going on in the capillary vessels, is dependent upon the kind of vitality with which they are endowed. In different organs, therefore, the nutritive exhalants must have different relations, according to the substances of which these organs are formed. Thus some must pour out phosphate of lime and gelatine, as in the bones; others, gelatine only, as in the cartilages and tendons. In the muscles they must supply fibrin especially, and in some other textures, albumen. It is to alterations in the living properties of the nutritient vessels that we are to attribute those morbid changes in the texture of parts, as ossification, scirrhus, &c. which are so frequently noticed, both during life, and after it has ceased.

The nerves of animal life may possibly influence nutrition, though this function is by no means dependent upon them, since it takes place in parts to which they are not sent. Neither is it observed to be most active in such as possess the most nervous sensibility. What influence the nerves of organic life may exert over this function, or others connected with the same system, we are totally ignorant. The capillary vessels are largely supplied with filaments of nerves from the ganglions, which seem almost to form a part of them, so intimate is their connexion. Bichat thinks that this

distribution supposes an influence on their functions which at present we do not understand.

Nutrition differs much in the different periods of life. In the fœtus it is most active, which is to be in part attributed to its greater proportional vascularity. During the fœtal state, too, there is but a comparatively small demand made upon the blood by the secretions and exhalations, and only a small proportion of it is returned by the veins. Hence the reason why the arterial system is more developed than the venous. In old age, on the contrary, when decay has commenced, this last system becomes predominant, for all the waste matter, or that which results from the action of decomposition, is poured into and conveyed through its vessels.

It has been already stated that composition and decomposition are continually going on in the body; now as the first or second predominates, the individual increases or decays. In the fœtus composition is most active; its growth is more rapid in proportion to its size, than at any after period of life. In infancy, childhood, and youth, decomposition still remains less active than nutrition, although there is a gradual approach made towards a balance between the two. In adult age an equilibrium seems to be nearly established. In old age decay takes place, decomposition at last predominating. Not only man, but all animals, and all vegetables, have their periods of growth and decay. It would seem as if nature had only a certain sum of materials to work into organized existence, for she bestows nothing permanently upon this part of

creation ; what she gives at one time, she is sure to demand at another.

There are a thousand causes, as climate, the different seasons, sleep and watching, the moral affections, &c. which exert an influence over nutrition ; but it is not our plan, nor do our limits permit us to go into a consideration of these different causes of influence ; we will therefore proceed to make a few remarks on the subject of animal heat as connected with the system of capillaries.

Animals during life have a capacity of maintaining nearly an uniform temperature in every variety of heat and cold to which they may be subjected. It was the remark of an eminent physician,* that if a definition of life were required, " it might be most clearly established on that capacity, by which the animal preserves its proper heat under the various degrees of temperature of the medium in which it lives ;" and that the degree of this capacity might be considered as a criterion of the strength of the living principle among individuals of the same species.

Not only animals, but all living organized nature has a power of generating a temperature. The degree of this power seems to be proportioned to the perfection of organization. In vegetables it is less than in animals, suited, no doubt, like all their functions, to the humbler grade they maintain in the scale of creation.

Many theories have been advanced by modern chemists to explain the production of animal heat, the

* Dr Currie.

greater number of which are as irrational and absurd as the mechanical ones which preceded them. They all suppose respiration in the breathing animals to be the principal source of their caloric; and that it is extricated either in the lungs themselves, or that the blood is so acted upon and modified in these organs, that it is enabled to give out this principle in different parts of the system. One of the latest of the chemical theories appears to make the general capillary system the principal seat of the extrication of caloric. It attributes its production to a difference of capacity for the principle of heat between the arterial and venous blood; making the air, at the same time that it operates on this fluid so as to alter its other properties, to increase also its capacity for caloric. Now we have said, that it is in the general capillary system that the blood undergoes its change from arterial to venous; the inference then is plain, according to this theory, that here the caloric of the body must be given out. Many of the phenomena, however, connected with animal heat, cannot be explained on any of the chemical theories; all present difficulties, which we can only get over by referring it to vital laws.

All substances which are endowed with life have a capacity of generating a temperature; organized bodies, to be sure, have it in the most perfect degree, in all of which there may be said to be respiration. Others, however, which possess life only, without any sensible organization, appear in some measure to be possessed of this faculty. The blood, when fresh, resists external temperature more powerfully than other fluids, or than after its vitality has ceased. The

same phenomenon is noticed in eggs; experiments have proved that these, after having been once frozen, freeze much more readily than before their life was destroyed by this process. The seeds of plants also, are said to be endowed with a capacity of resisting cold. Now none of these substances are possessed of the function of respiration; they have only the principle of vitality, without any of its sensible actions. Animal heat then does not depend immediately and solely on actions resulting from the vital principle; it seems, if I may so express myself, to be co-existent with, and to enter into the very essence of life itself; to be, in fact, one of the necessary conditions of vital existence, and from which we can no more separate it, than we can gravity from matter.

As the life of a part increases, its capacity for generating a temperature increases, apparently, in a direct ratio. Perhaps it may go on increasing in the substances taken into the body for its nourishment in the ratio of the increase of their life, and be produced by the same inscrutable laws which give to the nutritive matter its vital properties. On this supposition it would be especially developed in the system of capillaries, since here the living principle is bestowed in the most exalted degree. Could we suppose all the different operations of the system going on mechanically, by these means circulating inert matter, no animal heat I am persuaded would be generated.

Hunter thought that the more perfect animals were possessed of a faculty of generating cold as well as heat, both constitutionally and locally. The animal body is certainly capable of resisting high

degrees of temperature, which capacity no chemical theories can fully explain. May not this power be bestowed in a more exalted measure upon the dark races of men who inhabit equatorial regions? But we are to speak of animal heat as connected with the capillary vessels. Now the capacity of producing it being in a ratio of the sum of vitality, it will be proportioned to the supply of capillaries, for it has been remarked that as these are more numerous in a part, its life becomes more active. Perhaps like vivification it may be especially a function of these vessels.

I will now mention a few phenomena which tend to show an intimate connexion between the capillary system and the production of animal heat.

When the condition of the extreme vessels becomes altered, as in disease, the temperature evidently receives an influence. Antimonial medicines are well known to diminish, under certain circumstances, the heat of the surface, and is it not by their actions on the vitality of its vessels? Animal heat appears in fact to be subjected to similar laws as nutrition and other phenomena exhibited in the capillary system; for the capacity of an organ to maintain its temperature seems to be in the ratio of its quantity of life as shown by the vigor of its functions. Nature has protected those organs which are supplied with but a low degree of vitality from the influence of the changes of temperature, by enclosing them with others endowed with more energy of life; as is witnessed in the bones, cartilages, &c. When a part possessing but a low degree of the living principle, is

not thus guarded, it is very liable to become frozen, as noticed of the ears and tip of the nose.

It is Bichat's belief that the quantity of animal heat extricated in an organ is proportioned to its sum of life. Hence he supposes this principle to be given out unequally in different parts of the body, and that each system has its own degree, as well as its peculiar mode of heat. The nails, hair, and epidermis have less than the other systems, the white organs less than the muscles; the claws of birds, which consist only of white parts, not being so warm as the rest of the body. Each of the internal systems, he believes, could their heat be analyzed, would be shown to extricate different quantities of this principle; so that there is a variety of temperatures in proportion to the number of organized systems, the general temperature being the combined result of the whole.

Bichat's theory of animal heat supposes that caloric enters the blood with all those substances which repair its losses, and that in a combined state, it is carried to the general capillary system, where it passes from its latent to a free state in consequence of the various changes and modifications the blood undergoes there in forming the materials of the different functions; making it a phenomenon analogous to such as are exhibited in the other functions which have their seat in this system; a combination of foreign substances with the blood, circulation with this fluid, and finally their separation in the capillary system. "It seems to me that the explanation which exhibits

nature always pursuing a uniform course in her operations, drawing the same results from the same principles, has a greater degree of probability than that which shows her separating, as it were, this phenomenon from all the others, in the way which she produces it."* We as yet, however, know too little of the nature of caloric, and of the laws of its communication to subscribe implicitly to this theory. In fact we have at present too few data on the subject of animal heat to admit of profitable inquiries into its intimate laws.

Whenever the circulation is promoted in the capillary vessels, the temperature is increased. This is witnessed in inflammation, and in parts to which friction has been applied. In blushing, also, a sense of increased heat is felt in the face. Now in these cases the temperature may be increased without any perceptible change taking place in the general circulation. On the other hand, when the circulation is diminished in the extreme vessels we become cold, and even the rigors occurring in the first stage of fevers have been referred to the diminution of action in the capillary system.

When asleep, as Fordyce remarks, we cannot communicate so much caloric to the surrounding medium as when awake, though the temperature of the body remains the same. Now in sleep there are many circumstances which seem to show a diminished

* Bichat's General Anatomy, vol. II. p. 46.

energy of the capillary vessels, to which this phenomenon may be attributed.*

We would here remark that sensation is not always a sure criterion by which to judge of temperature. In fevers especially, as well as in many of the nervous diseases, our sensations give very erroneous ideas of the heat of the body or its parts. And even in health they are often much influenced by particular circumstances, as constitution, habit, &c. Animal heat is seldom, either in disease or health, increased so much as our sensations often lead us to believe; variations, however, do take place in it, both constitutionally and locally, as experiments have sufficiently proved.

In persons suddenly destroyed, as in strangulation, where the great circulation is first interrupted, the animal temperature will often continue for some hours; whereas in lingering deaths, as from chronic diseases in which life appears to receive its first check at the circumference, it will at once cease to be produced. Now in the first case the phenomena of life continue for a certain period in the extreme vessels after they have ceased in the great circulatory system; but in the second, death first attacks the capillary vessels, annihilating all their functions.

* I am aware that absorption is thought by many to be more active during sleep; one of the principal reasons for which belief is that persons more readily receive contagious diseases at this time, as well as those which arise from miasmata, as some fevers. But may not this be attributed to a want of energy of reaction in the system, incapacitating it to resist the operation of morbid causes?

There are some circumstances which would appear to show that the nerves influence the production of animal heat; but in many cases, certainly, this phenomenon is independent of the nervous system. Recent experiments relating to this subject have been attended with very different results, we must therefore rest in ignorance of it till new ones throw farther light on the question. How is it that the maniac opposes such a powerful resistance to cold? May it not have some connexion with his increase of nervous energy?

I shall now close this part of my subject with a few remarks on the influence which the passions exert over the capillary system. It is not within my plan, even were I competent to the task, to go into an examination of the different theories relating to the passions. Whether they primarily affect organic life, or whether the brain receives their first shock, and this life is affected secondarily, is of but little consequence in relation to our view of the subject; since we purpose only to show that the different affections influence the state of the capillary vessels, and that their condition may in turn, also, operate on our mental feelings.

I conceive the effect of the passions to be generally diffused throughout organic life, not exhibited uniformly and exclusively in one particular organ or set of organs; and also that the shades and degrees of influence are various and much modified in the different parts of this life. The apparent effect, however, must be more manifest in some organs than in others. The same comparative influence, for example,

exerted on the system of capillaries as on the internal organs, would be much less evident in the former, because their functions are more generally diffused; we cannot refer a derangement here to any definite point, as in organs which have distinct functions and location.

If then the opinion be correct, that the influence of the passions is generally diffused throughout organic life, the system of capillaries would come in for a large share of this influence, which seems actually to be the case. I suspect that the functions of the capillary vessels are as frequently affected by our mental feelings as the great functions of the heart, liver, &c., though for the reasons just stated, the effect here is not so obvious to our senses

I do not, for my own part, think that the effects exhibited in the capillary vessels, during the operation of the different passions, are to be so generally referred to sympathy as Bichat seems to believe. In sudden fits of anger, the blood will often enter and leave the capillaries of the face almost instantaneously, and without any perceptible alteration in the great circulation. The same thing happens in shame. Under the influence of this passion, the face, and even neck and ears, will become momentarily suffused with blood, and without our being able to refer any peculiar, any primary sensation to those organs which perform the great functions of life. In fear, the blood will at times very suddenly desert the cutaneous vessels, and often profuse sweating ensues. This passion, to be sure, frequently induces a sense of internal oppression, and fluttering about the heart; but may we not in part re-

fer these effects to an accumulation of blood in the internal organs, as a consequence of its desertion of the surface? It is well known, that the effect of an accumulation of blood about the heart is to excite palpitation. No doubt, too, but that there may, in many instances, be a direct diminution in the heart's power. In anger, we feel, especially, a sense of oppression when the surface is pale. Now in such cases why may not the state of the capillaries be directly influenced as well as that of the internal organs? Have we any more reason to say, that the extreme vessels sympathize with these, than that these sympathize with the extreme vessels? The tears flow in grief, excessive joy, &c., but there does not seem to me to be sufficient proof that this secretion is always the effect of sympathy. These passions, for any thing we know to the contrary, may exert a direct action on the vitality of the lachrymal gland; as well, in fact, as on that of the liver, which Bichat seems to admit.

When two different parts of the system take on morbid action, we are very apt to account for the affection in one, by saying it feels, or sympathizes with the other; often, too, when there is no positive proof to show but that they might both have been an effect of one and the same cause. We are especially disposed to explain affections of the extreme capillary vessels on the principle of sympathy; which is correct, perhaps, in many instances, but, as I conceive, not always, since the original cause of disease may as well be supposed to act on them primarily, as on the nervous system, or internal organs performing the great functions. The term sympathy is in fact often employed

without any precise idea being affixed to it; serving as a cover under which ignorance may shelter itself. I have sometimes even thought it would be as well for our science, were its employment for the explication of vital phenomena entirely dispensed with, as we might then endeavour to understand certain operations in the economy, which we are now content to be ignorant of, having so happy and effectual a way of concealing this ignorance. I am not, however, complaining of the term when employed judiciously, and within proper limits; it is its perversion to which my remarks are directed. Its vague and unlimited use brings to my mind certain physicians who call all fevers typhus, paying no regard to the signification of the term;—no matter whether the weight of the disease fixes on the head, the gastric organs, or the nervous system—a name is always at hand which will be sure to satisfy both themselves and their patients. But to return from this digression; let us adduce a few instances to show that the passions exert an influence over the capillary vessels.

It is a common belief, and not without foundation, as numerous facts might be brought to show, that grief has an effect upon the hair. Under the operation of this passion, especially if long continued, it becomes white and falls off, from not receiving a due supply of fluids which give to it colour and support. Bichat observes that he has known five or six instances in which grief has produced discoloration of the hair in less than eight days; also that the hair of a person of his acquaintance became perfectly white in the course of a night upon the receipt of melancholy intelligence.

It is said that terror will sometimes make the hair to stand erect. Whether this ever happens, or how it is caused if it do happen, I am ignorant. Baron Larrey, in a memoir on partial tetanus, relates a case of this disease in which the hairs of the mustachios on the right side stood on end, and were excessively painful on being cut, or even touched.

The effect which the depressing passions have on the appearance of the skin may be daily witnessed. How sallow, pale, and sickly is the complexion of the man whose days are passed in gloomy, melancholy repinings! The blood deserts the capillaries of the surface, and all the actions of these vessels become sluggish, or, in some instances, even morbid. But very different is the external appearance of those, who with light hearts and buoyant spirits, gratefully receive all the blessings which are bestowed upon them. In such, there is a fulness of the vessels of the surface, imparting to it a fresh and ruddy hue, lighting up the eye, and giving beauty and intelligence to the whole countenance.

In some of the passions, as fear and horror, the blood seems entirely to forsake the skin; it becomes pale, cold, and shivering, and often a peculiar creeping sensation is felt in it, which persons commonly express by saying, they *crawl all over*. This feeling is probably connected in some way with its capillary circulation.

Some of the passions, when excessive, as anger and grief, are said to produce erysipelas. I have at this time under my care a young lady, possessing a peculiarly delicate, irritable skin, in whom mental agitation,

even though it be very slight, will often produce in it a redness resembling erysipelatous inflammation. It occurs generally about the neck and face, but also on other parts of the body. It frequently continues for a day, and even longer. Sometimes it appears in circumscribed spots, at others it is more general. A short time since I had occasion to introduce a seton into the upper part of her chest for a pulmonary affection. Now, whenever I saw this dressed, I noticed about the neck, chest, and often on the face, this peculiar inflammatory appearance. On inquiring concerning it, I learned that it only came on during the preparation for dressing her seton, and that it was referred to the mental agitation she felt at this time. It would generally disappear in the course of a few hours, but it continued at times much longer.

The venereal passion acts evidently upon the capillaries of the erectile textures. Every one knows how suddenly its operation will distend them with blood.

As it respects the mind and the capillary system, there is, moreover, a reciprocal action; they act and react upon each other. If the state of one is much altered, the other feels it, and by reaction may increase the primary affection. I have very repeatedly observed—and no doubt others may have noticed the same thing—that whenever perspiration is checked, as in a common cold, the temper becomes gloomy and irritable. This state of feeling I can generally relieve in myself by an antimonial, especially if taken on retiring to rest; it seeming, when it begins to promote a softness and moisture of the skin, to give also a calmness and serenity of temper, which contrasts strongly with its previous gloomy and irritable state.

The mental affections act on the secretory capillaries of the different glands. The tears flow in grief and many other passions. Anger sometimes increases the flow of saliva. The same effect will at times be produced by the recollection of certain tastes, whether pleasant or disagreeable. Parental affection is said to occasion, even in some brute animals, a copious flow of milk.* It is stated also that some cows will not give milk freely to strange milkers. Parry gives an instance of a lady, who, after having long ceased to nurse, would have a secretion of milk produced by hearing a child cry. Fear produces an increased secretion by the kidneys, and probably at times of the mucous glands of the intestines. Sexual desire acts on the capillaries of the testes in males, and on the glands of the mucous membrane of the vagina in females. Some emotions of the mind, as sudden frights, have given rise to a copious flow of bile, and jaundice has also followed as their consequence.

Some mental affections produce sweating. " In one patient," observes Dr Parry, " the mere recollection of

* Capt. Franklin, in an account of his journey to the Polar sea, relates a singular case of a young Chipewyan, who having separated from the rest of his band for the purpose of trenching beaver, his wife, pregnant with her first child, was seized with the pains of labour, gave birth to a boy, and died in three days afterwards. The husband, inconsolable for his loss, and anxious to preserve the life of his infant offspring, acted as its nurse, and to still its cries applied it to his breast, when, as is stated, from the force of the powerful passion which actuated him, a secretion of milk actually took place. The left breast of this Indian, the one from which the infant nursed, continued, even in his old age, of an unusual size.

ham, cheese, and certain other kinds of food, which he much liked, but which disagreed with his stomach, immediately produced about his head a degree of sweating, which could be compared to nothing but his having dipped his whole head in water."†

The passions influence nutrition. Those which are cheerful give vigor and activity to this function, whereas those of a depressing kind, give to it a manifest imperfection, and sometimes almost a total check. This imperfection in the action of the nutritive vessels may often be in part the cause of that loathing, or entire disregard for food, which is so often the attendant on a depressed state of feelings.

Probably the diseases about the gastric organs, so frequently arising from the continued operation of the depressing passions, as chronic inflammations, scirrhus, &c., may be owing to a direct influence exerted by them upon the capillary systems of these organs. Grief, for example, will sometimes produce scirrhus of the stomach. Now under the operation of this passion we feel at first a sense of fulness and oppression about the situation of this organ, which is probably owing to a preternatural fulness of its capillary vessels; and if this state were long continued, a low degree of inflammation might follow, and perhaps scirrhus as the next consequence. These different states of the capillary vessels of the stomach would explain the origin and progress of the dyspeptic symptoms which usually attend the operation of this passion. In the same way might be explained many of the different diseases resulting from the long operation of any of the gloomy

* Parry's Elements of Pathology.

passions. The action of the heart, for the most part certainly, is not increased ; it rather in fact seems to be diminished. It is likely that more blood is determined to the internal organs in consequence of its diminution on the surface.

We will now proceed to the second part of our subject, in which we are to treat of the morbid functions of the capillary vessels.

In every disease to which we are subjected, the extreme vessels appear in some way or other to be intimately concerned. And that this must necessarily be the case can readily be conceived, when we reflect that it is especially upon the regularity and perfection with which their functions go on, that health immediately depends. In many instances, in fact, we notice a striking analogy between healthy and morbid phenomena. They are apparently produced and kept up by the same instruments, and may, perhaps, be owing only to some difference of modification of the same actions. How much, then, these vessels would be concerned in diseased phenomena, might be inferred from the number and importance of their healthy functions. In truth, in a large proportion of cases, the various alterations in the action of the capillary vessels, are the ultimate cause, and constitute the essence of disease. In all morbid processes, too, conducted in the economy, they are the point to which our chief remedies are directed.

To constitute health it seems necessary that there should be a medium state of fulness or distension of the capillary vessels ; and that a due balance should be maintained between those of the different parts of the

body; or, in other words, that they should bear, as it regards fulness, a certain relation to each other. And it is especially important that this relation should be kept up between the general and pulmonary capillary systems, and also between the capillary and great circulation. Slight variations may not give rise to manifest disease; yet if they occur in any considerable degree, the system, or some of its parts, will inevitably feel a shock. Now there are a thousand causes which may operate to destroy the relation of which we have been speaking. So numerous and ready are the communications among the capillary vessels themselves, and between them and the great circulatory system, that, the whole quantity of blood in the body remaining the same, if from any cause one set of vessels have their quantity lessened, it must be proportionally increased in some other, or in the rest of the system generally, and *vice versâ*. Thus, if you determine the blood to the surface, that is, make it pass readily from the arteries to the veins, you diminish it in the large trunks, and about the heart. It is in this way that internal congestions are often relieved by restoring or increasing cutaneous action. The converse of this is likewise true; for if the action of the skin becomes checked, accumulations of blood are apt to occur about the heart, or other internal organs. Sometimes, however, an emptiness of the cutaneous vessels, if continued but for a short time, seems to increase the healthy activity of the internal functions, as is often the case when cold is applied to the surface. But if this emptiness is permanent, and the blood becomes accumulated in the internal organs beyond certain limits, disorder will ensue.

Cold applied to the feet often gives rise to a preternatural determination of blood to the head; and, on the other hand, heat applied to them relieves excessive fulness of the vessels of this part.

These two conditions of the capillary vessels we have been describing, viz. fulness and emptiness, are intimately connected with, and often result from an increase or diminution of action in them. Thus, increase the action of the capillaries of a part, and blood, beyond what its natural state requires, is determined to it; diminish their action, and the blood becomes diminished. The converse of this also holds; lessen the blood in an organ, and its actions are languid; increase its quantity, and they grow more vigorous. Where we find, then, an increased or diminished quantity of blood in the capillaries of a part, we have very generally, for there may be exceptions, a right to infer a corresponding increase, or diminution of action, either as cause or effect. The well known theory, that increase of action in one part diminishes it in some other, or in all the rest of the system, might be applied to account for what we have stated, that fulness in one portion of the capillary system, supposes a partial emptiness in some other, or in all the remainder. That excessive action in one part should diminish action in another, seems to be a very general law of our economy. Hunter laid it down as a universal principle; it certainly, however, admits of exceptions. Of this principle physicians have availed themselves much in the treatment of diseases, though not always successfully.

From what we have stated, it will appear that alterations in the capillary circulation may be the cause of various disorders in the system. Sometimes there is a morbid fulness of the capillaries of a part, arising either from an unnatural excitement, or, as happens in some instances, from a sluggishness in their actions; hence follow congestions, with all their attendant consequences. There may also be a partial fulness and partial emptiness of these vessels; thus some parts will be hot and flushed, whilst others are pale and cold. In headach there is often a preternatural heat about the head, and a partial or general coldness of the rest of the body.

There is often a fulness of the capillary vessels of the lungs, and an emptiness of those of the surface. Since the pulmonary and general capillary systems are in opposition to each other, whenever the blood is diminished in one, allowing the whole quantity to remain the same, it must be increased in the other. Now the pulmonary capillary system corresponding with that of the whole body, this fluid, becoming diminished in the vessels of the surface, would be very likely to be increased in this system; thus, causes operating to check cutaneous action, frequently produce affections of the lungs, as oppressions about these organs, congestions, and inflammations. They appear to act by altering the healthy relation between the two circulatory systems.

Certain individuals are at times especially subject to a difficulty of breathing, or what is termed asthma, which is often brought on by very slight causes. May not this, in some instances, arise from the pulmonary and general capillary systems not bearing a natural

and healthy relation to each other? And may not disposition to disease in the lungs often originate from the same cause? In those disposed to pulmonary complaints, the capacity of the chest, and consequently the size of the lungs, is frequently small in proportion to the rest of the body; for which reason the capillary system of these organs cannot bear its ordinary and natural proportion to that of the system at large.

Local fulness of the capillaries may occur independently of any increase of action in the heart, apparently depending on changes in the properties of these vessels themselves; the action of this organ, however, may become subsequently increased. Local determinations also follow an acceleration of the heart's action.

Unnatural fulness of the capillary vessels is undoubtedly the cause of a vast number of morbid symptoms in the economy. Many of those local pains which we at different times experience, may arise from an extraordinary distension of these vessels. A determination of blood to the schneiderian membrane prevents a free passage of the breath through the nostrils, and gives rise to other symptoms of what is commonly called *cold in the head.* It is thought by Parry that the disease denominated spasmodic asthma, often arises from a preternatural fulness of the capillary vessels of the mucous membrane of the bronchiæ.

A preternatural emptiness of the capillaries may undoubtedly of itself give rise to symptoms of disease. It is a law of our constitution that the different sets of vessels should always adapt themselves to their contents. Now when the blood is diminished from any cause in

the system of capillaries, its vessels make an effort to contract, which is attended with an expense of vital power proportioned to the sum and suddenness of contraction. If the vessels, then, of a part have not power sufficient of their own to effect the necessary contraction, the whole system will become affected. One cause of reaction in the system seems to be to restore to vessels, which have been partially, or wholly emptied, their natural fulness and tension. Sometimes it is too powerful, giving rise to morbid fulness, or even inflammation, in parts which had been previously robbed of their blood. Reaction may occur in a part itself, independently of the heart, its vessels being able by their own powers, to recover their natural state; it is when their ability fails that the heart must lend its aid.

In some diseases, at their commencement, the capillary vessels of the surface are almost entirely deserted by the blood. This happens in the cold stage of fevers, and in hectic; we also see it in syncope. To employ a figure of Hunter, "the whole powers or materials of life are called into the vital parts or citadel, and the outworks are left to themselves." Hunter remarks, that in the commencement of diseases this state does not seem to arise from real debility of constitution, "but from the novelty of the action, and of course a debility of that action, and that only." In hectic, however, he supposes it to arise from debility, but assisted by the *unnaturalness* of the action. Reaction, for the most part, follows this state of the surface, by which its vessels have their fluids restored to them, either partially or entirely, and often in superabun-

dance. The powers of the system, after a certain time, appear to concentrate themselves for a new sally to regain the station from which they were driven. This object they generally effect by their own efforts, but at times they are not competent to the task, and fail altogether, or require foreign aid. In some cases, the equilibrium of the circulation produced by the reaction is perfect and permanent; as in syncope, in some colds, and in that fever which has received the name of ephemera; in others, it is only partial and temporary, as in continued fever, &c. In most chronic diseases we notice this state of emptiness of the cutaneous vessels, the vital powers seeming to be drawn off from the surface, and concentrated to carry on the disease.

In some diseases, however, at their very onset, the surface is preternaturally red and full of blood, the system, apparently, being at once aroused to exertion. Here, to go on with the figure of Hunter, the powers of life, instead of being compelled to desert the outworks, are reinforced by fresh supplies from the citadel, by which they are enabled to maintain their station.

The effect on the constitution of these different changes in the state of the capillary circulation we have been describing, will be proportioned to the importance of the part in which they occur. Thus a preternatural fulness may happen in the capillaries of the face and be productive of little or no inconvenience; whereas the same determination of blood taking place to the mucous coat of the stomach, would perhaps give rise to indigestions or dyspepsia with all the attendant feelings; or if it were to the liver, an increased flow of bile, and diarrhœa might be the consequence.

Particular local determinations are especially apt to occur in certain individuals. Different ages, too, and seasons predispose to determinations of blood to some parts more than others; so that the same exciting causes may give rise to affections of parts very different in different constitutions, at different ages, and in different seasons or climates, although they may be applied to the same part. If any one portion of the body be weaker than the rest, congestions will, on a general principle, be more liable to occur in it; for this reason, that, if from any cause the force of the general circulation should become increased, a corresponding increase of healthy action would be less likely to take place in such a part than in others possessed of more power. The relation, then, between the quantity of blood and of vital energy would be readily destroyed, and morbid fulness of the vessels, and perhaps inflammation, be the necessary consequence. On this last named affection we will now proceed to make a few remarks, since it is, without doubt, conducted by the capillary vessels. In all its stages, in fact, they seem to be the primary and special agents.

We cannot always draw a definite line between simple fulness or congestion of the capillaries of an organ, and actual inflammation. These two states appear at times to be vicarious, and as it were, to run into each other; the extreme cases may very readily be known, but there will be intermediate grades not a little difficult to distinguish. Hunter supposes that the first act of the vessels, after the exciting cause of inflammation has been applied, is exactly similar to a blush, being simply an increase or distension of the vessels beyond

their natural size; similar to what takes place from slight friction of the skin, or gently stimulating medicines applied to it, either of which being increased or continued, real inflammation will be the consequence.

The peculiar mode of action of the capillary vessels during inflammation, we do not pretend to understand; nor do we know wherein it differs from their healthy actions. Action in them is probably in most instances increased; in some perhaps it may be diminished, in every case it is *unusual.*

An inflamed part receives more blood than it does when in a healthy state, it being admitted into vessels which before conveyed only white fluids. The vessels probably become dilated, and perhaps, after a while, new ones are formed. Hunter supposes the blood vessels to be endowed with a power of active dilatation, which for some inscrutable purpose they exert in inflammation; the obvious effect of which is to admit more blood than they do in their ordinary state. Parry thinks that a proneness in the vessels of a part to dilatation, may give it a disposition to inflammation, and also that it may bear some relation to various other maladies.

That a part, in a state of inflammation, should receive more than its ordinary supply of blood, is in conformity with the general law of our constitution, that the more labour an organ has to perform, the greater must be its supply of this fluid. When any new process is set up in any portion of the system, more blood is sent to it. This is witnessed in many healthy processes; as in lactation, between which and inflammation there is a striking similarity. Before milk is secreted the vessels are dilated, and the gland becomes

full and harder than usual; there is also an increase in its sensibility and irritability, and pain is often felt in it. After secretion has taken place these appearances partially subside. They are most manifest during the first lactation. Now in inflammation there is some new and unusual purpose to be effected, which demands extraordinary efforts from the capillary vessels that are to conduce to it, and their supply of blood must be proportioned to the sum of these efforts. Thus slight inflammation may be carried on in an organ by its own powers, the system not being called upon for aid; but if it is severe, or the energies of the part feeble, the necessary purposes cannot be thus accomplished. Then the actions of the large vessels nearest the inflamed part become increased; and when necessary, this increase extends, by what Hunter calls continued sympathy, even to the heart itself. It would seem here as if the part made its first demand for assistance upon its nearest neighbours, and so on, when requisite, to those most remote. We may on this principle, then, in part explain sympathetic fever; but this may also arise from irritability, or that state of the system which disposes it readily to take on excessive and irregular actions, which it can neither limit nor control. Whether such actions have any final cause, that is, whether they are necessary to effect some salutary purpose in the economy, or are strictly morbid, we do not know; analogy would rather seem to lead to the belief that their end is salutary.

Inflammation consists in a series of processes set up for some definite purpose in the economy, and the different exciting causes appear to operate by producing

a necessity for those peculiar actions which constitute inflammation, to effect this purpose. Its general object, then, seems to be for the benefit of the economy, and though of itself frequently a serious disease, it is, no doubt, on a general principle, a means of preventing more serious evils of which we have no idea. Nature's means, to be sure, are not always successful; there may be peculiarities of constitution interfering with the perfection of the different processes of inflammation, or it may occur in such situations as to be productive of very unpleasant consequences, or even death; still its general tendency is beneficial. All nature's laws are in themselves beautiful and tend to good, though evil will in particular instances result from them. We in many instances can know the final cause of inflammation, and we always find it to be salutary. A thorn, when forced into the body, excites a series of actions which result in its expulsion. The different poisons, too, often excite inflammatory processes by which they are either prevented from entering into, or are thrown out of the system.

Inflammation may be produced by causes which increase the force of the general circulation, or it may be brought on by some direct operation on the capillary vessels themselves; in either case similar actions are induced in them, and the same necessity for inflammatory processes. Parry thinks that certain modifications of impulse from the blood may mechanically excite in the capillaries those actions which constitute health and disease.

There are other inflammations which we call specific. These arise either directly from the application

of specific causes, or are owing to a disposition in particular parts, or in the system at large, to take on peculiar actions, which may be excited even by the common causes of inflammation. Among the first would be ranked measles, small-pox, scarlatina; with the second, cancer, gout, fungus hæmatodes, &c.

In speaking of specific inflammations, it will be proper to notice scrofula, it being very commonly thought to have a specific character. Many eminent pathologists, however, believe it to originate in a want of power in the system to go through the healthy processes of common inflammation.

Persons of what is denominated a scrofulous habit, have very feeble constitutions. They for the most part exhibit a peculiar delicacy and transparency of skin, become flushed from slight causes, and sweat very easily. Diseased and healthy processes go on slowly in them, wounds are backward in healing, and every thing seems to indicate in such persons a want of energy in the actions of the capillary vessels. Now the facility with which a part takes on disease, other things being equal, is greater in proportion as its vital powers are less. Feebleness, too, prevents restorative processes from going on perfectly and regularly, and disposes to morbid actions, the healthy relation between the quantity of blood, and the power of the different parts, being very readily destroyed. Weakness of constitution, then, whether original or acquired, may be a predisposing cause to strumous affections; and the facility with which the scrofulous take on disease, may be owing to the readiness with which the natural relation between the vessels and their fluids becomes destroyed.

Individuals of the habit we have been describing, are subject to affections of particular parts at the different periods of life; in infancy, of the mesenteric glands; in youth, of the glands of the neck; and in adult age, of the lungs. In infancy nutrition is especially active; frequent supplies of blood are demanded for the purposes of growth, which must pass the mesenteric glands. At this period of life, then, they are particularly active, and of course largely supplied with blood; for which reason, from principles already stated, they will in a special manner be disposed to disease. In youth particular changes take place about the throat; the larynx becomes more fully developed, the voice alters, and the whole neck appears to be more largely furnished with blood to effect these changes. Perhaps, then, the glands in this situation may be somewhat influenced from these causes, and take on disease with more facility. In adult age, there not being the same demand for growth, more blood must be returned by the veins, and consequently more must pass the pulmonary capillary system. Now if the lungs were naturally weak, and bore less than their healthy proportion to the rest of the body, as is generally noticed in the scrofulous, would not disease be very liable to be excited in them at about the period when growth partially or wholly ceases? And more so than after these organs had had time to accommodate themselves to their increased quantity of blood, or the circulation had become restored to its healthy state and relations, which would naturally happen after a while? This principle, however, cannot be applied to all cases of pulmonary consumption. It often happens that persons, soon

after puberty, grow very rapidly, so much so that the whole system becomes weakened; they grow, as is commonly expressed, beyond their strength; at this time pulmonary consumption will often come on in the predisposed. Here, then, it occurs before growth ceases, at the very time, in fact, when it appears to be most active. In such cases there would rather seem to be a draught of power from the lungs, the forces of the system, seemingly, being expended in supplying the demand made on them by this rapid increase of the body.

In common inflammation particular phenomena often occur which we call morbid, from a want of energy in the inflamed part; sometimes there being a deficiency of action, and at others it becoming excessive, without corresponding power, constituting irritation. Thus inflammation is frequently affected in its healthy course, sometimes in one stage, sometimes in another. At times it becomes stationary; the vessels which conduct it apparently wanting power to effect the whole object which nature has in view. Where a part is feeble, common inflammation in it is very apt to run into specific action, if there is any disposition to such on the part of the individual.

Inflammation is always most manageable where the strength is greatest. Parts, therefore, which are nearest the source of circulation, and have their capillary systems fully developed, go through its processes most speedily, perfectly, and safely, and also make less demand on the powers of the constitution. Vital organs, however, must here be excepted, because their natural functions, the due performance of which is necessary for their own support and that of the system at large, are directly impeded by inflammation.

We are able only to refer thus generally to the different kinds of inflammation. They are all immediately dependent upon the capillary system, and they include, undoubtedly, a large proportion of the diseases to which the animal frame is subject.

It is believed by many, that each texture has its peculiar kind of inflammation; but there does not seem to be much proof of this; in fact, there are many arguments opposed to it. The same inflammation certainly extends from one texture to another by contiguous sympathy. Its phenomena are unquestionably much modified in the different textures; to use an expression of Bichat, it would appear always to be the same individual, but in entering each system, it has a different appearance there, so that often you cannot recognise it. The different textures may be affected with various kinds of inflammation, as noticed in the skin, &c.

Inflammation terminates in different ways, and diseases which are classed as distinct often follow as its consequence. It terminates, though very rarely, in resolution. Here the capillaries gradually return to their natural actions without effecting any manifest alteration in the part inflamed. Adhesion, in which coagulable lymph is thrown out, is another of its terminations. Suppuration also terminates it. Here new actions are set up by the capillaries, and pus is secreted. Inflammation likewise ends in effusion, in which case serous fluids, and sometimes coagulable lymph, are poured out; the former giving rise to dropsies, the latter, probably, to many of those swellings of the periosteum, thickenings of the membranes, &c. which

so frequently follow inflammatory actions. Depositions of certain kinds of matter are sometimes the consequence of inflammation. In gout the capillaries deposit chalky substances; and those depositions of bony matter so often noticed in particular textures, may in some cases be the result of inflammation. Exhalations of blood, too, frequently ensue during its action. In all the terminations mentioned, except the first, the properties of the capillary vessels appear to undergo some new and peculiar change, which disposes them to throw out particular substances, and which is usually accompanied by a relief of the inflammation. How the different effusions produce this relief we know not; neither are we certain of the relation in which they stand to each other as cause and effect; in fact, we do not know but that they may both be concomitant effects of one and the same cause.

We will now briefly notice two of the most important diseases which we have mentioned as sometimes resulting from inflammation. These are hemorrhage and dropsy.

Hemorrhages. These often follow inflammation, especially of the active kind; but they may also arise from other causes. Excessive increase of the heart's action, as happens after violent bodily exertions, will at times give rise to hemorrhages, and in a special manner if any part be predisposed to them. In such instances, it would seem that the power which the exhalants always possess in their state of health, to resist the entrance of fluids foreign to their nature, particularly if there is no predisposition to the affection we are describing, is overcome by the *vis a tergo;* in the same

way that we can conquer the vital resistance opposed to foreign fluids in the capillary vessels of animals recently dead, by increasing the momentum of these fluids by additional power applied to the piston of our syringe.

Though hemorrhages may be produced in the way we have described, still I believe they more frequently occur from some change in the vital properties of the exhalants, which alters or destroys their proper elective affinity; in the former case, placing them exclusively in relation with blood; in the latter, destroying their natural relations; so that in either, blood would be effused. Now the facility with which the natural relations of the exhalants are altered or destroyed, may constitute in different individuals a disposition to hemorrhage. It is most usually on mucous surfaces that hemorrhages occur, as in epistaxis and hemoptysis, both of which, we have strong reasons for believing, are owing, in most instances, to effusion.

As another cause of hemorrhage we may mention a direct diminution of the vital power of the exhalants, which incapacitates them for opposing their natural and healthy resistance to foreign fluids; their elective power from this cause being enfeebled and easily overcome. The passive hemorrhages of low fevers &c. arise, in all probability, from this state of atony of the extreme vessels. To the same cause the cold sweat of syncope, and that which occurs a little before death, is referrible; the vessels in these cases, as a distinguished physiologist has remarked, apparently approaching the state in which they are when life has ceased to excite them. Perhaps there are cases in which a

disposition to particular hemorrhages arises from a feebleness, either original or acquired, in the vital energy of the exhalants of the organ thus disposed ; so that, though the elective power of its exhalants might be adequate to the healthy force of the circulation, yet an increase of it from inflammation, or any other cause, would readily overcome the comparatively slight resistance offered by this power.

Dropsical effusions. These often follow inflammation, though it does not necessarily precede them. Like hemorrhages they would seem most frequently to depend on some change in the natural relations of the exhalants. They often, too, follow obstruction of the blood in some of the venous trunks, there appearing in such cases to be an effort on the part of the neighbouring exhalants to open a new passage to relieve the difficulty produced by the obstruction.

Dropsies may also arise from an increased force of the circulation, and from an atony of the extreme vessels. Thus we see them induced by excessive action, and likewise by great prostration of the vital powers, as in the last stages of fever, consumptions, &c. ; here they are at times vicarious with hemorrhage.

The secretory capillaries are greatly affected in disease. In fact, there is scarcely any complaint which occurs in the system, that does not produce, or is not accompanied by some alteration, either in the kind or degree of action, in some portion of the glandular apparatus ; so that the quantity and qualities of the secreted fluids are almost infinitely varied. Of what numerous changes the urine and bile are susceptible in different diseases, every one must have remarked. The

secretions of the stomach, intestines, salivary glands, &c. are each at times more or less influenced by disease. Sometimes, from an atony of their vessels, the intestines, liver, and kidneys pour out their fluids in great abundance. Thus diarrhœa will frequently occur shortly before death ; likewise, when the powers of the system are much enervated, large quantities of pale urine are often secreted.

A large proportion of organic complaints undoubtedly arise from some modification in the actions of the capillary vessels. In the principal surgical diseases, as tumours, cancer, fungus hæmatodes, and the innumerable cutaneous affections, the capillaries are the special agents concerned.

An inquiry into the state and different changes which take place in the actions of the capillary vessels in fever, would carry with it much interest ; but such an investigation we must leave for others more competent to the task, barely noticing a few of the phenomena exhibited in them under this disease.

The capillary vessels are certainly much affected in fever ; in fact the greater proportion of its phenomena are manifested in them. The function of nutrition becomes almost entirely checked ; the absorbents grow less active, the secretions and excretions are, for the most part, diminished in quantity and altered in quality. The urine is passed in small proportions, and deposits no sediment on standing. The mouth becomes dry, and a peculiar matter is thrown out, coating the tongue. The gastric and intestinal fluids are usually diminished in quantity, and perhaps have morbid qualities. It happens, however, in some fevers that particu-

lar secretions are increased, from which cause diarrhœas and bilious vomitings at times occur.

The skin in fever is generally dry, pale, and contracted, and its colour is changed to a dirty white. During the exacerbation, however, it becomes flushed, either generally or partially. Sometimes it is preternaturally hot, at others cold; or it may be cold in one part and hot in another, showing a difference of action in different portions of its capillary system. The capillary vessels of the eye, and especially of the sclerotica, also contain less blood than in health, hence this organ loses its accustomed brilliancy, and becomes dull and heavy. Fordyce remarks, that if there be an ulcer, or wound, on any part of the body, during the attack of fever, it dries up; showing a change or diminution of action of the capillary vessels, even among the muscles.

A return of the extreme vessels to their natural actions is among the first phenomena of a healthy crisis of fever. The skin grows moist, and there is a free circulation through its vessels. The secretions and excretions are also restored to their natural state; in fact, in every perfect crisis, the first appearances are a general restoration of the healthy actions of the capillary system. Those remedies, also, which have the greatest tendency to induce a crisis, are such as have their action particularly directed to the capillary vessels; ipecacuanha and antimony are both of this class. An emetic of either of these substances, given at the commencement of a fever, is more likely to check its course than zinc, copper, or any of those emetic substances, whose operation is more particularly confined to the stomach.

The sympathies of the extreme vessels are very extensive; for which reason we find their functions more or less affected in all diseases. I believe, however, they are of themselves oftener the prime movers in the catenation of diseased actions, than pathologists are wont to allow; and that their affections are often attributed to sympathy, when disorder first commences in them and is kept up by their state. Let us take dyspepsia for example. In this complaint the functions of the capillary system are much deranged; nutrition languishes; the skin becomes sallow, dry, and cold; wounds do not heal well; and all the actions of this system undergo an alteration, sometimes being diminished, at others becoming irregular or morbid. Now this state of the capillaries is usually explained on the principle of sympathy, and correctly no doubt in many instances, but not always; for dyspepsia, I conceive, may often originate in, and be kept up, certainly for a considerable time, by the condition of the extreme capillary vessels. One of the functions of the capillary system is nutrition. Now suppose this to languish from a torpidity of action here, or not to go on with its usual degree of perfection in consequence of the capillaries acting morbidly, the consequence would be a diminished call on the part of the nutritient vessels for new supplies, on which account the stomach would diminish its efforts; for a thousand circumstances might be brought to show that the action of this organ is, on a general principle, in the direct ratio of the activity of the immediate instruments of nutrition; it being a law of the living body, that where there are a series of actions going on to produce one and the same result,

there should be a due relation kept up between these actions. The whole chain of digestive phenomena proves this. When the stomach acts powerfully, the liver, pancreas, and mucous glands pour out their fluids profusely; and the converse of this happens when it languishes in its action. When there is a torpor in the action of the liver, the action of the stomach becomes diminished, and by restoring vigor to the former organ, we also restore it to the latter. If the nutritive vessels are active, digestion is brisk and perfect, the stomach seeming to put forth just so much power as their degree of vigor demands.

The exhalant, absorbent, and secretory vessels may also exert an influence on the digestive organs; for nutrition is active in proportion to the waste going on in the body. Labour, frictions, &c. all probably act on the digestive organs by wearing upon our machine, and thus increasing the demand for fresh supplies for its repair.

If the functions of the capillary vessels are impaired, the digestive organs, with the rest of the body, will, after a certain period, begin to suffer from the want of nourishment; for the body cannot be properly nourished if the functions of the immediate agents of nutrition are not well performed. This then will be a means of increasing disorder in these organs. A sedentary and inactive life seems to bring on dyspepsia by impairing the vigor of the capillary vessels, thus acting through them on the digestive apparatus.

The functions going on in the capillary system may also be much influenced by the state of the digestive organs. The agents of nutrition will lose their vigor

if they have no materials to act upon ; like every part of our economy, they become enfeebled from inaction. Derange, then, whatever link you will in the digestive chain, the effect is felt throughout the whole, every link becomes disordered. Thus, then, we have shown that dyspepsia may often originate in the extreme vessels, perhaps, as often as in the digestive organs themselves. Had we space, much more might be said on the subject of the sympathies of the capillary vessels. It would also be interesting to consider the action of remedies on them. Some act on them directly, as leeches, fomentations, the warm bath, &c. Others indirectly, as general bleeding, and vomiting. Nearly all, or perhaps all diseases are affected by our remedies through these vessels.

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