Krehl* says that the hypoplastic anæmias are due to an injury of some organ concerned in the production of a constituent of the blood. It is certain that many organs are concerned, and a disturbance of any one of these may bring about the result.

The consumptive anæmias may involve the destruction of normally produced blood. Here, also, many organs are probably concerned. The production of substances necessary for the preservation of the erythrocytes in the plasma might be limited, or deleterious substances might be produced. As another possibility might be mentioned acceleration of the normal destruction, by whatever processes that is brought about.

An evidence of increased destruction within the body is an increase in the amount of iron in the liver, spleen, and bone marrow. When the anæmia is due to loss of blood, the amount of this iron is decreased as a result of the activity of the regenerative processes.

The causes of the secondary anæmias may be classified as follows:

I. Hæmorrhages.

II. Insufficient nourishment and bad hygienic surroundings.

III. Malignant tumors and other organic diseases, poisons, parasites, etc.

I. *Hæmorrhages.*—The loss of blood may occur from: (1) the nose; (2) the lungs; (3) the gastro-intestinal tract in association with ankylostoma duodenale, ulcus ventriculi et duodeni, malignant tumors, and hemorrhoids; (4) the genital tract in women; (5) the bladder; and (6) it may also occur in the various forms of hæmorrhagic diathesis. Considerable losses are compensated for if sufficient intervals occur between the hæmorrhages. The more frequent the hæmorrhages the longer is the time required for this compensation.

II. *Insufficient Nourishment and Bad Hygienic Conditions.*—No satisfactory explanation of the anæmia is given. Improper food and surroundings (light, air), hard work, and mental distress are ordinarily given as the causes. Experiments upon professional fasters and upon animals have shown that acute and complete starvation does not produce anæmia. In the more chronic cases, however, it occurs especially when the diet is poor in iron-containing foods, of which the most important is meat. As these are the most expensive foods, this is probably an important factor among the poorer classes. In infantile scurvy the cachexia associated with the subperiosteal extravasation of blood is usually a result of improper feeding. Malted milk and condensed milk are most largely responsible. Animal experimentation and the experience of members of polar expeditions in the long polar nights seem to show that lack of light does not produce anæmia or have any other bad effects. Concerning the ill effects of polluted air, little is known.

III. *Malignant Tumors and Other Organic Diseases, Poisons, Parasites, etc.*—There is hardly an important pathological condition that does not have its effect upon the blood and upon the bulk of the frame. The reduction in the amount of food in disease of course aids in producing anæmia and emaciation.

In *suppurations* there is a loss of important materials and a considerable additional expenditure of energy. The great draft upon the bone marrow is shown experimentally by the increase of the red marrow, and by the relative increase of the neutrophiles — especially the mononuclear forms—and the relative decrease of the eosinophiles.

In *spermatorrhœa, lactorrhœa, catarrh of the air passages and of the alimentary tract*, the same causes obtain.

In *albuminuria* the loss of albumin probably brings about a state of hydræmia, and this latter condition no doubt exerts a deleterious effect upon the red blood corpuscles. The associated intoxication is also probably a factor.

In *fevers* the amount of hydrobilirubin in the urine is to a certain extent a measure of the destruction of the red blood corpuscles. Experimentally the simple elevation of temperature probably does not increase metabolism extensively, or alter the quality of the blood. Practically, however, the associated intoxication, as in the infectious diseases, is probably the important factor. The toxins may exert an erythrocytolytic function.

Diseases of the Digestive Tract. These are among the most frequent causes. Limitation of alimentation and intoxication operate as factors here. Decreased excretion of toxins, and possibly auto-intoxication, occur.

In *syphilis* the anæmia and emaciation are probably due to the specific toxin of the disease.

Tumors. Uncomplicated benign tumors have no effect upon the general health. Uncomplicated malignant tumors produce marked anæmia and emaciation. The cause is to be sought in a toxin which increases blood destruction and proteid metabolism.

Animal Parasites. Most of these probably produce toxins. The eosinophilia which occurs in connection with most, if not all, of the intestinal parasites is to be regarded as evidence of this. This is true of oxyuris vermicularis. In the case of ascaris lumbricoides the mechanical irritation may be a factor. With the echinococcus and the trichina no anæmia occurs. The complications seem to be responsible for the anæmia in the case of filaria sanguinis hominis and distoma hæmatobium. In ankylostoma duodenale the blood removed by the worm is an important factor. In the urine of patients infected with this worm is a toxin which produces marked anæmia in rabbits. In malaria a toxin undoubtedly exerts an influence in addition to the direct destruction of the erythrocytes by the parasites.

Poisons. In lead poisoning the anæmia is thought to be due to the lesions of the stomach and intestines. Arsenic probably destroys the erythrocytes directly.

In any of the above conditions, if there be marked emaciation, the condition of cachexia may be brought about.

Pathological Anatomy and Histology.—*Blood.*—The condition of the blood is that of a secondary anæmia. In only a few forms is a special feature noted; as, for instance, the presence of parasites in the case of malaria.

Other Organs.—The skin is yellowish rather than white, as in the acute anæmias. This is to be regarded as an expression of the increased destruction of the erythrocytes. The tendency to œdema and hæmorrhages is probably due to changes (fatty) in the blood-vessels. Hæmorrhages may occur into the skin, the mucous membranes, the central nervous system, and the serous membranes. No characteristic changes in metabolism are known. It is often impossible to say whether the gastro-intestinal disturbances which so frequently occur are primary or secondary.

Certain lesions sometimes spoken of as characteristic of pernicious anæmia may also occur in these grave secondary anæmias. Such are hæmorrhages into the omentum, fatty degeneration of the heart, degenerations in the brain and spinal cord, and atrophy of the mucous membrane of the gastro-intestinal tract. Changes in the bone marrow consist of an increase of the red marrow. This may gradually encroach upon the territory of the yellow marrow in the shafts of the long bones. However, the hyperplastic marrow has normal histological characters.

In the emaciation the most important tissues suffer least. The greatest reduction is of the fat; then follow the muscles, skin, liver, bones, heart, and central nervous system. The organs show no striking histological alteration. The atrophy of the fatty tissues is described as follows by Ribbert.* In cases of marked cachexia the fat, especially of the epicardium, may assume an œdematous, gelatinous character. In frozen sections of the fresh tissue one sees, in place of the large, closely packed fat cells, groups of fat droplets in a clear vascular tissue. Under a high power these groups are seen to be contained within cells which represent the atrophied fat cells. If the process is still more advanced they take on the character of the ordinary connective-tissue cells. Between these are connective-tissue fibres.

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* Krehl: "Pathologische Physiologie," Leipzig, 1898, S. 125.

* Ribbert: "Lehrbuch der pathologischen Histologie," Bonn, 1896, S. 11.

CACHEXIA STRUMIPRIVA. See *Thyroid Gland, Diseases of.*

CACTACEÆ.—(The Cactus family.) This strange and interesting family of plants occupies as yet a most uncertain place in the materia medica. It comprises some twenty genera and probably six hundred species, and its study is no less difficult for the botanist than for the pharmacologist. The plants grow chiefly in desert regions, being competent to withstand the most extreme conditions of aridity, and interest centres chiefly in their defensive provisions. The absence of leaves, which are usually metamorphosed into spines, protects them against desiccation. The succulent nature of their stems causes them to be sought by hungry and thirsty animals. In times of cattle famine, the spines are burned off and the stems then used as fodder, while a wholesome water supply can be obtained from cavities scooped out in the bodies of some of the thicker species. Against destruction from such causes, most of them are protected by their armament of spines. Those which lack this armature are commonly protected by poisonous alkaloids, and attempts have been made to utilize some of these in medicine. The important drugs of the family are the *Cactus grandiflorus* and the *Mezcal Buttons*, which see.

Their physiological properties are diversified. The berry-like fruits are commonly edible, and some of them, like the Prickly Pear or Tunya, are of much economic importance. Several of them are hosts for the valuable cochineal insect. Many succulent plants not related to this family are popularly called cactuses.

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CACTUS GRANDIFLORUS.—Cereus Grandiflorus. The flowers of *Cereus grandiflorus* (L.) Miller (fam. *Cactaceæ*). The stems have also been used. This plant, the well-known Night-Blooming Cereus of cultivation, is a native of the West Indies, and flowers in August. Adulteration with, or substitution by, the flowers of *Opuntia decumana* Haw. is very extensive. The flowers of the latter are cup-shaped, about an inch long and broad, with stamens one-fourth or one-half of an inch in length; while the genuine flowers are eight to ten inches in diameter when fully spread out, and have stamens two or more inches long. Much of the contradictory testimony as to composition and properties is doubtless due to this irregularity in the drug used, yet there is a wide discrepancy of opinion as to the merits of that which is genuine. No efforts appear to have been made to compare the flowers collected in different stages of maturity. The facts here stated, however, appear to be fairly well established. Both the stems and the flowers appear to be active, but the latter more so. An alkaloid and a glucoside are claimed, but our information regarding them is very meagre and indefinite. The drug is a cardiac stimulant of peculiar action. It does not affect the stomach nor the centres as digitalis does. It increases blood pressure by quickening and strengthening the heart beat, through direct action upon its nerves. Wilcox, who has studied it extensively, is positive in asserting its value in aortic regurgitation, where digitalis cannot be used, but its injuriousness in mitral stenosis. He recommends it generally in relative cardiac incompetency and functional cardiac weakness. The dose of the fluid extract is 0.6 to 2 c.c. (ηx. to xxx.).

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CADAVER, LEGAL STATUS OF.—*Scope of the Subject.*—The enactments of State legislatures and the regulations of sanitary codes in regard to the cadaver constitute the purely legal side of the subject, and are too extensive to be considered in detail. So far as they affect physicians, as practitioners, investigators, instructors, and medical examiners, they fall within the scope of an article suitable for this Handbook.

Questions involving the cause of death, and such other deductions as only a person possessing expert anatomical, medical, and surgical knowledge would be able to make from an examination of the cadaver, constitute the medico-legal side of the subject. Those matters, which can be determined only by an autopsy, have been considered in Vol. I under *Autopsies, Medico-Legal Relations of.* Besides pathological conditions, the cadaver presents certain appearances which form a basis for the determination of the fact of death, of the time when it occurred, and of the identity of the dead person.

Legal Aspects.—If we consider the subject from the physician's standpoint, it will be sufficient for us to enumerate the latter's duties and privileges in relation to the cadaver; we shall scarcely be expected to specify in detail the statutes and codes that relate to the subject. For more detailed information in regard to the latter the reader is referred to an excellent article by T. C. Becker on the "Legal Status of the Dead Body," in Witthaus and Becker's "Medical Jurisprudence, Forensic Medicine, and Toxicology."

A death having occurred in a physician's practice, it is his duty to examine the cadaver and verify the occurrence by unmistakable signs presented. (These will be discussed further on.) No statute or code requires this in so many words, but the physician's "Certificate of Death" presupposes such examination to have been made.

The "Certificate of Death" is a record and legal proof of death. The form is furnished by the health authorities, and on its reverse side it contains terse information about the legal requirements. The extent to which these are either neglected or disregarded in New York, and presumably elsewhere, is remarkable. Such neglect is frequently responsible for many vexatious occurrences that might and should be avoided.

The attending physician must furnish such a certificate within a specified time (thirty-six hours, according to the New York Sanitary Code, sec. 180).

The physician must be officially registered (New York Sanitary Code, sec. 5.; Bureau of Records).

The cause of death must be sufficient, no mere symptom being given as the sole cause.

When a cause of death is given which might possibly be the result of injury, if such is not the case the certificate should make that fact plain.

If death is due to other than natural causes, the case must be referred to the coroner, county physician, medical examiner, or justice of the peace, according to the law of the State. In doubtful cases the practitioner should not furnish the certificate unless authorized to do so by the proper official. Such cases are specified by statute in the various States. That of New York State is very broad. If a person dies from criminal violence, or by a casualty, or suddenly while in apparent health, or when unattended by a physician, or in prison, or in any suspicious or unusual manner, the case must be referred to the coroner's office (chap. 410, sec. 1,773, laws of 1882).

Still-Birth.—The still-born fœtus or child at full term is certainly a dead human body, having been alive in utero; yet the law takes no cognizance of this fact, and does not require an inquiry into the cause of death, unless it can be proved that the child was born alive and capable of maintaining a separate existence; the decision of the former fact being based upon breathing; of the latter, upon normal formation and sufficient development.

The physician or midwife in attendance at a still-birth should make a report thereof to the proper authorities. In New York, certificates are furnished by the Bureau of Vital Statistics, and these certificates require, besides other information, a statement of the "cause of death-birth, if known."

Concealing the birth of a child, which if born alive would be a bastard, is punishable in seventeen States.

A failure on the part of the physican to make a proper return to the authorities in a case of this nature might be construed as such concealment.

Autopsies.—In cases in which the coroner, county physician, medical examiner, or justice of the peace has jurisdiction, an autopsy may be ordered or performed by him (county physician, medical examiner, coroner's physician) to ascertain the cause of death. If the body has been interred, the coroner, justice of the peace, or district attorney—this duty falling upon a different officer in different States—may exhume, take possession of, and remove the body or any portion thereof, and submit the same to a proper physical or chemical examination or analysis to ascertain the cause of death, which in New York "will be made on the order of a justice of the supreme court of the State, or the county judge of the county in which the dead body shall be, granted on the application of the district attorney," etc. (sec. 308, Penal Code, subdiv. 3, as amended by chap. 500, laws of 1889). When the officials mentioned have no jurisdiction, an autopsy may be authorized by husband, wife, or next of kin. If no relatives charged by law with the duty of burial are at hand, and the deceased has left a will, his executors may authorize the performance of an autopsy. If the body has been interred, it may be exhumed on such authorization with the permission of the health authorities.

The removal or disinterment of a dead body without authority of law, or consent of relatives, for the purpose of selling such body, or for dissection, or for mere wantonness, is a felony, misdemeanor, and punishable by sentences which vary in different States.

The time that should be allowed to elapse before performing an autopsy is not specified by statute. It is best to await the development of unmistakable signs of death, the time for which varies in different cases and under different circumstances. This matter is discussed further on.

Dissection of bodies unclaimed by relatives or friends for burial is permitted by various State enactments. Their phraseology varies. In general, they are worded so as to include the bodies of criminals executed under sentence, those of persons dying in jails, poorhouses, asylums, and public hospitals, and those lying in undertakers' establishments—in brief, bodies which would otherwise be buried at the public expense. Dissection is prohibited in some States, under the following circumstances: if the deceased in his last illness expressed the wish that his body should not be used for such a purpose; if relatives or friends withhold their consent; if deceased was a stranger or a traveller; or, finally (in Maine), if ten voters object.

The Powers and Duties of Coroners, County Physicians, Medical Examiners, and Justices of the Peace in relation to the disposition to be made of a cadaver. A consideration of the coroner's inquest, and of the systems which have superseded it, although related to this subject, would occupy more space than can be spared in the present article.* In those cases in which these officials have jurisdiction, no disposal may be made of the body without their sanction. No person, however, would be adjudged as infringing such authority if he were immediately to cut down a suspended body on the chance of life not being extinct, or if he should in some other manner lay hold of the body in efforts at restoration.

The wisdom of having an official who is duly authorized, in a suspicious case, to take possession of the cadaver, of its effects, and even of the quarters in which it is found, while at the same time all other unauthorized persons are prohibited from disturbing the body, its effects, or the quarters in which it is found before such official possession is taken, is apparent, when the great importance of a proper record of all details in relation to the cadaver and its surroundings as first discovered is considered. Circumstances which seem at the time to be trivial may prove of prime importance at the trial. Expert medical knowledge is very useful in the first examination of the cadaver, especially in relation to the position which it occupies in the midst of surrounding objects; to the disposition of any blood and stains that may be present; to rigor mortis, and to other signs upon which the time that has elapsed since death took place may be estimated. Evidence furnished by one who possesses such knowledge is more to be depended upon than that given by a layman, and the results of the earlier examination are naturally more valuable than those secured after the cadaver or surrounding objects have been disturbed.

Determination of Death.—Immediate continuance of life depends upon respiration, circulation, and innervation. Cessation of any one of these functions entails that of the others. Clinically death is determined by complete arrest of both respiratory movements and heart's action, on examination with the stethoscope. Electro-muscular irritability may still continue for a variable length of time, not longer than six hours thereafter. Reaction of the pupil to light, and spasmodic movements of facial muscles, have been noted in cases of decapitation. The pupil may react to atropine for as long a time as four hours, and to eserin for two hours, post mortem. Respiratory movements and heart's action do not necessarily cease together. Temporary absence of respiration is not incompatible with the continuance of life. In the new-born, cases are on record in which respiration was not established until one and even two hours after birth. The heart's action may be extremely feeble in such cases, even inappreciable by the stethoscope. It cannot be doubted that respiratory movements may be so shallow, and the heart's action so slow and feeble, that both may be inappreciable, though not necessarily arrested. The usual clinical determination of death, although correct in the vast majority of cases, must therefore be considered as entirely inadequate. No grave error is probable, however, provided the conditions be kept in mind under which the state of apparent death, or one resembling it in some of its phases, is produced.

Apparent Death; Lethargy; Catalepsy.—Many stories of apparent death, and of burial alive, are entirely imaginary or are based upon certain appearances observed in exhumed remains—appearances which may readily be explained as effects of the gases of decomposition. A few authentic cases are on record in which life seemed extinct, but afterward became evident again. In these instances respiratory movements and heart's action could not be appreciated, and muscular relaxation, pallor, and marked reduction of surface temperature were present. In one case electro-muscular irritability was preserved throughout the period (thirty-three hours) of apparent death. It is hardly credible that respiration and circulation were actually arrested.

Besides the condition of apnœa in the new-born, and in cases of submersion in which it is stated respiration has been established after a lapse of half an hour or even longer, the conditions of lethargy and catalepsy might be mistaken for death by the laity, and occasionally by a physician, if reliance were placed upon apparent arrest of respiratory movements and heart's action alone. The muscular relaxation of lethargy, with apparent arrest of respiration and circulation, reduction of temperature, and absence of reflexes, may closely resemble death. However, there are other signs presented by the cadaver, even within a few hours after death, which render the decision quite easy. The rigidity of catalepsy, although presenting some resistance to passive motion, is readily overcome, and after such motion the limb remains rigid in the position in which it is placed (flexibilitas cerea). When rigor mortis is well established the rigidity does not return after it has been overcome. Lethargy and catalepsy are phases of the hypnotic condition that occur in hysteria. Lethargy may be the last stage of one of the acute infectious diseases; it occurs also in epilepsy and in the sleeping sickness of Africa, and it may follow cerebral injuries. Catalepsy also occurs in melancholia,

* *Vide* "The Powers and Duties of Coroners and Medical Examiners," by August Becker, in Witthaus and Becker's "Med. Jurisp., Forensic Med., and Tox.," vol. i.

in progressive paralysis, in meningitis, in brain tumors, and in apoplectic coma. (For further information, see under these headings.)

Signs of Death, their Application. — After death the body presents certain appearances which are due to physical and chemical changes. The character of these appearances, their causes, the time of their inception, their duration and disappearance, are matters of considerable importance, both as signs of death and as aids in establishing the time of death. Moreover, a thorough knowledge of these cadaveric appearances and of their relations to different pathological processes is necessary if one wishes to avoid drawing unwarranted conclusions. In regard to establishing the time of death—often a very important medico-legal question—no absolute rule can be given, since the cadaveric appearances may be subject to variations due to age, sex, constitution, and environment of the cadaver, and to the cause of death (namely, previous disease, injury, or poison). Consequently, great caution is necessary in arriving at a conclusion, and all the various conditions must be taken into account. It will therefore be best to consider carefully the cadaveric appearances, or signs of death, seriatim, their usual chronology, and the variations to which they are subject; and at the same time the conclusions which one is warranted in drawing from these appearances should be pointed out.

Muscular Relaxation. After death a primary period of complete muscular relaxation precedes the onset of rigor mortis. Some observers have maintained that voluntary muscular contraction at the time of death may immediately pass into post-mortem rigidity (cataleptic rigor mortis of Du Bois-Reymond).

Reduction of Temperature. The cadaver loses heat and, by evaporation, its temperature sinks below that of the surrounding atmosphere. Exceptionally a rise of temperature occurs post mortem, as after some infectious diseases; after cholera, tetanus, and diseases of the central nervous system; after asphyxia; after poisoning (accompanied by asphyxia and convulsions), and after injuries of the brain and upper part of the spinal cord. The temperature may reach 44° C. (111.2° F.), and be maintained at this height for from fifteen to twenty minutes. On the other hand, in cases of hemorrhage, drowning, and exposure to cold, and possibly in those of burns and scalds (through a loss of epidermis), the temperature is apt to sink rapidly (Hofmann). Within from 8 to 17 hours (according to Caspar) the body becomes cold to the touch. According to Seydeler, a period of from 23 to 38 hours is required before complete cooling, as shown by the use of the thermometer, takes place. Maschka's investigations showed that in an atmosphere of from 8°–15° R. (50°–65.7° F.), adult cadavers, lying upon a board or mattress, and covered with a sheet or simply naked, became cold to the touch in from 8 to 10 hours. Only in rare instances was a period as long as from 11 to 13 hours, or one less than 8 hours, required. Cooling of the parts takes place in the following order: feet, hands, and face, in from 1 to 2 hours; then gradually the extremities, chest, back, and belly. The epigastrium, axilla, and neck on either side of the larynx are the last spots to cool. The abdominal organs may still be warm at the end of from 16 to 24 hours after death. The rate of cooling is given by Goodhart as 4° F. per hour in the first 3 hours; 3° F. per hour in the next 6 hours; thereafter, a little more than 1° F. per hour. Bowman estimates the rate to be 2° F. per hour for the first 8 hours.

Cooling is postponed for a period of from 2 to 3 hours by clothing, and for one of from 3 to 4 hours by bed covering, hay, or straw. In a case reported by Maschka the body of a person who had died from epilepsy in bed was found to be still warm after the lapse of 14 hours; and in another case, one of homicide, reported by the same author, the body, covered with horse hair, was found to be still warm after 16 hours.

Obesity may postpone complete cooling for as long a time as from 2 to 3 hours. The bodies of those who are extremely obese may have the same degree of surface temperature 12 hours after death that the ordinary cadaver presents after the lapse of 2 hours (Hofmann). In such cases one may find the internal organs, 30 hours after death, still warm, although, as a matter of course, the surface of the body will be cold.

The cadavers of the new-born and of infants become cold in from 5 to 6 hours.

In ice and snow cadavers of adults may become cold in half an hour or an hour; in cold water they become so in from an hour and a half to two hours. After the human body has been in water at 18° R. (72.5° F.) for from ten to twenty minutes the surface may already be cold, and yet the epigastrium, the axillæ, and the neck on either side of the larynx are likely still to manifest some warmth (Maschka).

With progressive putrefaction a rise of temperature has been noted (Mende).

Evaporation produces changes in the eye, skin, mucosa of the lips, and hair.

Eye.—The globe loses its normal tension, becoming flaccid and softer. This is partly due to post-mortem sinking of blood, when the head rests in the usual position upon the occiput. The cornea loses its transparency, and is thrown into folds by the loss of intra-ocular tension. The earliest period in which these changes become apparent is from 2 to 3 hours after death. The transparency of the cornea may be retained for from 10 to 12 hours, or even, in some cases, for from 24 to 30 hours (Caspar-Liman). The protection afforded by closed eyelids favors transparency, exposure favors opacity. The cornea becomes opaque earlier in children than in adults. All influences favoring putrefaction, as septicæmia, pyæmia, and an abnormally high temperature of the atmosphere, tend to hasten the occurrence of these changes. The average length of time required for the development of distinct flaccidity is from 5 to 6 hours; and by this time slight opacity of the cornea also usually develops. The triangular spots described by Larcher, with base at the corneal margin and apex toward the external canthus, of a yellowish, bluish, or even black color, are not always present. They may occur from 3 to 5 hours post mortem, may also be present between the cornea and the internal canthus, and are due to drying of the conjunctiva and sclera—a change which allows the color of the choroidal pigment to become more and more apparent.

Skin.—Wherever denuded of epidermis—whether this occurred before or after death, it makes no difference—the corium, under the favoring influence of evaporation, becomes dry, firm, of the consistence of parchment or leather, and light yellowish brown. At a still later time the color grows darker, and may even become black. Such changes may be apparent in the course of 2 or 3 hours. In fat subjects the cutaneous fold about the neck may be the seat of excoriation from eczema intertrigo. From the above changes in drying post mortem, an appearance may be produced which simulates the marks left by a constricting band. Such a condition has led to the mistaken report of strangulation. An incision will readily show that the change is confined to the corium, there being no evidence of subcutaneous laceration of tissue, of hemorrhage, or of ecchymosis.

Lips.—The mucous surface of the lips may be divided into two regions: the narrow vermillion border which is adjacent to the skin and is smoother and more intimately adherent to the underlying tissues; and the remaining larger portion, which is thrown into folds, owing to the fact that it is more loosely attached to the submucous connective tissue. The latter portion, more especially of the upper lip, may become quite dry and black as a mere post-mortem change, the condition occurring more frequently in children than in adults. The line of demarcation between this dry and black portion and the vermillion border is under these circumstances quite straight and distinct. Such a change may occur as early as 2 to 3 hours after death. It has been mistaken for the escharotic effects of acids.

The hair may become loosened and fall out or be easily pulled out, after evaporation of fluid from the hair follicle.

Post-Mortem Hypostasis.—With the cessation of the circulation the skin loses its pink tint and becomes intensely pale. In cases of cyanosis (*e.g.*, in asphyxia, pulmonary œdema, heart lesions, and alcoholism) a bluish tint may be apparent, especially in the skin of the face and neck. In cases of carbon monoxide poisoning, and in those in which death follows exposure to a low temperature, the pink tint of the skin may not only be retained but even be exaggerated. The pallor of those portions of the cadaver which lie uppermost becomes intensified by contrast with those into the veins and capillaries of which the major portion of the blood flows by gravitation. The position of the cadaver will therefore determine which are the parts that are likely to show this condition of hypostatic congestion. When the blood has thus collected in sufficient amount, spots, streaks, and patches appear in the skin of the dependent portions. At first they are small, separate, and light red or purple in color, but later they become larger, confluent, and dark red, blue, or even black in tint. At first, while the blood remains in the vessels, the color may be made to disappear by pressure. Wherever, therefore, the skin is subjected to pressure, such spots of color are absent. If the cadaver has been lying upon the back on a flat surface, pale areas occur over the bony prominences of the scapula, the dorsal spines, the buttocks, and the calf of the leg. At a later period, with the first onset of decomposition, the serum takes up blood-coloring matter and transudes through the vessel walls, staining the surrounding tissues. Such spots, then, cannot be removed by pressure.

Post-mortem hypostasis also occurs in internal organs wherever the physical conditions are favorable, namely, in the pia mater of the posterior portion of the brain and cord, posterior portions of the lungs, stomach, and intestinal wall, bladder, uterus, and adnexa, when the body has been lying upon the back. The kidney, spleen, and liver do not present conditions equally favorable for the occurrence of such hypostatic congestion. Post-mortem transudation of serum into the meshes of the pia-arachnoid, and into the pericardial, pleural, and peritoneal sacs may occur. Such conditions are frequently mistaken for congestion and inflammation, and should not alone be relied upon in making such a diagnosis.

External Hypostasis, or Post-Mortem Spots.—With a knowledge, therefore, of the manner in which these spots develop, one can readily appreciate that the total amount of blood in the body and the degree of its fluidity will exert an appreciable influence upon the time when the external hypostases will manifest themselves, upon the intensity of their color, and upon the extent of their distribution. They appear earlier, are more widely distributed, and are more intense in color in plethoric than in anæmic individuals; in those who die suddenly rather than in those who succumb to some exhausting disease or in whom the lethal agony has been prolonged; and, finally, in those who die from asphyxia, from sepsis, or from some form of poisoning in which the blood remains fluid, rather than in those who die from cholera, from tetanus, or from poisoning by arsenic or by strychnine, in both of which conditions the blood is less fluid. External hypostases usually appear from 3 to 4 hours after death, and after the expiration of from 12 to 14 hours they become widespread. Exceptionally, they may be plainly developed in an hour and a half, but usually a period of from 4 to 6 hours intervenes before they can readily be distinguished. In some instances they are not well marked and extensive until after the lapse of from 16 to 18 hours. A high temperature, or the artificial warmth afforded by coverings (clothing, bedding, etc.), causes their earlier appearance and more extensive distribution.

The color of the spots is affected by age, it being usually lighter in the new-born and in infants; it is also affected by poisons, being light red or pink in poisoning by carbon monoxide and by hydrocyanic acid and compounds, and grayish in poisoning by potassium chlorate. The light-red tint observed when the cadaver has been exposed to cold (as in water, snow, or ice) is ascribed by Hofmann to the easier access of oxygen to the blood through the moist epidermis, by Blumenstock to the interference of low temperature with the reducing power of the tissues post mortem.

After excessive hemorrhage, hypostases are late in their development and are much less marked, although rarely absent. Devergie and Hofmann have observed a few instances of such entire absence, especially in young subjects.

The presence of external hypostases is an important and reliable sign of death, and, in addition, of the position in which the body lay when they developed. The important fact should also be stated that in an early stage these areas of hypostatic congestion may disappear on changing the position of the cadaver, and subsequently appear in new places, namely, in the most dependent portions in the new position. Tourdes ascertained the following facts: that, on reversing the position of the cadaver, 4 hours after death, the hypostases which had already developed, disappeared entirely, and new ones appeared in the new dependent portions; that, at the end of from 12 to 15 hours after death, the hypostases which had developed no longer disappear, but simply grow fainter, and new ones appear; and, finally, that 30 hours after death these spots grow paler but do not appear in new dependent parts on changing the position of the cadaver. Other experiments have shown that, on changing the position of the cadaver 4, 6, and even 12 hours after death the hypostases already developed may disappear, but that this does not occur after the lapse of so long a period as from 23 to 28 hours.

Rigor Mortis.—After death muscle tissue becomes firmer and more resistant to compression and extension. Rigidity of the entire muscular system results. This rigidity offers a greater or less resistance to the movement of parts, but the resistance may readily be overcome by force. After muscle has been thus stretched, there is free mobility, and the rigidity does not return. Various theories in regard to the causation of this rigidity have been advanced. The discussion of these would be too lengthy for the scope of this article. The most plausible one ascribes the occurrence of rigor mortis to coagulation of myosin.

The time of the inception of rigor mortis, its intensity and duration, and the conditions affecting them, have an important bearing on the subject now under discussion, since rigor mortis affords reliable evidence of death, and also aids in establishing the time when it occurred. Rigor mortis does not affect all muscles equally at the same time. The determination of its presence and the estimation of its intensity and duration rest upon the degree of force necessary to overcome it, *i.e.*, in the case of the voluntary muscles, to produce free motion in the joint or joints with which the given muscle or group of muscles is related. If this degree of force were measured in foot-pounds, there might be more unanimity in the reports of different observers. As it is, the personal element, which plays a part in the estimation of this force, accounts for the more or less considerable variations. Maschka reached the following conclusions from a study of over five hundred cases:

Rigor mortis occurs in all cases, no matter what may be the cause of death. It is absent only in the decomposed cadavers of still-born infants, and locally where muscle is excessively contused, lacerated, gangrenous, or the seat of purulent or phlegmonous processes of inflammation. Rigor mortis does not follow immediately upon death in any case; a shorter or longer period of complete muscular relaxation intervenes. Strychnine poisoning, tetanus, hydrophobia, and hemorrhage cause no exception in this regard.

Rigor mortis usually begins between 2 and 3 hours after death. All the muscles are not affected at the same time. The usual order in which the rigor shows itself in the different parts of the body is the following: lower jaw, neck, trunk, and upper extremities, in which parts rigor mortis becomes distinct after the lapse of from 3½ to 4½ hours after death; then the lower extremities become affected, so that after the lapse of from 6 to 9 hours from the time of death the entire body will have become rigid. Exceptionally this order varies as follows: lower jaw, upper extremities, neck, trunk, etc.; or the lower extremities are affected before the upper; or the upper extremity of one side becomes rigid and then that of the other side, etc.

The earlier or later inception of rigor mortis is not constantly or characteristically affected by the degree of muscular development, the sex, the age, poisoning, hemorrhage, sudden death, or, with few exceptions, by pathological processes. General hydrops or œdema of an extremity delays the development of rigor in that extremity until from 4 to 6 hours after death. Paralyzed muscles may not show rigidity for 4 or 5 hours after it has appeared in the non-paralyzed muscles, although this is not always the case. In amputation stumps rigidity is developed later than in other muscles. In very atrophic or fatty muscles rigidity may be entirely absent. After acute diseases of the brain and spinal cord the rigor appears earlier. No difference in time of onset is ascribed to injuries of the brain and spinal cord which are followed by sudden death.

The covering of the cadaver, as with clothing, bedding, etc., seems to favor the earlier appearance of rigor mortis.

As regards the time of appearance of rigor mortis, there are considerable variations for which no explanation can be given. Maschka reports a number of such cases, in which the conditions, so far as they were observed, were apparently the same. In one of these cases, that of an emaciated tuberculous woman, rigor mortis began in three-quarters of an hour after death; in another, in 3 hours; in 4 cases of strychnine poisoning the facts were as follows: in a child of seven years, it began in half an hour; in 2 other cases, also children, and in a male adult, it began at the end of 1½ hours and 2 hours respectively. Rigor mortis begins usually not earlier than one-half hour, nor later than 6 hours after death.

In regard to the intensity of the rigidity, Maschka was unable to find any constant or important difference for the production of which special influences could be held responsible.

If the cadaver is not interfered with, rigidity usually remains marked, in adults, until after the lapse of from 50 to 60 hours, and then it gradually disappears, so that nothing remains of the rigidity after the lapse of from 70 to 75 hours. In exceptional cases it may last for as long a time as 80 or even 90 hours, and then again it may disappear as early as at the end of 40, 30, or even 20 hours without special causes therefor being apparent. It is evident, therefore, that absolute rules in regard to the duration of rigor mortis cannot be laid down; for under the same development, mode of death, previous pathological processes, and external circumstances, great differences in duration have been noted.

Rigor mortis may still be present when the early signs of decomposition—such as green color of the skin of the abdomen, the sides of thorax, the neck, and the back—appear. When the cadaver swells with post-mortem emphysema, and the epidermis becomes loosened and easily strips off, rigidity will always be found to have disappeared.

In children rigor mortis usually commences at the same time as in adults. In the new-born, however, and in infants a few days old, it may appear as soon as ten minutes after death or not until after the lapse of 1½ or 2 hours. The degree of rigidity is apparently less, on account of the small muscular development. The duration is also shorter in the new-born—say from 8 to 10 hours,—yet in some cases it may last for from 36 to 42 hours, or even—in the case of infants—50 hours. In older children, when poorly nourished, the rigidity may last only for from 20 to 24 hours, but in the majority of cases it persists for 40 or 45 hours, and in some cases even for 60 or 70 hours.

Rigor mortis disappears in the different parts of the body in the same order in which it begins, the foot being the last part to become freely movable. Yet it is not unusual for the rigidity in the jaw and neck to outlast that of the extremities (Hofmann). The latter authority places the time of inception of rigor mortis at from 2 to 4 hours after death, and that of complete development at from 4 to 6 hours after inception; for the new-born and infants, he names earlier periods. According to him, the rigidity lasts for from 24 to 36 hours in the new-born, and for 40 hours in infants; in adults it is marked for 48 hours, then gradually disappears, and is absent after the lapse of from 72 to 84 hours after death. Rigidity makes its appearance earlier after hemorrhage, injury to the cervical portion of the cord, poisoning by acids and strychnine, and perhaps in insolation and lightning stroke; it either appears later or is entirely absent in acute parenchymatous degeneration of muscle (as in poisoning by phosphorus and by toadstools) and also after sepsis.

Du Bois-Reymond, Rossbach, and Brinton record instances in which rigor mortis developed immediately after death. From observations upon the battlefield, the conclusion has been drawn that rigor mortis may set in with the occurrence of death, and thus the facial expression and action which existed at the moment when death occurred may be preserved. If this conclusion were well founded, it might afford important aid in determining whether death, in a given case, were due to an accidental or inflicted injury, or to suicide. Caspar-Liman, Hofmann, and Maschka point out the danger of relying upon such evidence, as the positions observed, indicating action, may simply have been the result of the passive interference of surrounding objects. They assert that, so far as their experience goes, complete muscular relaxation precedes rigor mortis. This is evident from the expressionless countenance of the dead in the great majority of cases. Occasionally such a countenance does present an expression of mirth, sadness, pain, or anger, but to draw any conclusion therefrom would be hazardous, since it may simply be due to pressure after death and before rigor mortis has set in, or it may be the result of sagging of the lower jaws and of open eyelids. In no case of death from apoplexy, so far as the writer's experience goes, can a diagnosis be made from a mere study of the facial appearance after death. On the contrary, in a case of sudden death from chronic interstitial myocarditis, without any brain lesion, the face of the cadaver presented the typical picture of hemiplegia.

In no case of suicide has either Maschka or Hofmann found the weapon grasped in the hand of the cadaver. Taylor states that he has made such an observation. Maschka's experiments in securing weapons within the grasp of one of the hands of the cadaver before rigor mortis set in, showed that they either fell out when the bands were loosened or that the grasp itself was very feeble. The writer has never encountered a case of suicide in which the weapon appeared to be grasped by the hand of the cadaver.

Decomposition of the cadaver is brought about by the invasion of saprophytic bacteria. If the conditions are such as to favor their access and growth, decomposition will begin earlier and will advance more rapidly. Access of air and moisture, and a warm temperature, in so far as they are necessary to bacterial life, favor decomposition. A cadaver exposed to the open air decomposes far more rapidly than when it is immersed under water or buried in the soil. If in a given temperature, in the open air, a cadaver requires one week or one month to reach a certain stage of decomposition, it will require, if submerged, double the length of time to reach the same stage of decomposition, or four times this period if buried under ground (Caspar-Liman). If, however, a body is exposed to a current of air, evaporation is favored, and, instead of marked or rapid decomposition, mummification may take place. Under these conditions the growth of bacteria is interfered with by the lack of water. Somewhat the same conditions are established when the cadaver is buried in dry, sandy soil and at a sufficient depth. When burial is just beneath the surface, or in