ON THE
MODES OF DYING.

A THESIS

by

WILLIAM J. MARSHALL.

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"It is of especial importance to keep in mind
three different modes of fatal termination in three
diseases (such as fever) which admit of the
greatest variety, in which different dangers
threaten on different occasions, and in which
various kinds of treatment are recommended;
because it is only by anticipating the kind of
fatal termination which is most probable
in each case, that we can expect to be guided
to a rational and scientific selection of remedies."

ALISON.
a Kay. On ephelstria.
"Moriendi mille figurae."

If a very great part of the practice of medicine consists in "obviating the tendencies to death" observed in diseases, it must be a matter of the greatest importance for the physician to know the rationalia of the various modes of dying, so that he may thereby understand the tendencies in each case, and discover the different remedial agents, which may prove serviceable in retarding or arresting these tendencies.

By the term death I would here indicate somatic death (a term suggested by Dr. Prihhard) as distinguished from that molecular death, in which every particle of the body is released from vital laws, and is abandoned to the uncontrolled influence of the mechanical and chemical laws of matter. Death in this sense then according to some "consists in the disunion of the intellectual principle from the material organization"; but here I would limit the term for convenience sake to such a condition of the corporeal frame as necessitates that disunion of mind and matter, and renders the mutual action of the soul and body no longer possible in any manner whatso-
"Vita humanae nomine, hic loci, securi per
bulgata, intelligo solum corporis, quoad firmam,
flavida, conditionem, quae omnino requiritur,
ut commercium mutuum inter mentem et
corpus durum quodam modo, ut quod recti
tui utunque, nec recedere est id omnino tolli."
Boerhaave. Institutiones Medicæ.
ever. This condition follows more or less speedily in different cases, when the functions of Innervation and Circulation have been arrested; and our enquiry into the modes by which that condition is produced must therefore consist in investigating the various ways in which these two great functions are arrested. As to what takes place between their arrest and the arrival of that condition to which I would here limit the term Death, we are in complete ignorance. But in some cases of apparent death life has been restored, and in these have not differed in external symptoms from other conditions from cases in which all attempts at resuscitation have failed. We are led to the conclusion that the time at which the condition of death arrives must vary according to laws as yet unknown.

The harmonious as well as continuous action of these two great functions of Innervation and Circulation is necessary for the continuance of perfect human life. If either be disturbed or arrested, the other is as a consequence impeded or brought to a stand at a more or less remote period. And if there is any difference between the Nervous and Circulatory systems it is this that Circu-
lution can continue longer without innervation than innervation can without circulation.

Upon the integrity and harmony of the nervous and vascular systems the life and vigor of the human being depend. By the circulation nutrient is conveyed to all the organs and tissues of the body, and by it likewise are the various effects of matter carried to the different organs of nature. By innervation peculiar influences are transmitted to all the tissues and organs, influences which have been proved to be no less necessary to their healthy nutrition and action than are the materials conveyed by the circulation. That the circulation may continue without interruption there must be efficient organs to propel and a proper amount of nutrient fluid to excite those organs to action. But it is likewise necessary for the proper nutrition of the body, and for the continuance of the circulation, that the blood be from time to time exposed to the air, that certain matters may thus be expelled and others received into the economy. If this process of respiration is not performed the blood becomes at the unfit to nourish the tissues, and incapable of passing through the capillaries of the lungs, and also (as appears probable from some
Anatomical, Physiological & Pathological Observations
observations of Dr. John Reid) through the capillaries of the system at large. That this function of Respiration may be duly performed there must be a proper motion of the respiratory muscles, and a free access of pure air to the blood. Now that the respiratory motions may take place, there is required an integrity of that system which receives the sensations and transmits the influences necessary for the performance of respiration acts. This system again, the Nervous, requires for its support that a due amount of properly arterialized blood should be sent to its various organs. Thus are these two great functions mutually dependent, Circulation upon Innervation chiefly for the progress of Respiration, Innervation upon Circulation entirely.

The causes producing death cannot act upon either of these functions without sooner or later thereby affecting the other; but as has been above remarked, the effect in general is more slowly produced upon the Circulation through the Nervous System, than upon Innervation through the Vascular System. Gulden has divided the causes of death
An Inquiry into the Nature of Sleep and Death.
into "those acting directly on the nervous system de-
sroying its excitement, and those that indirectly pro-
duce the same effect by destroying the organs and
functions necessary to its support." But they might
with equal justice have been divided into those acting
directly upon the organs and functions necessary for
the support of the nervous system, destroying their
action, and those that indirectly produce the same
effect by interfering with the nervous system.

Dr. Wilson Philip makes death coincident
with the cessation of the sensorial functions, but on ob-
jection to this view I would urge the cases of resusci-
tation after apparent death, where all manifestations
of sensorial functions had ceased. The cessation of
the sensorial functions always precedes death, but
death does not always follow upon that cessation.
He cannot mean this cessation of the sensorial function
to be the only mode in which death is produced, for
he refers to the modes of dying dependent on causes
affecting vital organs and their proper stimuli.

Both err by connecting life too exclusively
with the continuance of nervous functions, for
we know that the arrest of the circulation is quite
as detrimental to life as the arrest of sensation.
The condition of the corporal frame, to which I apply the term death, may be the result of the natural law of organized beings, and the termination of the decay of old age. This mode of production is commonly called Natural Death. Death again may be the almost instantaneous result of violence or accident. This mode is generally styled Sudden or Violent Death. Lastly it may be the consequence of disease, not so rapidly induced as in the last case, more speedily than in the first.

Let us glance at each of these modes of dying in succession.

**Natural Death**

is the result of the gradual deterioration of all the vital powers, which is observed in advanced life. Each year of our lives may truly be said to remove a link from the several chains which bind us to the world around us, whether of matter or mind. As life advances the general nutrition of the body becomes impaired, but this is not at first to manifest as the changes which take place in the nervous system. The organs of the senses become less perfect recipients of impressions
from without, their sensibility declines; and this deteriora-
tion it seems probable is irrespective of any change
in their nutrition, and would appear to be the result
in the first instance of a gradual exhaustion of sensi-
bility, produced by the action of the various stimuli
to which the body has been exposed during life. It is
no less true, however, that after a time the gradual
changes in nutrition observable in old age will have
no small share in rendering the organs of the senses
less competent to perform their functions. The decline
of sensibility is in all probability the first step in the
process of decay, this according to physiological laws
leads to defective nutrition of all the textures, and
the nervous tissue among the rest, and thus to the
insensibility aggravated. In the old man the
eye grows dim, the ear becomes heavy, the sense
of smell is deadened, the sense of touch blunted,
all become less efficient messengers between the
world without and that of mind within. The sense
of taste remains longest unaffected probably as
has been suggested because it has such close con-
nections with the organic process of nutrition so
immediately essential to life. As life advances
the energy of nutrition too becomes infected, and
this as well as the changes in the muscular tissue affords an explanation of the slow and painful motions of the very old man. Thus the old man comes to live within himself as it were, and to be sequestered from the world around. Along with this gradual decay of sensation and volition, the intellectual functions become disturbed. This depends as much upon the change of relation to external objects as upon the change in the nervous system. Here are now no impressions from the senses so distinct as to correct erroneous judgments drawn from creations of the fancy. It must be admitted, however, that not a few individuals well advanced in years have given evidence of very exalted mental operations even to the close of life, so that this failure of intellectual faculties though a general is not a universal rule. The powers of memory and association of ideas are those which are most affected. Present impressions on the senses are less vivid, and are little if at all remembered, while in regard to those of past life the memory is often unusually tenacious. The effects of this change in memory and association are
exhibited in that rapidity with which many old persons are carried off to subjects wholly foreign to the topic of conversation. From this disturbance in the balance of the mental functions it is not surprising that the old man's judgment is not unfrequently weakened, and in many cases he may justly be said to be in a state of second childhood. Old age and childhood, as Richet observes, are alike reduced almost entirely to one set of impressions, from which to form ideas and draw conclusions;—old age to those of the past, childhood to those of the present.

While all these changes are taking place in the nervous system, and the phenomena connected with it, the vital powers are retreating step by step from every organ and tissue of the body. In consequence of the decline of sensibility, Nutrition, and this includes Assimilation, Secretion, and Absorption, is becoming less perfect, and in the circulation likewise gradually fails. The heat of the body declines, and the power of generating heat decreases. The hair become grey, and fall from the body. The subcutaneous tissues shrink, the skin
becomes hard, and wrinkled. Digestion becomes more and more imperfect, and supplies a poor and a deficient chyle. Respiration becomes slower and slower, and but partially purifies the blood, and the circulation of a scanty and impure blood becomes every day more languid, till last of all the heart ceases beat, it is the extremum morium.

In old age death may be said to proceed from the circumference to the centre.

Cases of uncomplicated natural death are but rare, and much of the complication from accident and disease must we doubt be attributed to the artificial and sometimes pernicious modes of life too common among the so-called civilized nations. In cases of natural death it is the physician's duty to smooth the passage to the grave, and to be especially wary of interfering with any of the inevitable processes of nature in the course of the decay.

Violent Death & Death from disease.

The mode of dying with which the physician is more called upon to deal actively
Recherches physiologiques sur l'air, l'œil et la mort.
are either sudden, the consequence of some violent disturbance of the vital functions, or more gradual as the tendency of some disease. In the former, death is often too rapidly induced to allow of any salutary interference, but it is by studying the phenomena of sudden death, that death from disease can be most clearly illustrated and best understood. For in the case of sudden death, the cause is comparatively well known, and the sequence of the phenomena in many cases can be analysed, and thereby we may learn what we should seek to arrest in disease.

Richet divides the modes of dying into those beginning at the Heart, those beginning at the Lungs, and those beginning at the Brain. Under the former he includes all cases of Syncope, even those from mental emotions, as well as those dependent upon haemorrhage or heart disease. But we now know that the former might be classed under those beginning at the Brain, for really the first step in the process takes place there, they are the results of impressions on the nervous system. So that there are two modes of dying connected with the heart, one resulting from
some disturbance of the Nervous system, the other dependent upon causes acting directly upon the Vascular system. In the same way it may be shown that there are two modes of dying connected with the Lungs, one dependent upon disturbance of the Nervous system, (that by Coma) the other the consequence of direct interference with the Respiration, (that by Asphyxia). From this it would appear that there are two modes in which death can begin at the Brain, one in which a state of the Nervous system influences the Heart, the other in which a state of the Nervous system influences the Lungs.

It seems strange that Bichat should deny that any influence is transmitted to the Heart from the Nervous system, and is connected with it only through Respiration. He explains emotions as affecting the Heart directly, making the viscera of organic life the seat of the emotions. Older authors were inclined to believe the Heart entirely dependent upon the Nervous system for its motions. For example
a. Fruto de la estructura del corazón, de su acción, el de los Músculos.
after it has been removed from the body and emptied of all blood, the renewal of that motion after mechanical irritation, yet maintains that the motion and vigor of the heart depend upon some influence from the brain. Among the causes affecting the circulation he enumerates mental emotions and explains their action by their producing some change in the nervous system. Hence again he cites instances of persons born without brain or spinal marrow to prove how independent the circulation is of the nervous system, yet does not deny the power of impressions on the organs of that system to affect the circulation. He says, "The force of the heart is an inconstant force; it varies continually, it is subject to the vicissitudes of age, to the impressions from the world around, to the secret force of our passions, and to the action of our senses." But that impressions on the nervous system do affect the circulation has been rendered indisputable by the experiments of Le Galleois and Wilson Philip. These prove that the circulation can con-
a. Alison's Outlines of Pathology and Practice of Medicine.
time for a time after removal of the brain and spinal marrow, provided artificial respiration is employed, and likewise that certain injuries of the Nervous System directly paralyze the organs of circulation.

The modes in which sudden death is induced may be arranged as the modes in which the circulation is brought to a stand."

This arrest of the circulation may be the consequence of a suspension of the vital action of the organs of circulation, or of non-arterialization of the blood.

The suspension of the action of the circulatory organs, may be the result of causes paralyzing them, or of causes withdrawing their stimulus.

The non-arterialization of the blood may be the result of causes interfering directly with the process of respiration, or of causes producing insensibility, which ultimately causes the respiratory actions to cease.

There are thus four principal modes of dying:

1. The mode by failure of the power of the
Circulatory organs, or by syncope.

2. The mode by failure of the quantity of blood, or by Haemorrhage.

3. The mode by interference with respiration, or by Asphyxia.

4. The mode by insensibility, or by Coma.

Let us run over each of these modes in succession, and describe under each the symptoms presented when death is threatened to be produced in that manner, and the appearances seen after death in each way — we will illustrate the subject by reference to the effects of violent injuries and disease, and lastly point out the general remedial indications to be followed as likely to arrest or at all events retard the tendency to death by each mode.

I. The mode of dying by failure of the power of the circulatory organs, or by syncope.

The tendency to death from this cause is marked by weakness of the pulse, great pallor of the countenance, coldness and clamminess of the skin, especially on the face and extremities, weakness of muscles, general prostration, often nausea and vomiting, vertigo, tinnitus aurium, confusion
Experiences sur le Principe de la Vie.
of thought, and if the cause continues in action, or if it have been severe at first, in the one case gradual, in the other sudden, loss of sensibility, power of motion, and consciousness.

After death produced in this manner all the tissues and organs, except perhaps the skin, retain their natural appearance and color, and the heart contains an equal quantity of blood in either side.

Some of the causes which produce death in this way act primarily upon the Nervous System, then upon the Heart, and a third class upon the Blood.

1. Causes of Death by syncope acting primarily upon the Nervous System.

That certain injuries of the Nervous System will exactly in this manner has been proved by the experiments of Le Gallois and Wilson Philip.

Le Gallois found that after crushing the spinal cord, the body of the animal operated on became instantly palsied, and destitute of sensibility and motion, - that the motions of the heart were no longer distinct, and could not be restored by insufflation, - and that no haemorrhage.
Experimental inquiry into the laws of the vital functions.
occurred when the limbs of such animals were amputated. Since the destruction of the spinal marrow had such effects, and the removal of the brain had no immediate influence upon the circulation, Le Gallois came to the conclusion that the heart depended for its power upon the spinal cord. Wilson Philip, however, has shown the error of this deduction for by experiment he has proved that little or no effect follows upon simple removal of the spinal cord, while a similar depressing influence on the circulation is observed after crushing of the brain. He thus demonstrates that it is not the portion of the nervous system injured that affects the results, but the nature of the injury inflicted. His words are, "If the head and spinal marrow of a frog be removed, the heart continues to perform its function for many hours, nor does it cease at all immediately affected by their removal. But we find the effect very different, when the most sudden and powerful agent is applied to them. If either the brain or spinal marrow be instantly crushed, the heart immediately feels it." That it is to the peculiar impression made upon the nervous system that the depression of the vascular system is in this case to be attributed.
is further proved by the fact that de Gallois found, that if the greater portion of the spinal marrow was destroyed by small portions at a time comparatively, little effect was produced on the heart, while if a considerable portion was crushed at once, the power of the heart was immediately impaired, that circulation soon ceased. I need not enter into his explanation of this anomaly according his theory; it is very ingenious, but far fetched and quite gratuitous. de Gallois supposes the destruction of each little bit of spinal marrow to act as a ligature upon all the arteries of that segment of the body, over which this portion of spinal marrow presides, and so that the heart has less to do, it is still able to accomplish that diminished amount of work.

It is on the same principle of a peculiar impression on the nervous system reacting upon the vascular that we must explain death from concussion in certain injuries of the head, when no local disease or injury can be discovered sufficient to account for death. In such cases there is a sudden loss of sensibility and power of motion, the patient lies unconscious, helpless, cold and
pale, with a weak, fluttering, and gradually failing pulse, and out of this state he never rallied.

Cases of shock, or collapse after severe injuries, or surgical operations are not seldom fatal, and likewise illustrate the depressing effect upon the circulation of certain impressions acting through the nervous system. Some cases have occurred in which the shock has been more mental than corporeal; in these death has followed upon operations not at all formidable or severe in themselves, but the patients minds have evidently been strongly affected, for they have even predicted the fatal termination.

A case illustrating the effects of violent injuries in thus producing death occurred in the practice of the Greenock Hospital, while I was house surgeon there, which it may not be out of place to narrate. It was that of an old woman between 60 and 90 years of age, who had been knocked down in the street by a loaded cart; the wheel of the cart passed over her left knee, and produced comminuted fracture of the ends of the femur and tibia, without breaking the continuity of the skin. When admitted to the Hospital the patient was
completely prostrate, pale, cold, and almost pulseless. Notwithstanding the internal administration of stimulants and the external application of heat, the patient never rallied, but gradually sank, becoming slightly delirious at the last, and died a few hours after receiving the injury.

Travers relates many similar cases of prostration without reaction, as he denominates them, and he points out that when reaction does take place it is apt to prove excessive, and that the inflammation and the fever coinduced assume a peculiar character in proportion to the previous amount of depression. In such cases the inflammation is prone to run on to gangrene, and the fever is apt to assume a typhoid character. Dr. Allison suggests that, as the effects of such injuries are so far analogous in their symptoms to typhoid fever, it is not unphilosophical to suppose that they may also arise on arriving at the true pathology of such fevers, and on conjecturing that typhoid fever is a state of excitement following the action of a poison, which has had a peculiarly depressing influence on the system.
The amount of shock following violent injuries depends upon the nature of the injury, the importance of the parts affected, and the previous constitution of the patient. These circumstances illustrate the influence of the nervous system in the production of shock. Fractures and lacerations about joints, and implicating important viscera, especially those of the abdomen, in constitutions previously debilitated from disease, or irregular living are peculiarly apt to prove fatal in this way. These points of course suggest obvious cautions to surgeons as to the management of patients before subjecting them to any important operation; and also demonstrate the great benefit to be derived from the administration of chloroform, because much shock, bodily and mental is thereby avoided.

There are various other causes which act as sedatives on the circulation through impressions produced on the nervous system, and illustrate the tendency to death by syncope.

To a peculiar impression on the nervous system coincident with diminution of pressure in the Brain, reacting upon the organs of circulation is the attributed the occurrence of syncope.
in tapping for Hydrocephalus or Ascites, when the operation is performed rapidly, and when a counter-balancing amount of pressure is not maintained externally, while the fluid is withdrawn.

To a similar influence on the Nervous System doubtless are due the feelings of giddiness, dizziness of sight, and tendency to fainting sometimes experienced on rising suddenly after long stooping. In many weak persons, especially in those who are reduced by the long continuance of any disease, the sudden assumption of the erect posture has been the cause of fatal syncope. This has not unfrequently been witnessed in cases of Fever. We know likewise that in most cases of ordinary syncope, the putting the patient into the supine position with the head low is sufficient to restore him. These are good illustrations of the influence which the Nervous System has upon the Vascular System.

Another cause of death by syncope is excessive fatigue. This is to be explained partly by influences acting primarily upon the Nervous System,
partly by exhaustion of the irritability of the heart.
In the latter principally perhaps is to be attributed
the death of the animal mentioned by Herotus as
being chased to death. After death the heart was
found quite unaffected by stimuli. There
are a number of other cases of fatigue however,
where the failure of the heart power is mainly
the result of impressions on the nervous system.
That too violent or too long continued muscular
efforts may have this effect is proved by the oc-
currence of syncope after long journeys either
on foot or horseback, after excessive gymnastic
exercise, after remaining long in any constrained
position, especially in delicate persons and
those not accustomed to such exercises.

All sensations whether general or local,
when either very acute or very long continued have
a depressing effect upon the circulation, and have
in some cases on record produced fatal syncope.
It is in this way alone that we can explain
death from severe pain, or the sudden transition
from agony to ease. This too is the reason
of the occurrence of syncope in some individuals
in consequence of impressions made upon the
Practical Essay.
organs of hearing, smell, and touch. Various odors have caused painting, and it is related of Italian ladies, that they are so sensitive to the odors of flowers, and to apt to paint when they perceive these odors, that no flowers can be kept in their rooms. Various sounds have had similar effects, and the contact of certain substances, such as, velvet, satin, paper, or the down of fruit, has in some peculiarly sensi-
tive persons been the cause of painting.

As illustrating this effect of sensations upon the circulation we may refer to the peculiarly depressing influence of the feelings of nausea and vomiting, as also to the effects of a blow upon the abdomen, or of a draught of cold water, especially when one is overheated. Instances of sudden death from these two last causes have been recorded. Dr. Bell says that when a man is brought to an hospital dead after falling from a height, and when no sign of a wound, or injury of the head can be discovered, death may either be the consequence of the general shock, or of a slow on the stomach received in his descent.
He states that he believed this happened in a case which came under his own observation. The man in question (he supposed) had been dented over the iron of a lamp.

Among the causes which can affect the heart and general circulation only through the medium of the Nervous System are the various emotions of the mind. Their powerful effects upon the animal economy attracted the notice of the earliest observers, and are the foundation of many of the most vivid descriptions of our poets. Many fanciful theories have been carried to explain these effects, but it would be tedious and uninteresting to enter into them here, seeing that it is now generally admitted that affections of the mind can influence the body only through the medium of the Nervous System. The depressing passions of the mind, such as, Fear, Horror, and Disgust, by their effect upon the circulation depress vital action generally, and predispose the body to the attacks of disease, and if this does not intervene may by their own influence compromise life. Thus Cord,

"Atteuant vigilo, corpus miserable curae"
a. Analysis of the inoculation for the smallpox.
"Addictive custom makes its own success.
"Corporis omnis abit, quod tantum autque propter emfusant.
"The exciting passions again, such as, joy, love, anger, have when moderate a beneficial effect upon the body as gentle stimuli to the circulation. But both the depressing and exciting passions have, when excessive, been the cause of death.

The occurrence of syncope on seeing certain objects is to be attributed to the influence of the emotions, which they excite. The sight of spiders, toads, and other disgusting objects have produced fainting in some sensitive individuals.

Dr. Kirkpatrick narrates the case of a patient, who had recovered from smallpox, but who had not been told during his illness of its real nature, because of his excessive dread of it, and who, on being made aware after his recovery instantly, dropped down dead without uttering a single word. It would be difficult to tell, he remarks, to which emotion, whether joy, surprise, or horror this remarkable effect was owing; but it demonstrates clearly the influence of mental emotions. Kirkpatrick.
De Mortis Newram.

Elementa Phylaeologye.
also quotes from Beurlaave the case of a young woman of good family in reduced circumstances suddenly expiring, when her brother, who had been made a governor in India, showed her on his return some valuable ornaments which he had brought for her. Beurlaave refers to the story of the death of a young soldier, who had made himself conspicuous in an action between Thracians and Christians. When all were eagerly inquiring who he was, the general ordered that the corpse should be brought to him; he discovered that it was that of his own son, and, while all around were indulging in lamentation, he alone stood immovable and unchanged and quietly expired. He cites also the example of a Roman Emperor, who was so overjoyed, when he saw the decrees of the Senate conferring upon him the highest honours, that he forthwith died. Matter refers to these as well as to a great many other authors for cases illustrative of these effects of mental emotions. He speaks of death occurring from an excessive dread of it, from joy at the unexpected return of some loved object, or on the conferring of some great boon.
a Memorias Cirujanales.
Another agency acting through the nervous system, depressing the heart action as well as
interfering circulation generally is that of intense
cold. This was abundantly experienced by the
French army in Russia, and Baron Larrey has
given graphic descriptions of its effects in that
unfortunate campaign. Though in many
cases this agent causes death by inducing a
cornucopia state, yet there are other cases in which
the predominant impression is that of general
constriction paralyzing the powers of circulation.
This was connected in the case of the French
soldiers with the great amount of fatigue to
which they were likewise exposed. Death
was predicted according to Larrey by pallor
of the countenance, difficulty of speech,
clumsiness of vision, great muscular weakness,
or that those affected reeled like drunk men;
this weakness increased till they felt dead or
dying. He gives it as his opinion that the heart
is at the last struck with paralysis through
the influence of the cold upon the nervous
system.

An excessive amount of heat suddenly
applied does evidently act in the manner of severe concussion, and the effect upon the circulatory system is demonstrated by the state of the pulse after severe burns and scalds.

The effects of lightning too are in some cases similar to those of serious injuries. Dr. Young, for example, (in the Med. Gazette vol. XIV. p. 454) narrates the case of a young lady about 13 years of age, who was struck with lightning. He describes the patient as in a state quite analogous to that produced by severe concussion from blows, falls, or other injuries. There was insensibility with deep slow interrupted respiration, complete muscular relaxation, a slow soft pulse, and dilated but insensitive pupils. She was revived by dousing cold water upon her face, and upper part of chest, and the state of depression was, as in many cases of severe injuries, followed by a state of reaction, for which he deemed it necessary to use the lanceet, and he did so with good results. In no other way than that of acting as a shock to the system can the influence of lightning be explained in inducing instantaneous death,
Philosophical Transactions 1811–12
and cases of such a description are on record. There are a class of cases in which death from lightning takes place more slowly by way of coma, but these will fall to be noticed hereafter.

Certain poisons have a similar degrading influence upon the circulation, and kill strictly by paralysing the organs of circulation, and rendering them insensible to their proper stimulus. The experiments of Mr. B. Brodie prove that this is the effect of the infusion of tobacco, and the Opium Antiar poison. He found that in animals poisoned by these substances, the circulation ceased before the respiration, or at all events did not survive it, that after death no contractions of the heart or intestines occurred. He concludes that these poisons act through the Nervous System because they act very rapidly, and also in such circumstances that no other channel can be imagined, as when all connection between the lower portion and upper portion of a limb was severed except that through the nerves passing between the two.
Though alcohol in general compromises life by interfering with sensibility and the function of respiration, yet that it may kill by depressing the powers of circulation in some instances is rendered probable by a case recorded in the Monthly Journal of Medicine for 1854. A man after a debauch was found dead in bed in the morning, on opening the body an equal quantity of blood was found on either side of the heart, and no lesion could be discovered to account for death.

It is probable that the hydrocyanic and opallic acids in most cases kill in this manner by fatal depression of the circulation. Coldness, and palselessness are prominent symptoms in individuals poisoned by these drugs. This is also the case in the state of collapse induced by the class of irritant poisons generally, which, besides their direct influence on the nervous system, produce lesion of the alimentary canal, and illustrate what was said above as to the effect of injuries of the abdominal viscera.

Chloroform likewise in some constitutions
has proved fatal by depressing the heart action.

The effects of these various causes of the tendency to death by syncope illustrate the influence of impressions upon the nervous system in paralyzing the powers of circulation. Let us next advert to

2. Causes of Death by syncope acting primarily upon the Heart.

Among these may be enumerated the following:

1. Effusions into the Pericardium, of blood, or a fluid, or a wound or rupture of the heart or great vessels, or of serum, pus, or lymph, which compress the heart from without inwards, prevent its proper dilatation, and interfere with its regular movements; dilatations of the cavities, allowing a larger quantity of blood in these than they are able to expel; organic changes in the walls or valves, neutralizing the effects of the sytole; disturbing the heart's functions; ossification of the coronary arteries, interfering with the nutrition of the organ.

All these changes have been the cause of sudden death, manifestly have been so.
Reids Observations.
by very materially modifying the propelling power of the heart.

3. Causes of Death by syncope acting primarily upon the blood.

We must admit that certain changes in the blood force may interfere with the power of the circulatory organs. The state of Aedone has been said to affect the body in this way by causing a greater quantity of fluid in the cavities of the heart, than that organ is able to expel. The mixture of air with the blood likewise produces death in this manner, because the heart has not the power to propel such a mixture of air and blood. That this has been the cause of death after surgical operations in the neighborhood of the great veins of the chest is rendered highly probable by the observations of Dupuytren, Sir E. Bell, Cormack, Reid and others. In such cases the patients have exhibited nearly the several symptoms of collapse, falling down sometimes after an explanation, becoming cold, pale, and unconscious, while clammy sweat appears on the forehead and extremities.

Treatment of this tendency.
In endeavouring to avert the tendency to death by syncope, our principal object must be to revive the flagging powers of circulation. This is usually attempted to be accomplished by administering internal stimuli, such as various Alcoholic Lignes, or various preparations of Ammonia or Ether: the external application of stimuli is also beneficial, but not so manifestly so in this case as in the tendency to death from Apoplexy or Coma. It has been recommended to apply saturation to the præcordial region, and in some cases it may be our duty to attempt in this way to excite the action of the Heart.

II. The mode of dying by failure of the quantity of blood, or by haemorrhage.

The tendency to death in this way is characterized by symptoms very analogous to those of the preceding mode; the difference in these two modes is shown by the difference in the treatment which is demanded and proves beneficial. There are some differences however in this mode itself, which must be pointed out, differences which depend upon the rapidity with which the
fluid is lost.

The effects of a succession of several small bleedings are on the whole as follows: the skin and mucous membrane become blanched, as is most distinctly and speedily observed in the face, lips, and conjunctivae, the general surface becomes cold, muscular motions become tremulous and irregular, the pulse becomes gradually weaker increasing at the same time in frequency, and latterly the senses become affected, vision is more or less impaired, as also hearing. A cold clammy sweat breaks out upon the forehead, the surface of the chest, the palms and soles, the respirations become slightly heaving and difficult, while the patient intellect may be clear, and his voice tolerably strong to the last.

The effects of such gradual haemorrhage not proceeding at once to fatal termination are often seen in cases of bleeding from haemorrhoids. Such patients are described as having pale, ashy visages, their lips and conjunctivae are pale, they are weak, and easily thrown into a state of depression by a small amount of exertion, are annoyed with vertigo, tinnitus aurium,
à Paris, Hémiocaphes Thématiques.
muscles, colic, and palpitations.

The symptoms accompanying the sudden loss of a large amount of blood are somewhat different. There is the same pallor, coldness, and weakness, with in addition the rapid induction of nausea, vomiting, loss of voice, thirst, restlessness, irregularity of the respiratory movements, intermitence of the pulse, palpitations, vertigo, tinnitus aurium, sometimes convulsion, and even delirium just before death. In some cases, where the haemorrhage has been very quick, and very sudden, death is instantaneous and no analysis can be made of the phenomena. The patient falls down at once, blanched, cold, and sometimes convulsed.

In this last case, the mode of death is complex, partaking partly of the nature of that by failure of the power of the heart, partly of that by diminution of the vital tensions. The sudden loss of blood produces a peculiar depression upon the nervous system, which, acting upon the heart after the manner of a compression, so that in such cases a much smaller amount of blood may have been
lost, when fatal dynespe supervenes, than there generally is in cases of gradual haemorrhage. The conservative effects of the induction of dynespe, which is not necessarily fatal, are manifest, and I need not dilate upon them. A much smaller quantity of blood is lost, and opportunity is given for the natural means of arresting haemorrhage taking their effect. It is for this reason that arterial haemorrhage is often less dangerous than venous, the flow in the former case being more sudden and more likely to be followed by curative dynespe before much blood has been lost. The difference between these two kinds of haemorrhage, sudden and gradual, is further illustrated by the fact, that if the haemorrhage is not fatal, the weakness and delirium are much more speedily removed after sudden than after gradual haemorrhage. The amount lost, and the deterioration by diminution of red corpuscles have been much less in the one case than in the other. As illustrating these differences it is important to remember that dynespe is much more speedily induced.
a Decorder

b Statistical Essays
when the patient is bled from a large orifice in
the upright position, than when he is bled from
a small orifice in the recumbent position.

The effects of haemorrhage are well il-
lustrated by the experiments of Lower, and of
Hales.

Lower in making experiments upon the force
of the circulation by opening the cervical arteries
in dogs found that when the greater part of the
blood had escaped, the pulse became feeble
and quicker, and that as the haemorrhage
continued it became still smaller and more fre-
quently, until the influx of blood to the heart
failed altogether, and its motions consequently
ceased.

Hales also found that in bleeding a mare
to death, she grew very faint after losing a
large quantity of blood, becoming likewise
sweaty, breathing quick, and making violent
efforts to get more, and that as more blood
was evacuated she fell into cold clammy
sweats just before death. In opening the body
little or no blood was found in the aorta,
about 1 oz in the left ventricle, but none in
the eight. The vena portae and vena cava were full. The force of blood in the arteries (as indicated by the height to which the blood rose in a tube affixed to the orifice of a vessel after different evacuations) became gradually but irregularly less, owing to the lashing and straining of the animal, which always caused the blood to mount higher for the time. Then the experiment began the blood was raised 3 feet 3 inches, while just before death it rose only 2 feet 4 inches.

The effects of haemorrhage in the human subject are well illustrated in cases of injury implicating important vessels, or of disease affecting arterial coats after surgical operations. Fatale haemorrhage with all its most marked symptoms likewise frequently occurs in obstetric practice before, during, or after parturition.

This mode of dying is also illustrated by the symptoms observed on the sudden bursting of internal aneurysms, and a consequent great and sudden flow of blood.

Under this head as illustrating this mode of dying we may refer to another mode in which
though the most important deviation from health is the gradual diminution of the vital fluid, and though this is combined with this as a consequence failure in the power of the circulatory organs, resulting from their deficient nutrition, I refer to the mode of dying by starvation.

In this case the vital fluid decreases in quantity and quality because no new material is supplied, and though in the last stages such cases are complicated by a peculiar form of delirium depending no doubt upon the defective nutrition of nervous centres, yet the general symptoms are those of a failing circulation, gradual emaciation, blanching and increasing weakness. Toward the termination of such cases the function of absorption which had been gradually modified is wholly suspended, and a putrefying odor has been likewise described as exhaling from the body during life.

After death from sudden haemorrhage all the tissues and organs are found more or less decolorised, the arteries and left cavities of the heart are empty, and contracted, while
a very small quantity may remain in the right cavities and venous system. When the death has supervened upon a long continued drain, or a long continued deficiency of supply, there may be, in addition to the above appearances, a state of general atrophy, more or less marked according to the time which has elapsed between the commencement of the process and death.

This last mode of dying, by failure of the quantity of the stimulus of the vascular system in many cases, graduates into, and is combined with, the first mode, that by failure of the power of the vascular system. For in almost all cases where there is diminution in the quantity of blood, there is either gradual or sudden loss of power in the vascular organs, in gradual haemorrhage as the blood drains away the pulse becomes weaker, and in sudden haemorrhage the heart almost instantaneously ceases to beat.

The reason of making the distinction between these two modes is, that in this last the loss of power in the vascular organs is not generally so great, but that they could carry on the circulation, if the vital fluid were gradually
rectored.

It is by a combination of these two first
modes of dying, (of which combination the
mode of dying by inflammation will serve as a good
example,) that all excessive and long con-
tinued evacuations prove fatal. This mode
may be called that by general Asthenia.
In such cases there is a gradual failure of the
vital stimulus, and an increasing weakness
of the propelling organ. Nutrition is not
supplied to the blood so fast or in such quantity,
as the blood is spoiled to supply material for
the evacuation; and the heart likewise
like all the other organs of the body exhibits the
effects of deficient nutrition in diminis hed
fower.

It is in this way that we are to explain death
from most chronic diseases, from repeated
vomitings, from long continued diarrhea,
from too long protracted lactation &c. Death
is produced in this manner likewise by such
diseases, as prevent the introduction of food,
such as diseases of the Oesophagus, or interfere
with its digestion or assimilation, such as
In all cases, of course, where direct external arrest of the bleeding is practicable, means should be taken to secure this, such as the tying of torn or cut arteries, and the application of astringent preparations to the bleeding surface.
diseases of the Stomach and Intestines.

Treatment of this tendency.
The treatment of this tendency varies somewhat according to its cause.

In the less severe forms of Haemorrhage, the principal indication is rest and quietude.

In the more severe forms again besides the internal administration of Astringents, such as, the Acetate of Lead, Sulphuric Acid, Iodide, and Tartric Acid, transfusion of blood has been practiced with such results in some cases as to show that it is a remedy of no mean power.

We have indications in old authors of Transfusion having been practiced in remote times. But it was revived with great vigor in the 17th century, and for a time was resorted to as a panacea, and then submitted to the Transfusion of the Blood of Animals as a cure for all kinds of disease, real or imaginary. Lower was among the first at that time, who showed by actual experiment upon Dogs, that transfusion could be practiced with success. He tells that he bled a dog till its life was in danger, and then he performed transfusion into it; he repeated the bleeding, and the transfu
been several times, until the blood of two larger dogs was exhausted; by this the dog experimented on. He retained what was last transfused into his dog, and states that when it was released it leaped from the operating table and jumped about as if nothing had occurred.

D. Harwood's experiment performed in 1785 prove the same possibility of transfusion; the following of his may be quoted, as is given in Gray's work on Asphyxia. "All the blood of a pointer was let out (as far as it was possible to evacuate it) till the animal was in convulsions on the table, and apparently expiring. The blood was then transfused from the jugular vein of a sheep into the corresponding vein of the dog, and in less than half a minute after the introduction of the tincture he began to inspire, and as soon as he had received a quantity of sheep's blood equal to what he had lost of his own he leaped from the table and walked home without experiencing any apparent inconvenience either then or at any subsequent period."

Transfusion has proved successful in the
human subject not only when the heart's action has been failing, but even after it has apparently ceased, though it cannot 
admit of a doubt that the period must be very short indeed 
after cessation of the heart's action, when resuscitation 
is practicable in this manner. It is the possibility, 
however, of this, which clearly marks the difference 
between this mode of dying, and the first, in which 
with no want of fluid there is complete loss of power 
to propel that fluid, a condition in which transfusion 
could not be of the smallest benefit. A case illustra-
ting the beneficial effects of transfusion is quoted 
from the London Medical and Physical Journal 
for February 1827, in the Edinburgh Medical and Surgical 
Journal vol. XXXIX. It is that of a lady who was re-
duced to a state of very alarming collapse by post partum 
haemorrhage. Her extremities were cold, her breathing 
slow and uneven, her pupils insensible, and her lips 
tremulous. After 30 drachms of blood were injected 
the pulse began to return at the wrist, and the pupils 
became less dilated, and after 6½ oz had at intervals 
been introduced the respiration became perfect, 
the patient recognised all her friends around her.

In cases of threatened death by way of Pneumonia 
and general asthenia, a mingled treatment con-
Listing of the cautious administration of stimulants and mitrioment is what is indicated. In cases of pure fasting, the state of the function of absorption, and the condition of the alimentary mucous membrane (that of chronic inflammation) must be borne in mind to regulate the administration of mitrioment. The mitrioment must be of the most digestible and nutritive description, and should be given in small quantities at frequent intervals. When food has been too liberally supplied after much deprivation, a state of mental excitement has been induced not unlike that resulting from indulgence in alcoholic liquors; and not a few have been killed by the mistaken kindness of attendants giving too much mitrioment to such patients.

III. The mode of dying by interference with respiration, or by Asphyxia.

The tendency to death in this manner however produced is characterised generally by the following symptoms, viz., indications of great manner, which from those who are accustomed we learn is referred to the chest, this is accompanied by violent though vain efforts at respiration, gradually the face becomes turgid and phlegm is due, insensibility next supervenes, then a
fit or fits of convulsions there is a cessation of all motion, while the heart may continue to pulsate for a little while longer, ceasing to contract however in about 3 or 4 minutes from the commencement of the phenomena.

After death the lungs are found more or less congested according to the duration and velocity of the phenomena; the pulmonary arteries, right cavities of the heart, and great veins are distended with blood, while the pulmonary veins, left cavities, and great arteries are comparatively empty. In some cases more especially in those in which there has been much struggling before death, there are evidences of congestion within the head.

It will be interesting and instructive to run over the principal theories, which have been broached upon the order of the phenomena, and the causes of the cessation of vital action in asphyxia. The review will demonstrate how firm the foundation is on which our present opinions are based, seeing that the data for it are admitted some of them by each of those who may disagree on other points; it may be useful also in illustrating how preconceived notions are apt to influence us in observation, and to prevent facts occurring before our eyes from having their due weight.
Exercitationes alterae ad J. Richarmon

1. Phil. Trans. abridged vol. III.
The more ancient opinions with regard to drowning, which has always been a favorite illustration of this mode of dying, were that life was destroyed by getting into the cavities of the body. But after the discovery of the circulation and its connection with respiration, death was attributed to water finding its way into the lungs, an opinion sufficiently refuted by the fact that after death from drowning water is very seldom found in the lungs, and when it is, the quantity is very small, and is, as has been proved by the experiments of Goodwyn, incapable of compromising life.

Harvey in speaking of the empty state of the arteries, and the plenitude of the veins after death attributes this mainly to the cessation of the respiratory motions. He believes those motions to be the principal agents in transferring blood from the right to the left cavities of the heart, so that when they cease the blood necessarily elevates in the lungs, and the contractile power of the heart and arteries sends on into the veins the last blood which they have received.

Drs. Hooke in the 17th century made a great stride towards the explanation of this pheno-
a  

On Respiration.
mena observable when respiration ceases. He kept up a circulation of air through the lungs without any expansion or contraction of their substance; and he found that blood circulated freely and that even through those parts of the lungs which were collapsed. The manner in which he accomplished this was by blowing air in through the trachea and allowing it to escape through incisions in the pleura after the walls of the chest had been removed. His conclusion I shall quote in his own words, "Which seems to be arguments that as the bare motion of the lungs without fresh air contribute nothing to the life of the animal, he being found to survive as well when they were not moved as when they were; so it was not the mere subsiding or movements of the lungs, that was the immediate cause of death, or the stoppage of the circulation of the blood through the lungs, but the want of a sufficient supply of fresh air."

Whytt combats this inference of Hookes by maintaining that there must have been some motion produced in the lungs of the animal experimented on by the passage of air through them. Whytt admits that the action of air upon the blood is necessary to fit it for the purposes of the economy, and
a. Elementa Physiologicæ.
that the flow of blood through the lungs is somewhat impeded both at the end of inspiration and expiration, and yet holds that the motions of inspiration and expiration are necessary for the transmission of blood through the lungs, and that the blood is by their alternate inflation and contraction pressed forward to the left ventricle. He does not perceive, that if the flow through the lungs is fastest when they are in a medium state, and that if, when, as in the foetus, the blood is aerated in any other way, no respiratory motions take place, the fair conclusion is that the respiratory motions serve not to transmit blood through the lungs, but to admit air to the blood.

Haller likewise maintains that without the alternate dilatation and compression of the lungs the blood cannot pass through these organs, averring that in inspiration a free passage is allowed to the blood into the lungs, and that in expiration come the blood is sent back to the right heart, some forwards to the left, and that if the state of expiration be continued the blood will require the same with greater force, or will pass with much less velocity through the lungs, and that as the powers of the heart are limited, and its contraction cannot
On the connection of life with Respiration.
be continued long against the resistance of the lungs it
conceives to act. He fails to perceive that coinci-
dently with the cessation of respiratory motion, there is
an absence of renewed application of air to the blood,
which Dr. Hook had shown to be insufficient itself
to maintain the circulation through the lungs.

Goodwin combats the opinion of Baller by
narrating experiments to prove that so much air
remains in the lungs at the end of an ordinary inspira-
tion, that no material impediment can exert to the
passage of blood from suffused collapse. He supports
his own opinion by referring to the continuance of the
circulation through the lungs in conditions when it is
much more contracted than in expiration, as when
fluid exists in the pleural cavity as the result of disease,
or such experiments as he made. He maintains it to
be the legitimate conclusion from all his experiments,
that the chemical change which occurs in ordinary
expiration gives the blood a stimulating quality by
which it excites the left ventricle to contract, and that
in apoplexy the heart's action ceases because fresh
blood is not a sufficient stimulus to the left cavities
of that organ. He overlooks the difficulty of explaining
how, if the blood passed freely through the lungs and
On the recovery of the apparently dead.

On submission.
only stopped because the left cavities could not send it on, but the left cavities are not disturbed after death, and how the restoration of respiration can cause the circulation to go on again before it affects the blood in the left cavities of the heart. But there is evidently an impression on his mind of cause of obstruction in the lungs for in explaining how the right heart ceases to act, he says, "from the resistance to the entrance of blood into the pulmonary arteries, and from the want of the synchronous action of the left ventricle, the contractions of the right become gradually more feeble until they cease." Yet he plainly admits resistance to the entrance into the pulmonary arteries as well as non contraction of the left heart as a cause of the cessation of the circulation, and if he had only studied the references from Hook's experiments he would have seen that the cause Haller was the venous character of the blood at the lungs.

Note being able to refute that part of Lord-Louys theory referring to venous blood not being a sufficient stimulus to the left heart. He ventures the explanation of Haller and Weydt, and holds with them that the cessation of the respiritory motion
On natural and suspended respiration.
in the cause of the stagnation of blood in the lungs, but he adds that the cause of death is Apoplexy, the result of the venous concretion produced by the stagnation of blood, founding this opinion upon the loss of sensorimotor motion observed in this mode of dying, and alleged constant post-mortem appearances of congestion within the cranium. He objects to Cordwainer's theory by showing the left headdoes contract on venous blood, and maintains that the clotting of the circulation is not induced "by chemically depriving the blood of certain properties which it should acquire from the air in its passage through the lungs," and that circulation is restored before the nature of the blood in the left heart is altered. He does not prove, however, that it is restored before the nature of the blood in the lungs is changed, and he must either have been general or not studied Dr. Hors's experiment, or reflected upon the conclusions deducible from it.

Salman next objects to the theory of the cessation of motion in the lungs being the cause of cessation of circulation thorough the lungs, and maintains that it is a state of collapse, which can alone account for it. He states that the heart is able to overcome this obstruction for a time, and proves as he did
à *Une la Vie et la Mort.*
that the left heart does contract on venous blood, for he showed that when the chest was opened immediately after drowning without including the pulmonary artery, the left side of the heart contained nearly as much blood in the right. But while he thus maintains that collapse of the lungs is the cause of the cessation of the circulation, his mind is evidently not fully satisfied, and he cannot avoid admitting the necessity of some chemical change in the blood, which he calls the admission of latent heat. He opposes Kite's theory of asphyxia by denying that there is always unusual cerebral congestion after death in this manner. He argues that if asphyxia were the cause of death, recoveries would be much less frequent than they are.

Bichat corroborates the experiments of Goodwyn proving that there is no mechanical obstacle to the circulation through the lungs, he likewise corroborates the experiments of Kite and Coleman, proving that the left heart does contract on venous blood, but like Goodwyn he err in looking to the heart for the cause of the cessation of the circulation, maintaining that it ceases to contract not because black blood is an insufficient stimulant, but because it acts,
A deleteriously in the faculties of the heart, and that the other organs of the body suffer not so much from the deficiency or from the impiety of the blood. With all this he cannot help observing that the lungs are the point at which the circulation is arrested. Arrested by the stagnation of the blood in the blood vessels behind, and the comparatively empty state of those before them. He labours strenuously but unsuccessfully, I think, to account for this in accordance with his own theory. He says that the venous system is fuller than natural, because the tissue have not abstracted any nutriment from the impure blood, and because, from the want of the stimulus of air to the lungs, in addition to the presence of black blood in the bronchial arteries, there is great obstruction in the pulmonary capillary system to be overcome by the right heart. Then in the general capillary system the overcome by the left heart. He likewise refers the phenomena of loss of sensibility and motion to the contact of venous blood with the brain and nervous system.

Dr. Williams from reflecting on the appearances seen after death by suffocation, when the bodies were opened immediately, viz. blood flowing into and accumulating in the right cavity of the heart, while
On aphasia.
the left cavities remained comparatively empty, concluded that the cause of obstruction must exist at the lungs, and feeling the inadequacy of any mechanical theory to account for it, decided as Bichat did before him, that blood does not pass through the pulmonary capillaries because it is not acted upon by atmospheric air.

Dr. Kay subsequently came to the same conclusion in a similar way; he found the left head contracting some time after blood had ceased to come from the lungs. In opposition to Bichat's theory he quoted experiments of Edwards and his own to prove that venous blood through a less perfect peristaltic action than arterial blood can, by no means exert such a deleterious influence as Bichat would attribute to it. He also objects to the experiments of Bichat on the deleterious influence of venous blood on the nervous system, viz., by injecting venous blood along the arteries to the brain, and makes it probable that the injurious effect on Bichat's experiments were due rather to the manner of the experiment than to the character of the blood. He himself maintains that the failure of sensibility is due partly to a deficiency, and partly to an imperfection in the nature of the stimula
a. Edinburgh Medical and Surgical Journal vol. XXXV.
...ent to the brain.

In all the experiments performed, except that of Moseley, the mechanical actions of the chemical changes in the lungs were simultaneously suspended, and therefore there was still room for debating the suspension of which the cessation of circulation at the lungs was owing. But an experiment of Dr. Alison, the converse of that of Moseley, completes the evidence on this point, and proves that the respiratory motions continued without the chemical changes do not prevent the stagnation of blood at the lungs. The experiment was performed in this manner, a small animal was put into an atmosphere of nitrogen gas under a bell glass jar. It was allowed to remain, until its respiration, though slower, were yet fuller and deeper than natural. It was then quickly removed and put suddenly to death, the body was immediately opened. Every time the experiment was tried a larger quantity of blood was found on the right than on the left side of the heart.

Experiments performed by Dr. John Reid corroborate the conclusion drawn from the experiment of Dr. Alison. Reid's experiments were performed.
with the view of ascertaining the variations in the force of the
blood, when air is excluded and motion of the chest takes
place, and when respiratory motions continue, and yet
oxygen is withheld. The force of the blood gradually declined
after the access of pure air was denied, and still declined
even although nitrous gas was admitted, and respiratory
motions took place; the force rapidly again increased
when oxygen was admitted. These facts prove the
necessity of chemical change for the continuance of the
circulation. He found also that after insensibility
is established, the force of the venous blood seems to
become greater, and he believed that this depended
upon obstruction to the flow through the generally
capillary system, and might account for the oc-
casional presence of a considerable amount of blood
on the left side of the heart, from this increase in the
force of the blood after a time, and from the continuance
of the circulation for a certain period he concluded
with Ray in supposing that the cessation of the senso-
rial functions is at all connected with deficiency
of blood, but thinks it depends wholly upon the quality
of the blood, and the want of the proper excitations
of the organ.

I may here quote his account of the order of

cession in which the vital processes are arrested: for they appear to be the legitimate conclusions from all experiments on accord.

"Dark blood is at first transmitted freely through the lungs, and reaches the left side of the heart, by which it is driven through all the textures of the body. As the blood becomes more venous, its circulation through the vessels of the brain alters the cerebral functions and rapidly suspends them, so that the individual becomes unconscious of all external impressions. The functions of the medulla oblongata are suspended about the same period, that the cerebral functions are arrested, but are not fairly suspended for some time longer. Immediately after the cerebral functions are suspended, and the blood has become still more venous, it is transmitted with difficulty through the capillaries of the lungs, and consequently begins to collect on the right side of the heart. A smaller quantity of blood must now necessarily reach the left side of the heart, and this diminution in the quantity of blood dead along the arteries, conjointed with its venous character, and the ultimate arrest of the circulation being circumstances incompatible with the manifestation of life in the other tissues of the body.
general death is sooner or later induced.

From this review it will be seen that all, however divided on other points, agree that after death, from this cause, the right cavities of the heart always contain a larger quantity of blood than the left. From this circumstance we must conclude that the lungs are the point at which the circulation comes to a stand. Further the crucial experiments of Hooke and Alton prove that this stagnation is the root of the non-arterialization of the blood. In the one of these experiments air was admitted without respiratory motions and the circulation through the lungs continued as before — in the other pure air was denied while respiratory motions were carried on, and yet the circulation through the lungs was impeded. Thus we see that all the earlier observers were right in seeking for the cause of obstruction to the circulation at the lungs, but all wrong, except Hooke, in making that cause purely mechanical. Goodwin and Bichat while they observed that the changes in the blood were the chief cause of obstruction, yet seemed to shut their eyes to the seat of the obstruction, and directed their attention to the heart as the seat of it. Subsequent observers have now combined what is
Correct in these opinions, and rejected what is erroneous, for physiologists are now agreed that the seat of the obstruction is the capillary system of the lungs, and that the cause of it is the venous state of the blood.

This discussion as to the theory of asphyxia is not unimportant with reference to treatment, but explains how that treatment is successful.

Treatment of this tendency.

In a case of tendency to death in this way our aim must be to keep up or restore the circulation through the lungs by promoting the chemical change of the blood. Every means therefore of imitating or restoring the process of respiration must be employed. Let air be introduced respired regularly and gently at first, if this be done, the blood will flow on to the heart; that organ will contract on it and send this renewed blood to the brain and other organs.

Gradually the functions of the medulla oblongata will be restored and respiration will then continue naturally. As an auxiliary means of exciting respiration, cold water may be dashed on the face and chest, or stimuli may be applied to the nostrils.

This last proceeding requires great caution, for
injuries result if the nasal mucous membrane has been the consequence of too long continued or injudicious application of stimuli. Galvanism likewise has been recommended, and employed with advantage both to excite the action of the heart, and of the respiratory muscles. Restoration of the animal heat is to be promoted by friction with warm and dry cloths. The experiments of Dr. Reid, Cornack, and Lonsdale prove that bleeding from the jugular, and in many cases prove beneficial by unloading the right side of the heart & thus promoting the heart's action.

Asphyxia may be produced in a great variety of ways. The causes producing may be arranged in somewhat. manner as the following.

1. Causes preventing the action of the respiratory muscles and the expansion of the chest.

Section of the phrenic and intercostal nerves, whereby the respiratory muscles are paralysed, produce death in this way. So also might section of the cord be said to produce death, though in some respects the mode is analogous to that by coma.

Another cause acting in this way is forcible constric-
of the chest and abdomen by external compression.
2. Causes preventing the access of air.

Among these may be enumerated: immersion in gases or fluids not containing oxygen, but not exercises any deleterious influence upon the economy of the skin, such as, water, nitrogen, and perhaps hydrogen; the last however is doubtfull because some of the symptoms which it produces.

Obstruction of the air passages, such as, by forcible compression of the windpipe by hand or cord, by impaction of foreign bodies, by spasmody closure of the phmyn.

3. Causes preventing the dilatation of the lungs.

Among these we may mention the presence of gases or fluids in the pleural cavities, and also perhaps in the abdominal cavity.

IV. The mode of dying by insensibility, or by coma.

The tendency to death in this way is characterized by the loss of sensibility, power of motion, and consciousness, while the circulation and respiration continue for some time, and the former longer.
than the latter. The expiration often stimulate from the first becomes more and more imperfect, and before death is seen to be performed at long intervals. The pulse at first slow and full of at one becomes weak and frequent towards the last, but is distinctly felt to be for some time after expiration has ceased. The heat of skin is throughout good, and this symptom with the con-
tinuance of expiration and circulation serves to dis-
tinguish coma from syncope. Coma is not so easily
distinguished from Asphyxia, being that in both the ultimate result is the same, viz., the stoppage of the circulation at the lungs. In Asphyxia, however, the loss of sense and motion is secondary, and is a result of the contact of venous blood with the nervous centres, while in coma the loss of sensibility and power of motion is primary, and is the cause of the gradual cessation of respiration, and deterioration of the blood, not the result of it. In animals dying by coma, moreover, all is quiescent; there are no convulsive efforts at inspiration, such as are seen in animals dying by asphyxia, where the sensibility is still alive. The ultimate result of this mode of dying is the gradual cessation of the respiration, because from the defect of sensibility, the changes m
the lungs, which usually excite the respiratory acts, are less and less vividly felt; the respiratory acts in consequence are less and less perfectly performed, and at last blood stagnates in the lungs.

As can be readily understood from this explanation the post-mortem appearances are very similar to those seen after asphyxia, with the addition in many cases of appearances in the cranium explaining the primary loss of sensibility and motion.

Certain injuries of the nervous system fall in this way. It is in this way that removal of the brain brings all vital action to a stand. Fontana, Cruikshank, Brodie, Le Gallais, and Wilson Philips, have kept cold-blooded animals alive in a state after removal of the brain by keeping up artificial respiration.

Mechanical pressure on the surface of the brain is often fatal and that by inducing coma. This is the tendency in cases of fracture of the cranium with depression, or without depression from effusion of blood below the fracture. That the pressure is the cause of the coma is rendered certain by the fact that coma can be induced or removed at pleasure by alternately applying and removing pressure.
to and from the brain through a trephine hole in an adult, or an open fontanelle in an infant. From these facts we are entitled to conclude that the pressure on the brain by extravasations of blood, effusions of serum, abscesses, tumors, adhesions &c., is the cause of the comatose symptoms observed in patients whose bodies on dissection exhibit morbid appearances are discovered. The element of doubt and uncertainty is thrown upon the subject by the fact that appearances have been seen after death, from which we might conclude there had been pressure and yet no coma has been observed during life. As to this point it is important to remember, that it is by interfering with the functions of the medulla oblongata, that pressure on the brain affects the respiratory motion, and that all pressure may not affect the medulla oblongata. And further that if pressure is gradually applied the brain has a wonderful power of accommodating itself to it, possibly by the absorption of some of its substance.

Strong mental emotions are among the recorded exciting causes of apoplexy and death by coma. Dr. Coke narrates the case of a gentleman about 45, who in a violent paroxysm of anger was forced
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with vertigo and pain in head, which gradually in-
creased ended in about two hours in apoplexy
with claret. He quotes also from Bonetus the
case of a lady, who in a sudden fit of anger was
drugged with strong apoplexy attended with much
claret. This was a case in which the mental agi-
litation was the cause of extravasation for on examining
the head blood was found oozing and concreted
in each ventricle of the brain. In other cases
recorded, however, it would seem to be only by
deranging the circulation within the cranium
that such motions cause comatose symptoms,
for no extravasation or other cause of pressure
has been discovered after death.

Other causes of apoplexy and death by coma
are by obstructing the venous return from the head,
and in that way deranging the circulation within
the cranium. Soldiers have been known to die
from apoplexy in consequence of having their cravats
so tight. Dr. Abercrombie quotes from Fitzile,
the case of a boy, "who had drawn his neckcloth
alarmingly tight, and while whipping his top riding
and stopping alternately, after a short time fell down
apoplectic." He was speedily restored by undoing his
weakness, and drawing blood from the jugular vein. This tendency of obstruction to venous return to produce coma, or the symptoms of serious illness, is illustrated by the effects of tumors on the neck or chest interfering with the venous circulation. It is on this same principle of decreasing the cerebral circulation by obstructing venous return that violent muscular efforts, coughing, straining, etc., in most cases act in producing coma or symptoms. Cases are on record of coma having been induced by twisting of the neck, and it is easy to understand how especially in short-necked individuals such a motion would interfere with the return of venous blood from the head.

Another agency, which undoubtedly in most cases kills by inducing a state analogous to that of coma is cold. It was mentioned before as in some cases, (when the nervous system was from any cause peculiarly sensitive, and the sensation was very acute and very suddenly applied) producing death in the manner of a shock by paralyzing the heart, and it is unquestionable that it will have some influence on the power of the heart even in those cases where the corporeal symptoms are predominant.
This tendency of cold is illustrated by the well-known and oft quoted story of Mr. Banks and Dr. Rolander; and the appearances in the cases narrated by Dr. Kelie of Leith render it highly probable that it was in this way that cold proved fatal to the unfortunate individuals whose bodies he examined. Cold has a number of other interesting effects, which I cannot enter upon here; it diminishes the power of generating heat, it checks the capillary circulation at the surface, and this last effect may assist in producing the stupor which cases by altering the cerebral circulation as well as that of the other internal organs. There can be little doubt however that the stupor is mainly to be accounted for by the peculiar influence of the cold upon nervous system itself.

Heat is another agency which kills by inducing coma, especially when applied to the head in cases of coup de soleil. Its poisonous effects are most frequently observed (as in the case of cold) in those whose nervous system has not been tenderly peculiarly irritable in any way either by mental or bodily exhaustion. In all the cases recorded by Mitchell in the Edinburgh Med. and Chem. Journal there was a state of apoplexy induced characterized by
loss of sensibility, stupefied, and electron's breathing, and in all the appropriate treatment was depletion, cold to the head, and stimulating stimulations and enemata.

Lightning likewise in some cases, where the death has not been so sudden as to be explicable only by hypnose, induces a comatose state. A case of Dr. Hartmann's is quoted in the Brit. and For. Med. Rev. for Oct. 1842. This patient was restored from a state of unconsciousness with electron's depletion and full pulse by depletion, cold to the head, and stimulating enemata.

It is in this way also, that all the strictly narcotic poisons prove fatal, viz., by inducing insensibility, for this is the predominant symptom, though they exert likewise a sedative influence upon the circulatory system. Among these poisons we must reckon pure oxygen and Carbonic Acid. This last has been said to produce death by asphyxia, but that can only happen, when it is so undiluted as to excite chockedemic closure of the gillies. That when diluted extent, as a narcotic poison and not by mere depriva-

tion of pure air is proved by the following considerations, that death is much more rapid when there is a small quantity of this gas present, than
When there is merely a deficiency of air, it produces similar symptoms when introduced by other channels than the pulmonary mucous membrane, and that its effects are more persistent than those of mere want of air, so that removal from its influence after it has begun to act does not always ensure ultimate recovery. Individuals have died from poison by the fumes of burning charcoal in ill-ventilated apartments, by choking damp in mines, by the fumes from fermentation vats and lime kilns.

Sir B. Brodie in his experiments with vegetable poisons found that Alcohol, the essential oil of bitter almonds, the juice of the leaves of the foxglove, the oil of tobacco, and the koolara poison kill by inducing a state of insensibility with electrotonus and imperfect respiration, and that in such cases the chest was opened when the animal was apparently dead, the heart was often found still contracting upon venous blood. These observations show that these poisons exert their main influence upon the nervous system.

This is further proved by the fact that he restored animals from the influence of the koolara poison and oil of bitter almonds, or rather kept them alive...
till the influence of these poisons passed off, by artificial respiration; from this proceeding could not have been successful if the power of the heart had been very materially interfered with. Artificial respiration has proved successful in narcotic poisoning in the human subject. That it has not been often tried, or not often successful is no doubt to be attributed to the very evident effect which narcotics also have upon the vascular organs. But that it is an operation from which much might be hoped for in cases of pure coma, where the affection of the nervous system is of a transient nature cannot be doubted.

A case illustrating the benefits of artificial respiration in poisoning by opium is quoted in the Edinburgh Med. Surg. Journal for 1828. In this case that of a child affected with hooping-cough, who had taken an overdose of opium, artificial respiration was had recourse to by Dr. Ware of Boston. The pulse had ceased at the wrist, and the action of the heart was reduced to a few pulsations with long intervals between them, and the respirations were very few and imperfect. But as soon as artificial respiration was tried the pulse returned at the wrist, and in the course of an hour the breathing became natural, the pulse
was pretty strong and regular, and the kind of surface good. While the patient was thus improved a violent fit of hooping cough came on and ended in suspension of the respiration. The artificial respiration was again employed with similar good effects, but the paroxysms of coughing continued to return with great violence and the patient was carried off in one of them. Had this been an uncomplicated case of poisoning by spavin it seems not unreasonable to believe that the patient would have been restored from a state in which the powers of the vascular system were much depressed before the operation was had recourse to.

It remains to be mentioned that a comatose tendency has frequently been observed in connection with great improvement of the blood. Ignorance of this has given rise to mistakes in diagnosis and far worse errors in practice.

It is a very interesting question to investigate what is the proximate cause or causes of the insensibility in all these cases, and it is no less difficult than interesting. Dissection gives but little aid for the appearances in the brain after death from coma are so various that almost no kind of connection
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can be traced between themselves, and between them & the comatose symptoms in many cases. In some we find extravasation of blood, in others effusion of serum, in others congestion, in others various mortified states of the Cerebral tissue, while in a very great number no distinct appearance can be traced.

Dr. Abercrombie is of opinion that all the remote causes of coma act by destroying that relative balance between the arterial and venous blood in the cranium which he supposes to be necessary for the due performance of the functions of the brain.

Dr. Lieberbrun carries this opinion a little further and maintains that the proximate cause of the cessation of the renal functions in all the cases above described is the impeding or arresting of the circulation within the cranium. That this condition is adequate to produce the effects ascribed to it will be admitted by all who believe that the brain like other organs is dependent upon a due supply of blood for the proper performance of its office. It is further probable that this condition is produced by all the causes of coma above enumerated. Compression by tumors, extravasation, etc. blocks up the vessels which are most compressible parts within the
Cranium, and so impede the circulation. That this is the true explanation of such cases is further rendered probable by the fact that Coma is more likely to occur from such causes when suddenly applied, where there has been no time for a corresponding absorption of poison by which the compression of the vessels might be avoided.

Filling of the arterial system within the cranium will according to this theory produce stasis by blocking up the venous system, and vice versa.

Impoverishment of the blood manifestly impairs the circulation in the cranium as in other parts.

But there still remains the explanation of the cases of Coma from narcotic poisons, and this explanation seems possible only on the supposition of a peculiar impression on the Nervous System irrespective of the first instance of any effect on the velocity of the circulation.

Treatment of this tendency.

As to the treatment to be pursued in checking the comatose tendency it must vary somewhat according to the variety of the causes. An external cause should be sought for, if there is one, and if it is practicable let it be removed by appropriate means.
Pressure on the surface of the brain may be removed in many cases by trepanning; the causes obstructing passing action from the head can also in many cases be withdrawn; and in all cases of poisoning attempts must be made to evacuate the stomach by emetics and the stomach-pump. Bleeding has been recommended and has seemed beneficial in cases where the circulation has been unusually strong and full. In most cases benefit will be derived from the application of cold to the head. In all stimulating lacrimation and emetications must be employed with the view of causing the comfort of the patient, and while this is done artificial respiration may also be kept up, that the patient may survive if possible the effects on the nervous system. In the cases in which this tendency results from debility or lachrymation of treatment is required, rest and food nourishment have been sufficient to remove the unpleased symptoms.

In bringing this essay to a conclusion it must be admitted that the progress of dying is almost always more gradual than those above described and therefore more complicated, death resulting from a combination
Of all the modes described, yet in some cases of
death death is suddenly produced in some or
other of the ways above described, and in others
a predominant tendency is more or less frequently
observed, a tendency which must have a material
influence upon the remedies to be employed.

In inflammations within the abdomen for
example the pulse is always characteristically de-
pressed and death may be produced purely in the
way of a sympathetic failure of the power of the
heart.

The tendency to death by asthenia, or that
complex onode, in which both the powers of the circu-
latory organs, and the quantity of the circulating
fluid, are decreased, is observed in most cases
of fever, the effect upon the powers of the circulatory
organs is characteristic of the action of the poison. It is
in this way too that all chronic or non-fatal diseases
prove fatal; in such cases assimilation is in
abeyance, and various depressing agencies are
at work to produce a state of general asthenia.

The tendency to death by atrophy is observed
in all cases of inflammation affecting the air passages
of the respiratory organs - In Group and Bronchitis
The air passages are occupied by new material, thus
preventing from reaching the ultimate vessels of the lung. The same result follows upon acute
inflammatory swelling of the phthisis, or spasmodic
closure of that orifice. In Phrenorrhaphy and Pleurisy
the respiratory surface is variously curtailed, and
Asphyxia is the natural result in many cases
before the powers of the vascular organs have been
much diminished.

The tendency to death by Coma in the last place
is observed in all affections of the Brain - and
after death in many such cases appearances have
been seen, which were deemed satisfactory &
sufficient to account for the fatal result.

This tendency is also the result of certain diseases
in the course of which the blood becomes poisoned,
as in some diseases of the Liver and Kidney,
from retention of bile and urea in the blood.