centripetal march, appears last in the cornea. Progressive anæsthesia measures the degree of asphyxia, and absolute general insensibility indicates complete arrest of life beginning at the lungs. After all other movements have ceased the heart continues to beat, and finally stops in a state of diastole.

ETIOLOGY.—Asphyxia is one of the most frequent of the immediate causes of death. It may result from any of the causes that hinder respiration. These causes may arise from circumstances inherent to the individual, or they may be exterior to him. Asphyxia being brought about by the circulation of non-oxygenated blood in the lungs and the respiratory centre in the medulla oblongata, may be produced by any cause that tends to oxygen starvation and the accumulation of carbon dioxide in the blood. Arrest of the thoracic movements and hindrance of hæmatosis may sometimes be produced by any of the causes of thoracic spasm; by hemorrhage at the base of the brain or in the medulla oblongata, or by poisoning by curare; by the slow and gradual feebleness which precedes and leads to fatal disease; by the introduction of air into the blood, and by the action of cold or of heat.

Mechanical obstacles to respiration often bring on cyanosis and anæsthesia, resulting in arrested hæmatosis. Special instances occur in the case of arrest of respiration by a foreign body in the larynx, or by a polypus, by œdema of the glottis, by an abscess of the pharynx or of the tonsils, by a goitre compressing the trachea, by an accumulation of mucus in the trachea in capillary bronchitis, by an extensive pneumonia, by a considerable hydrothorax, by strangulation, by intestinal pneumatosis compressing the diaphragm into the thoracic cavity; by pressure on the chest, not capable of being overcome by respiratory efforts, such as the falling in of earth, being crushed in a crowd, or by the accident of overlying that often happens to young children, and by changes in the pressure of the air breathed, no matter whether this be a gradual diminution, a sudden diminution, or an increase. Asphyxia may also result from traumatic cause, as injury to the spinal cord or the base of the brain, a double wound of the chest admitting air, an opening of the diaphragm permitting the passage of the abdominal organs into the thorax, and from hemorrhage.

In the foregoing instances the air surrounding the individual does not present any alteration, the inspiratory efforts produce still some effect, but this effect is insufficient to preserve life.

Submersion in any liquid medium whatever causes asphyxia, and it may be caused by being surrounded by a medium devoid of oxygen and improper to support sufficient hæmatosis, as hydrogen, nitrogen, and the protoxide of nitrogen, gases not toxic, properly speaking, but considered irrespirable.

The three typical modes of asphyxia, the most important practically and the best studied in theory, occur in *strangulation*, *submersion*, and *confinement*.

In occlusion of the air passages from mechanical impediment, such as garotting, throttling, or by a noose or ligature, death results essentially from asphyxia. In some cases of hanging death may occur from asphyxia in combination with coma, the conjoint causes of occlusion of the air passages and disturbance of the cerebral circulation giving rise to the condition known as neuroparalysis. It is observed in a general manner that all kinds of death caused by the privation of respirable air have among themselves the greatest resemblance. Whatever be the obstacle that intercepts the connection of the lungs with the atmosphere, the apparent differences are only secondary, and the essential symptoms are identical, because all act in suppressing the functions of the blood and hæmatosis. In fact, the phenomena of asphyxia are constant, and related to disturbances in the respiration, innervation, and circulation, which vary according as the asphyxia is the result of submersion or of the absence of oxygen in the surrounding medium, according as it is immediate or slow. The fatal result of asphyxia is owing to the introductory arrest of the pulmonary circulation, the capillaries of the lungs being incapable of conveying venous blood. The stagnation of the blood in the lungs is followed by paresis of the respiratory centre and stoppage of the heart.

It is doubtful whether life be ever recalled in any case after stoppage of the heart following on asphyxia, yet the facts of suspended animation prevent the formulation of precise statements in this regard. Pigeons apparently dead from the effects of chloral hydrate recover, and fish frozen for a considerable time can be resuscitated by immersion in cold water. The writer has seen frozen terrapins resuscitated in the same manner. A striking difference is observed in dogs submitted to experiment. They recover after they have been deprived of air for three minutes and fifty seconds or even four minutes, but they die if they are submerged in water for a period of two minutes. They recover after two minutes and fifteen seconds if chloroformed before submersion. Dr. B. W. Richardson reports a case of recovery in a child with croup who was completely asphyxiated for eleven minutes, and cases of recovery from hanging are known in which the time was much longer.

Asphyxia, though not always the *mode of death* in those submerged, is commonly present in a certain number of cases. The resistance of new-born animals to this mode of asphyxiation is especially noted in the greater time required to drown a new-born pup than an adult dog. One minute and a half usually suffices to drown a dog, while a new-born pup often requires as much as fifty minutes. This great difference is owing to the less active change of tissues, and the smaller consumption of oxygen in the young animal. The more active the vital combustion, and the greater the demand upon the general store of oxygen in the blood, the quicker the young animal perishes when the respiration is obstructed.

Accidents owing to the absence of respirable air, or to confinement in places where the air is not renewed, are of common occurrence. Asphyxia from this cause is less prompt than that by strangulation. The phenomena connect and follow one another. Efforts to hold the respiratory function in abeyance are soon followed by head troubles, with nausea, loss of consciousness, diminution of the pulse, and insensibility of the skin. The more energetic the subject the more intense are the effects of asphyxia.

Although no warm-blooded animal can live in any medium not containing a sufficient mixture of oxygen, yet animals may become habituated to deteriorated air, and in certain conditions of suspended animation they may live for a certain length of time with impunity in a vacuum, and even in a medium charged with carbon dioxide. Rats and mice live in air containing but one, and even 0.5 per cent. of oxygen, and carnivora and birds resist death in an atmosphere in which the proportion of oxygen is so small as barely to support the combustion of a candle. There is also a tendency in the new-born to resist asphyxia from confined air. Young sparrows without feathers have been known to live twenty-four hours in a space where the adult sparrow died in two hours. Marmots in a state of hibernation live under an exhausted receiver, but die when awakened. Cold-blooded animals resist longer the privation of atmospheric air, as can be fully seen in the case of frogs.

It is sufficiently demonstrated that death in confined air is due, as is death in nitrogen, to simple privation of oxygen. Death from asphyxia may also occur in atmospheres which are still rich in oxygen, but in which the proportion of carbon dioxide is too high, as in caves, cellars, and the like.

The important facts relating to the cadaveric lesions, the treatment, and the medico-legal questions likely to arise in connection with asphyxia, will be found in the following article.

Irving C. Rosse.

ASPHYXIA, MEDICO-LEGAL RELATIONS OF.—*What is asphyxia?* Nothing is more difficult than to express in a definition all that any medical or legal

term may mean. No proof of this assertion is required by the reader who sees how differently authors define the meaning of such terms, and how constantly the simplest definitions are varied, qualified, and amplified by the authors themselves.

Nor can the derivation of the word itself determine its present technical meaning, for it has long since acquired a meaning distinct from the meaning derived from the Greek, *α*, privative, and the verb, *σφύξειν*, to pulsate, without pulse, as all death is that.

The definition accepted by lexicographers is best stated in the Century Dictionary, as follows: Asphyxia, the extreme condition caused by lack of oxygen and excess of carbon dioxide in the blood, brought about by a sufficient interference with respiration, as in choking, drowning, or paralysis of the muscles of respiration.

In its medico-legal sense, asphyxia is the cessation of the heart's action which arises from interrupted respiration, caused either by expelling the air from the body or by preventing the entrance of pure air into the body. When air is eliminated from the body, or pure air prevented from entering the body, the action of the lungs is paralyzed, and the blood, no longer aërated, loses its vital qualities and circulating powers. The combination of these conditions causes death. Death so resulting is called death from asphyxia, and the condition produced by this combination is asphyxia.

While asphyxia in a certain measure produces general effects which are practically similar in character, yet, as above indicated, it is not always caused by similar agencies, nor does asphyxia always present symptoms entirely uniform. On the contrary, there are found in cases of asphyxia produced by different agencies strikingly different physical symptoms, both external and internal. For sake of illustration: in the cases of asphyxia resulting from suffocation, there is rarely any positive disarrangement of the vascular system of the brain, and ecchymoses are comparatively slight, and often unapparent to the untrained eye; while in the cases of asphyxia resulting from strangulation, the vascular system of the brain presents strong evidence of death by strangulation, the condition of hyperæmia being marked, and ecchymoses are, as a rule, much more pronounced in number and in extent, so much so as to challenge the observation of the unprofessional witness.

There have been almost as many divisions and subdivisions of asphyxia as there have been treatises devoted to the subject. However, for the purposes of this article, asphyxia may be divided as follows:

1. Asphyxia from the want of respirable air, and from the inhalation of noxious gases.
2. Asphyxia from suffocation.
3. Asphyxia from strangulation other than from hanging.
4. Asphyxia from strangulation from hanging.
5. Asphyxia from drowning.

In this article, however, asphyxia from drowning will not be discussed, as a separate article upon this branch of the subject will be found elsewhere in this work (see *Drowning*).

How Asphyxia May be Proven.—Without trenching too much upon that branch of medical jurisprudence which treats of the introduction of expert testimony, it is not amiss briefly to sketch the principles applicable to the admissibility of expert testimony in reference to asphyxia.

In such cases, in the administration of justice, it frequently becomes necessary to determine the nature and cause of physical injury and death. These questions arise in tribunals vested with the power to try civil causes and also in tribunals vested with the power to try criminal cases.

The judgment of human courts is fallible enough at all events, but it is evident that no judgment can be approximately just unless founded upon a true statement of facts. Recognizing this axiomatic truth, the administrators of the law recognize the further principle that in determining the nature and cause of physical injuries and death, they must look for help from that profession the members of which have devoted their time and talent to the study of the human body, its nature, and its infirmities.

The rules that are prescribed by the courts in securing the help of medical experts constitutes a large part of medical jurisprudence.

In questions arising from injuries and deaths from asphyxia, the courts exercise the function above mentioned, and summon to their aid medical experts.

The questions upon which these experts are to shed light are necessarily these: Was asphyxia the cause of the injuries or the death of the person; and second, if so, by what means was asphyxia effected?

These opinions, given by the medical witnesses, constitute expert evidence.

The law recognizes the value of such evidence (in many cases it is the only method of arriving at a just conclusion), but both the law and the science of medicine recognize the dangers of relying upon expert evidence alone, and usually it has its greatest weight when supported by collateral evidence.

The Lay Witness.—However, the law does not rely alone upon expert evidence, in arriving at the facts in a case of death supposed to have been caused by asphyxia; if it did, oftentimes justice would miscarry. Indeed, in the majority of cases it is necessary to have witnesses both lay and expert.

The physical facts, including the surroundings, the position of the body, its appearance after death, etc., are facts which may all frequently be proven as well by one of the commonalty of men as by the skilful scientist. To illustrate: Should the subject of investigation be whether or not the deceased died from strangulation, lay witnesses would be permitted to testify as to the position in which the body was found, the marks of violence upon it, the prints of fingers or marks of hands, the discoloration of the skin, the protrusion of the tongue, etc. But they will rarely, if ever, be permitted to give opinion as to whether or not the deceased was strangled to death.

In a great number of cases, the lay witness is very valuable and sometimes is indispensable. He is indispensable when no physician viewed the body after death. In such a case, without lay testimony, the expert opinion is necessarily useless, having no physical facts upon which to base an opinion.

Nevertheless, the legal profession recognizes the danger of determining the cause of death from asphyxia, when the physical facts upon which the expert opinion is based are derived entirely from lay witnesses. The justness of this can be readily appreciated when it is considered how easily the lay witness might fail to discover some physical sign which would readily appear to the medical expert, and have the effect of compelling a radically different opinion as to the cause of death.

The Expert Witness.—The testimony given by the expert witness is twofold; first, it is purely opinion evidence, based upon hypothetical questions. When such evidence is permitted to be given, the hypothesis submitted to the expert must be made up of facts testified to by other witnesses.

The opinion, therefore, of the witness can have no weight with the court, unless the facts upon which it is based are accepted by the court as the true facts of the case.

But the expert witness is not confined to purely hypothetical questions where he has made a personal examination of the body And in a case of asphyxia, the expert, having examined the body, will be permitted to testify that in his opinion death was or was not caused by asphyxia, and by what means he believes asphyxia was effected.

Upon cross examination it may be elicited as to how carefully his examination was made, and the witness can be compelled to give in detail his reasons for his conclusions.

The student will readily conclude that in preparing to testify as to whether or not a death was caused by as-

phyxia, great care should be taken. In fact, before one is really competent to pass upon such a question, he should be learned and experienced in medicine. He cannot hope to be able thoroughly to prepare himself by the study of works upon medical jurisprudence alone.

Starting with the proper foundation of professional accomplishments, it is well for the witness to freshen his mind upon the minutiæ of the subject, and if called to respond to hypothetical questions alone, this will be doubly essential, for the witness may expect a rigorous cross examination, often conducted by an adroit advocate, coached to the edge by some accomplished medical expert.

If, however, the witness has had occasion to examine the body and its surroundings, and proposes to testify as to the cause of death based upon his own personal examination, he will find that he will require accurate information not included in his science. He will be expected to have a distinct recollection of the surroundings and of every detail of the physical appearance of the body, internally and externally. For this reason, whenever any substantial doubt exists as to the cause of death, and especially where crime is suspected, the physician should by all means make an autopsy.

On such occasions memory should not be trusted too far, and copious notes should be made by the physician concerning the surroundings, and especially concerning the results of his physical examination.

The extent of his ability as physician will tell him best what to look for and what to make note of, in regard to the condition of the body, and his knowledge of medical jurisprudence will prompt him to decide what facts concerning the position of the body, etc., he should preserve.

Having progressed thus far, it now remains for me briefly to discuss the four divisions of asphyxia which it is the province of this paper to treat, namely: (1) Asphyxia from the want of respirable air and the inhalation of noxious gases; (2) asphyxia from suffocation; (3) asphyxia from strangulation other than from hanging; (4) asphyxia from strangulation from hanging.

(1) *Asphyxia from the Want of Respirable Air and the Inhalation of Noxious Gases.*—Doubtless this division of the subject embraces what is more commonly understood to be asphyxia. In this division are included such instances as where the asphyxiated person has been shut in a small apartment with no means of receiving fresh air; instances of death in which the illuminating gas is blown out, or turned on in the room, when the victim was asleep; instances in which unfortunate miners meet the fatal damp of the mines, or unfortunate laborers perish in sewers by reason of being overcome with what is known in the popular vernacular as "sewer gas." And the books do present instances of death coming to one who was keeping guard over flowers which exhaled a poison in their perfume which was deadly to the watcher.

The three most common ways by which death is caused by this class of asphyxia are as follows:

(*a*) There is a certain amount of oxygen in all pure healthy air. When this air is taken into the lungs a part of this oxygen is exhausted, and the air is expelled from the body, charged with a poisonous gas, called carbonic acid gas. Whenever the air becomes charged with this gas to a certain percentage further inhalation is deadly. Deaths occur usually from this cause when a large number of people are placed in a small, ill-ventilated room or apartment.

(*b*) This same poisonous gas frequently destroys life by being generated in a room where the victim is sleeping, in a most unexpected manner, as from the combustion of charcoal, coke, or anthracite coal. Sometimes it is turned directly into the room from a defective gas pipe or an open burner.

(*c*) Asphyxia is often produced by inhaling another noxious gas, even more deadly than the carbonic acid gas, and that is sulphureted hydrogen gas—commonly called sewer gas—which is most frequently found in sewers or the vaults of privies.

In the investigation of the cause of death, where asphyxia from noxious gases is supposed to be the agency, the first proceeding should be to discover, if possible, the presence of the gas in the air, and then to trace it to its source. If this can be done, it requires, as a rule, little skill to determine that the gas was the cause of the death; although it is possible that a dead body may be found in the midst of such poison, and yet death have arisen from another cause, as when murder has been committed and the assassin turned on the gas to hide his crime. It is also frequently the case that death ensues from such a small charge of the poisonous gas as to render its detection difficult. In such cases, and in cases in which the expert does not visit the scene of death, he must rely mainly upon the signs and evidences upon the body in arriving at his conclusion as to the cause of death.

The usual signs pointing to such death are swollen head, face, neck, and abdomen, jaws firmly set, discolored lips (dark blue), abdomen often violet-colored. The body preserves its warmth, especially when poisoning results from carbonic acid gas, for some hours, and the rigor of death is tardy in setting in, although these indications are frequently not all found in one case.

When death has not ensued, the physician will find, when the patient is suffering from carbonic acid gas poisoning, a disposition to sleep, a rapid losing of strength and sensibility, heavy breathing, accompanied at times with frothing at the mouth, and occasionally with delirium and convulsions.

When the patient is asphyxiated with sewer gas, nausea and irregular respiration, rather than labored respiration, agitated pulse, cold skin and loss of motion, frothy saliva tinged with blood, and closed eyes, are commonly accepted symptoms.

(2) *Suffocation.*—Following the definition in Wharton and Stillé's work on "Medical Jurisprudence," suffocation may be said to ensue when, "by any means air is excluded from the larynx or chest, or the chest is prevented from receiving it."

Suffocation is most commonly accomplished in two ways:

(*a*) By expelling the air from the lungs, by pressure upon the abdomen and chest, and by such continued pressure preventing the physical action necessary for respiration. Cases of this kind are more usually found where small children have been overlaid by older persons during sleep, and occasionally where one has been caught in a jam of heavy material, or pressed excessively in a great crowd.

Death in such cases is attributed to the fact that pressure upon the abdomen and chest compresses the vital organs, expels the air from the lungs, and so closes the lungs and windpipe as to prevent other air from entering. Death of this character usually results from accident.

Beck reports the case of a child who died from being wrapped up too closely by the parents, when it was being taken to a nurse.

(*b*) By covering the mouth and nostrils so as to prevent the ingress and egress of air, most frequently accomplished by the use of bedclothes, or other heavy clothes, a method made famous among all English-speaking people by the genius of Shakespeare, who makes his Moorish hero adopt it as a means of revenging his imagined wrongs upon the innocent and beautiful Desdemona.

In this division should also be included those cases in which the victim has been covered by dirt, ashes, snow, or the like, as by being buried alive or caught under a slide of snow. And in the same connection should be mentioned those cases in which feeble or intoxicated persons have fallen face downward in snow or sand or other similar substance, and, being unable to rise, have been suffocated.

Suffocation is not often adopted as a method of suicide, and it is infrequently resorted to for the purpose of homicide. Perhaps it more frequently occurs by accident.

Unless some facts are proven which point to the cause of the death, the expert is at a great disadvantage in attempting to determine whether or not death was due to external cause, or was the result of apoplexy, faucial disease, or pulmonary congestion.

Some of the most common physical indications of death by suffocation are lividity of the face and sanguineous engorgement of the viscera of the thorax and abdomen. There are frequently bloody infiltration of the eyes and eyelids, and very small ecchymoses of the neck and chest; a partial engorgement of the lung; little, if any, blood in the left ventricle of the heart, while the right ventricle of the heart is generally engorged. Sometimes a reddish froth is found in the trachea and bronchiæ. As a rule, the body is slightly if at all discolored, and the vascular system of the brain shows rarely any evidence of disorder. One of the most common indications is congestion of the kidneys. When a dead body is found in earth, ashes, or snow, or the like, the question presents itself at once whether the death preceded the fall or the burial. Perhaps the best-recognized test is to examine the stomach, gullet, and air passages. If the foreign matter is found in the stomach or in the gullet, this is regarded as very positive evidence that death followed the fall or burial, as only by the action of a body instinct with life could the foreign matter be so drawn in. On the contrary, if the foreign matter is found only in the nostrils and mouth, this is positive evidence that death was not caused by suffocation.

Suffocation frequently is caused by foreign substances becoming lodged in the windpipe or in the œsophagus. Children and infirm people more frequently suffer in this way. This often makes it necessary, in order to determine the cause of death, to make an examination of the windpipe and gullet, frequently by incision.

(3) *Asphyxia from Strangulation Other than by Hanging.*—The first question to be determined in this division is, of course: Was death caused by strangulation, and if so, by what means? Under this head we shall consider the indications of strangulation other than that accomplished by hanging.

As in all cases of asphyxia, the trouble in strangulation is the lack of air in the body. But the means used to create this lack is, in strangulation, different from the means employed in either of the two preceding divisions.

In strangulation, the access of air into the lungs is interrupted by a pressure upon the windpipe at the throat. This method provides a double means of death, and in the majority of instances death is the result of combined causes, namely, the lack of breath caused by the pressure upon the windpipe and the closing of the larynx, and congestion of the brain caused by pressure upon the veins of the neck. Either of these might be, in itself, sufficient to cause death, according to the violence of the attack, but it is rarely the case that the expert can definitely proportion the responsibility.

In the majority of cases, there are many apparent physical signs that point with great clearness to the cause of death, and give great aid in arriving at a proper conclusion.

Some of the physical indications that tend to lead to the conclusion that death has resulted from strangulation may be enumerated here. One of the most common indications is the presence of ecchymoses upon the face, neck, and chest caused by extravasated blood. The presence of these ecchymoses points strongly to death by strangulation, although it is usually conceded that the absence thereof will not be conclusive proof to the contrary. Frequently these ecchymoses are so minute as to fail to attract the attention of the lay observer, and for this reason a careful examination by the medical expert is often invaluable.

An examination of the brain will disclose more or less congestion and disarrangement of the vascular system generally, and congestion of the kidneys and liver is very common.

Aside from these indications, the swollen face, often the protruding tongue and eyes, and the distortion of the features generally throw much light upon the subject.

As strangulation other than by hanging is usually homicidal, great attention should be paid to noting any mark of violence upon the body, any evidence of struggle either upon the body itself or upon the surroundings. The condition of the clothing may be strongly indicative of attack and resistance.

Death from manual strangulation may be accomplished by means of the hands, cord, or other ligature.

When the hands are used, it is very easy, as a general thing, to determine that the strangulation was manual; but when a cord or ligature was used, the conclusion cannot be so safely or easily arrived at. In such cases, the mark of the cord or ligature will give aid. Where the strangulation was manual, as distinguished from strangulation from hanging, the mark of the cord will be very nearly horizontal, whereas in strangulation from hanging, the mark will be higher on one side than on the other, and will at the point of the knot approach near the head. The mark of the cord or ligature in manual strangulation is also, as a rule, much lower on the neck than when the strangulation results from hanging, as the weight of the body invariably causes the cord to slip as high as possible, only being stopped, as a rule, by the head.

There are seldom (in manual strangulation) any injuries to the vertebræ, and the ligaments of the neck are rarely torn; while, on the contrary, such results are frequent when strangulation is caused by hanging.

And, finally, it may be observed that in manual strangulation the throat is rarely so perfectly closed as in strangulation from hanging, for the suddenness of the fall, combined with the weight of the body, tends thoroughly to shut all the air passages. While the position of the body usually throws some light upon the question, yet this is by no means decisive, for it is an easy matter for the assassin, after accomplishing murder by manual strangulation, to suspend the body by a cord in order to cast about the death the appearance of suicide. The foregoing signs are merely helpful, and rarely unconnected with collateral evidence entirely satisfactory to the conscientious administrators of the law.

Human experience has demonstrated that few signs of this nature are to be absolutely relied upon, for oftentimes incidental and accidental physical facts tend to incriminate an innocent man, and frequently the guilty deliberately make evidence of this character in a speedy and skilful manner for the purpose of creating the impression of self-murder.

The importance of a careful investigation and physical examination is very apparent, when it is considered that while the law takes great care to punish the destruction of human life, it also takes greater care that no innocent man shall be punished. To such a degree is this carried that if from the evidence the jury should have a reasonable doubt as to the fact that the death was homicidal, under the instructions of the court an acquittal is necessary.

(4) *Asphyxia from Hanging.*—In determining whether or not death was caused by hanging, either when the dead body is found suspended or when it shows certain external evidences of such a death although no longer suspended, many of the evidences found in death from manual strangulation should be considered and sought for.

The congestion of the brain and the derangement of the organ in other respects are largely alike in the two forms of asphyxia, although more pronounced in death from hanging; the ecchymoses are also in evidence again, usually in a more pronounced manner, and the same physical distortions and swellings of the face and neck will be found, save, as in the congestion and ecchymoses, to an accentuated degree. But to the unskilled observer these indications may be said to be similar in death from hanging and in death from manual strangulation. After having observed these indications, which are largely alike, as just set forth, it is probably best to look carefully for those marks which

are common in both cases, but different in form or degree. The first should be the mark of the cord. In hanging it will be found not to be horizontal, one side usually being much higher and terminating in something like a point; the mark, furthermore, is invariably higher than in manual strangulation, the weight of the body drawing downward and forcing the cord to the base of the head, while the air passages are closely shut by virtue of the weight of the body or the sudden force of the fall. The marks of the cord are usually deeper and more distinct, and there will rarely be the same evidence of finger marks upon the face and throat. There are more pronounced excoriations in connection with the marks of the cord. The great majority of deaths from hanging are due to the combined causes of asphyxia and apoplexy; while in manual strangulation, perhaps a majority of deaths ensue from asphyxia alone.

One of the most common physical evidences found upon a body when death is attributable to hanging consists of injuries to the ligaments of the spinal column and the tearing of the carotid arteries in the neck.

The lens of the eye is said to be often cracked by the sharp shock of descent, and this sometimes gives help to the expert, if he is prepared to make a proper examination.

The effect upon the genital organs of both the male and the female victim often throws great light upon the question. It is mentioned by the authorities that hanging causes a certain excited condition of these organs both in the male and female, but usually more pronounced in the male. However, evidences of this are not always present, and in view of the fact that often they are found after death from other forms of violence, they alone will not suffice to prove that death was caused by hanging.

The usual effect upon the male genitals is a state of tumefaction; spermatozoa are found in the urine and in the urethra, and frequently there is an emission of semen. In the female, there is often found a dilated and inflamed condition of the genitals, and sometimes a bloody discharge.

Another indication commonly observed is the discharge of the bowels.

As many deaths resulting from hanging are suicidal, it is often a question of grave importance to determine whether the hanging was in fact suicidal or homicidal. It is the unanimous opinion of those who have made profound study of this subject that in the absence of collateral evidence the presumption is that the death was suicidal.

Hanging is such an easy and convenient method of exit from the world that the wretched and despondent frequently adopt it, in ridding themselves of those "ills they have." This is probably due in a certain measure to the fact that unlike many other methods of suicide, hanging, when once begun, can rarely be stopped by the would-be suicide. The first compression of the air passages tends to benumb all sensibilities, to stupefy the will, and to paralyze those other members of the body which, upon a change of mind, would be necessary to effect a self-rescue. Therefore, doubtless, in many instances in which the resolution to destroy one's self is only partially fixed, when the first step has been taken there is rarely an opportunity to go back.

Hanging can be accomplished in so many ways, and with such simple appliances, as also to present a royal road to death to the melancholy and desponding.

The main things to consider in this connection are: the position of the body, whether it swings clear or barely touches the ground; whether the hands and feet are bound; whether or not the cord or other device gives evidence of being prepared by another; and sometimes the manner in which the knot is tied.

There is no doubt also, as a rule, that in suicide there are no marks of violence upon the body, and rarely any evidence that would tend to show struggle.

But, in the end, evidence purely expert and hypothetical, in this as in all methods of determining the cause of injury and death, is to be received with caution, and is most valuable when considered together with proven facts that point to a cause of the death.

John Bell Keeble.

ASPIDIUM. See *Male Fern.*

ASPIDOSPERMA.—QUEBRACHO. *White Quebracho.* "The bark of *Aspidosperma Quebracho-blanco* Schlechtendahl (fam. *Apocynaceæ*)" (U. S. P.).

This plant is not to be confused with the quebracho Colorado (red quebracho), the wood and bark of which are very largely employed for the preparation of an extract used in tanning, and pertaining to the *Quebrachia Morongii* Britton (fam. *Anacardiaceæ*). The title "quebracho" means axe-breaker, and is, for obvious reasons, applied to various trees. In the last-named species it is the ironlike wood which has given the name. In that under consideration, it is the great abundance of stone cells in the bark which, occurring in masses, chip out the edge of the axe. The tree is of medium size, widely spreading, evergreen and handsome, and inhabits the northwestern portion of the Argentine Republic and adjacent countries. The supply of bark is irregular, and it is usually scarce and dear. It occurs in irregular chiplike or blocklike pieces, and is about the thickest and roughest bark of commerce, resembling only dita bark in this particular. The gray outer surface is most coarsely and deeply fissured, while the texture is so compact and tough that there is little tendency for it to scale off. Half the thickness or more consists of cork and cortex, the latter filled with large groups of stone cells. The color of this layer may be either of a yellowish white or pale yellow, or more or less rusty or brick red. The inner bark consists of several thick layers of very coarse bast fibres and varies from nearly white to a rather dark brown. It is very compact, tough, hard and woody, and of splintery fracture. All parts of the bark have an intensely bitter taste. The variation in the color of the bark cannot be explained in the present state of our knowledge. It is not the darkening of age, as the writer has bark which has been kept for many years, but which is almost white throughout. It is not improbable that a number of closely related species are in use. If so, the matter is in much need of investigation, as the composition and properties may differ more than the physical characteristics of the bark.

Composition.—Although aspidosperma contains, along with a small amount of tannin, no less than six alkaloids, its action is remarkably simple, owing to the fact that the alkaloids agree rather closely in their general action. *Aspidospermine*, *quebrachine*, *quebrachamine*, and *aspidospermatine* are crystalline, *aspidosamine* and *hydroquebrachine* are not.

Properties.—Their combined action is first to stimulate, then to depress the respiratory centres and to produce a nauseating expectorant effect, followed by muscular depression or weakness, including moderate cardiac depression. Abnormal temperature may be reduced. The drug, used in moderate doses, thus becomes capable of increasing both the number and the depth of the respirations, and of relieving spasmodic conditions, while in large doses it induces convulsive breathing and ends in fatal respiratory paralysis. Vomiting very rarely accompanies the nausea. It is said that aspidosamine, used alone, acts as an emetic. Little has been done therapeutically with the individual alkaloids, that usually sold as aspidospermine being an alkaloidal mixture. Neither has the therapeutical use of quebracho in any form been greatly developed. It is said to be used in its native home partly as an antiperiodic, and partly, like coca, to overcome the dyspnœa of mountain travel. Its chief use in professional medicine is to relieve the dyspnœa of asthma and other spasmodic conditions, as well as of emphysema. Owing to its weakening effect upon the heart, it is contraindicated in case of organic disease of that organ. The results of its continual use have not been found satisfactory, being those of continued depression of the nerve centres, with salivation and nausea.

A peculiar effect has been reported, in some cases, of promptly curing erysipelas by the hypodermic injection into the affected part of a half-grain of commercial aspidospermine. The dose of aspidosperma is 1 to 4 gm. (3 ¼ to 1). There is an official fluid extract, but the extract, in five-grain doses, is more often employed.

H. H. Rusby.

ASPIRATION.—In a paper presented to the French Academy of Medicine, November 2, 1869, Dr. Georges Dieulafoy brought to the notice of the profession a valuable method of detecting the presence of fluids in, as well as of removing them from, various parts of the body. The process is called pneumatic aspiration, or simply aspiration. Briefly stated, it is a method of exploring diseased parts with a hollow needle, connected with a vacuum, or, as it is called by the inventor, a "previous vacuum."

Instruments.—While several different patterns of aspirator have been devised and recommended, only two require notice here, as they comprise the principal advantages of each of the others.

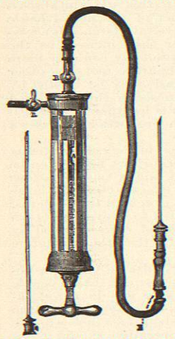

Fig. 364.—The Dieulafoy Aspirator.

The Dieulafoy aspirator (Fig. 364) consists of a glass syringe holding three or four ounces, and having two outlets at its lower end, each of which has a stopcock, *B*, *B*; a rubber tube, into which is let a glass index, *E*; and four needles of various sizes. The apparatus is used as follows: The needle having been connected with the syringe by means of the tube, and the outlets closed, the piston is withdrawn to its full extent, and secured by a quarter turn. The needle is now to be introduced at the proper place, and as soon as its point is buried in the tissues the corresponding cock is to be opened, thereby extending the vacuum to the extremity of the instrument. The needle is carefully pushed forward as far as is desirable, or until fluid is found, which will be indicated by its appearance in the index, if not in the syringe. The latter may be emptied by closing its outlet leading to the tube, opening the other, and unlocking and driving the piston home. Another vacuum is to be made as before, and the process may be repeated indefinitely without removing the needle or disconnecting the syringe.

Should the needle become stopped up during the operation efforts may be made to clear it by reversing the action of the syringe, and forcing a little fluid back, or it may be partially withdrawn, or carried a little deeper, or its direction may be changed. These manœuvres failing, it must be taken out, cleared, and introduced in another place.

With this instrument, stimulating or other liquids may be injected into a cavity by filling the syringe with the fluid, instead of exhausting the air.

Potain's aspirator (Fig. 365*) comprises an air pump, *A*, having two openings, *C*, *D*, each of which is supplied with a metallic valve, working in opposite directions, the former allowing an exit, and the latter an entrance, of air to the pump; a bottle, with a capacity of a pint or more, fitted with a rubber stopper, *B*, which is perforated by a double metallic tube, whose outer portion terminates in two branches, each having a stop-cock, *K*, *L*; two rubber tubes, with the necessary needles, complete the apparatus.

* Codman & Shurtleff, Boston.

It is made ready for use by connecting the bottle with the needle by the indexed tube, *E*, and with the pump by the tube, *G*. The cock, *K*, nearest the pump, is opened; the other is closed. The air is exhausted from the bottle by a few sharp strokes of the piston, and the cock, *K*, is closed. The puncture is now made, and as soon as the point of the needle is under the skin the corresponding cock, *L*, is to be opened, and the exploration carried to completion. Another vacuum is readily established without disturbing the needle or its connections.

By attaching a rubber tube to the inner end of the metallic one, long enough to reach to the bottom of the bottle, and by changing the tube *G* from *D* to *C*, so as to force air into the bottle, instead of exhausting it, the apparatus may be used for injection or irrigation, or the bottle may be emptied of its contents by simply working the pump. This action is due to the fact that the inner orifice of the tube *K* is on the side just below the stopper, and hence independent of the tube in the bottle.

As a more perfect vacuum can be obtained with Dieulafoy's instrument, it is the best one for diagnostic purposes. It is also well suited for evacuating or injecting small quantities of fluid, especially when it is desirable to be exact as to the amount. But for drawing off large effusions, or for irrigating large cavities, Potain's apparatus saves time and labor. And it may be said that for general use the latter instrument is the more serviceable of the two, as it can be made to do the work satisfactorily in most of the cases requiring this operation.

The peculiar feature of the aspirator, which distinguishes it from the suction trocar, and which makes it so much more valuable, lies in what Dieulafoy calls the "previous vacuum." As this extends to the point of the needle the operator is notified of the presence of fluid the instant it is reached, and therefore there is little danger of passing through a small collection of fluid without knowing it, or of wounding deeper structures unnecessarily, a matter of much importance in tapping joints and other cavities. The strong suction power of

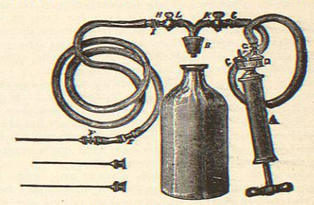

Fig. 365.—Potain's Aspirator.

this instrument enables one to use smaller needles, as well as to evacuate fluids which are too thick to be withdrawn with an ordinary trocar.

The aspirator should always be tested just before it is used upon a patient, because, from its peculiar construction, it is very liable to get out of order. The piston gets loose, the needles are easily plugged with rust or dirt, the tubes crack and break, the cocks stick, the stopper may not fit the bottle. All of these points require attention in order to avoid embarrassment and delay.

It would be well if all aspirator needles were made after the pattern recommended by Dieulafoy, namely, Nos. 1, 2, 3, and 4, having the respective diameters of 0.5, 1, 1.5, and 2 mm. ($\frac{1}{50}$, $\frac{1}{25}$, $\frac{1}{15}$, $\frac{1}{12}$ inch). After having been used, the needles should be thoroughly cleansed with hot water (carbolized), dried, and threaded with a wire to keep them patent.

Small trocars can be used with the aspirator in place of the needles for purposes of evacuation and irrigation.