The illuminating power of gas is measured by comparison with a standard spermaceti candle of six to the pound, and consuming, as near as may be, one hundred and twenty grains of spermaceti per hour. It is assumed that the light given off is in direct proportion to the sperm consumed. The gas to be tested is to be burned at the rate of five feet per hour. Such a burner should give as much light as sixteen or eighteen standard candles. It may reach as high as twenty-five or thirty candle-power.

Water gas may be referred to here as a gas manufactured and sold for the same purposes as coal gas. Its manufacture is conducted on a large scale in most cities, and to a large extent it has taken the place of coal gas.

This gas is manufactured as follows: Steam from a boiler is forced through a bed of glowing anthracite coals, previously heated to a very high temperature by an air blast. The steam from the boiler is passed through pipes or flues over the fire box, so as to superheat it to a temperature of 800° to 900° F. In passing this hot steam through the coals the water is decomposed, the oxygen combines with the carbon of the coal to form carbon dioxide, which is reduced, by the heated coal above, to the monoxide: $C + 2H_2O = CO_2 + 2H_2$. $(CO_2 + C = 2CO)$. The hydrogen of the steam remains in a free state. After the steam has passed through the coal for about six minutes, the latter cools off and the process stops. The air blast is now turned on until the coal is again heated to the required degree—*i.e.*, for about eight minutes—when the steam is again passed into it. It is, therefore, an alternating process. The gas thus produced has very little illuminating power, but answers well for heating purposes. To give illuminating power it must be charged with hydrocarbons. This is accomplished as follows: Naphtha, or light benzin, is placed upon shelves in a carburetter, and the gas passed through the apparatus. A small quantity of the vapor of the naphtha is taken up by the gas. This mixture is now passed through retorts heated to bright redness, by which process the vapors are decomposed and converted into permanent gases instead of condensible vapors. This is the Tessie-du-Motay process. By the Lowe process the carburetted gas is made in one operation instead of in two, as above described. Water gas is cheaper and usually of higher illuminating power than coal gas, and is consequently superseding the latter.

The principal differences in the chemical composition of coal gas and water gas are, that the latter, as usually manufactured, contains a larger percentage of illuminating agents and of carbon monoxide than the former.

The following analyses of the two gases, by Professor Remsen and Dr. Love, will serve to illustrate these differences:

Constituents.	Remsen.		Love.
	Coal gas.	Water gas.	Water gas.
Carbon dioxide	0.0	0.3	0.0
Illuminants (ethylene, propylene, butylene, ethane, propane, butane)	4.3	12.85	15.75
Carbon monoxide	7.9	28.25	21.51
Hydrogen	50.2	30.30	46.49
Marsh gas (methane)	29.8	21.45	11.75
Nitrogen	7.8	6.85	4.30
Oxygen	....	....	.20

Oil gas is now largely made by heating petroleum, tar, or shale oils in a retort to a temperature of about 1,000° C. This gas, especially that made by the Pintsch process, is much used in lighting cars. Oil gas is frequently used to enrich other gases of low illuminating power.

Air gas, so called, is produced by passing air through layers of very light petroleum distillates, known as gasolene, when it takes up enough of the light hydrocarbons to form a combustible mixture. Air gas is much used where other gas is not available. It cannot be stored long or piped a long distance because of the condensation of the illuminants.

Acetylene, C_2H_2, has recently become prominent, and is used as an illuminant in small lamps. It is prepared by treating calcium carbide with water, when the following reaction takes place:

$$CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2.$$

The calcium carbide is prepared by heating a mixture of powdered coke and lime in an electrical furnace. One ton of calcium carbide of eighty-per-cent. purity is said to produce 1,000 cubic feet of acetylene gas. Its illuminating power is very high, and when burned in an ordinary burner gives off considerable soot. When burned in a specially constructed burner it gives a light of great brilliancy. The cost of production prevents its general adoption for illuminating purposes. Acetylene combines with copper and silver, forming acetylids, which are explosive. It combines with the hæmoglobin of the blood, and thus acts as a poison. The gas has a pungent, suffocating, disagreeable odor, by which its presence in the air can usually be detected.

Fuel Gas and Furnace Gases.—Gases of more or less poisonous character are produced during various smelting and roasting processes and which may be the cause of serious accidental poisoning. The most commonly met with are arsine (arseniuretted hydrogen), stibine (antimoniuretted hydrogen), and sulphurous oxide, obtained by roasting ores containing arsenic, antimony, or sulphur, and CO_2 and CO obtained in smelting processes generally.

Carbon monoxide is an important constituent of *fuel gas* or *producer gas*. Producer gas is made by forcing air through a bed of incandescent coal or coke in specially constructed furnaces. It contains from twenty-five to thirty per cent. of CO, to which it owes its value as a fuel. It also contains some CO_2 and free nitrogen. In another form of furnace steam is forced through the heated coal, when CO and hydrogen are produced, as in making *water gas*. It is needless to say that both these gases are poisonous.

Natural gas is so called because it exists already formed in the earth whence it issues spontaneously, or is obtained by boring wells. The gas is found chiefly in localities where petroleum is found. In this country this gas is found in western Pennsylvania, in eastern Ohio, in West Virginia, and in Fredonia, N. Y. At the last-named place it was used as an illuminating gas as early as 1821.

The "Burning Springs" of Baku, on the Caspian Sea, have been known since the sixth century B.C. The composition of natural gas is fairly uniform, and it consists of about ninety per cent. of marsh gas (methane) with small quantities of ethane, C_2H_6, propane, C_3H_8, and other paraffin hydrocarbons, hydrogen, carbon monoxide, and carbon dioxide.

It is a valuable fuel, burning with a feebly luminous flame, but giving out an intense heat. In many localities it is the chief fuel. When heated in a suitable furnace with petroleum or the higher hydrocarbons, its illuminating power may be greatly increased and it is then used for illuminating purposes.

Action of Illuminating Gases on the Economy.—All forms of illuminating gas are irrespirable and more or less poisonous.

They are irrespirable because they do not furnish oxygen. The chief poisonous agents are carbon monoxide and the heavier hydrocarbons mentioned above under the name of *illuminants*.

The physiological action of carbon monoxide has already been discussed in the section which treats of that subject.

The heavy hydrocarbons are more or less poisonous when mixed with air. The symptoms produced are dizziness, headache, nausea, and prostration. These compounds are more deleterious than is the lighter marsh gas, but their exact physiological action is not well understood. The physiological effects of illuminating gas are due not alone to the carbon monoxide, as some have supposed, but to the combined effect of this gas and the

heavier hydrocarbons, together with the loss of oxygen due to the displacement of air by the gas.

Symptoms.—The symptoms of acute poisoning by ordinary illuminating gas are: headache, dizziness, nausea, a staggering gait, great muscular weakness, prostration, loss of memory, and finally, unconsciousness and complete asphyxia. Convulsions frequently end the scene. There is usually little difficulty in making the diagnosis, as the circumstances under which the patient is found, the odor of the gas, etc., will prevent deception. The only diseases likely to be confounded with this form of poisoning are, cerebral apoplexy and uræmic coma. Should the physician not see the patient before the odor of the gas has escaped, such difficulty might arise. In both of these diseases the symptoms are pretty constant, while in *coal-gas* or *water-gas poisoning* they are apt to fluctuate; the patient will frequently rouse up for a time, and answer questions intelligently, and then lapse into unconsciousness, or be seized with convulsions.

A marked difference in the symptoms will be noted, dependent upon whether the gas is admitted into the air rapidly or slowly. In the first condition the person rapidly becomes unconscious, and recovers rapidly when removed into fresh air. When the gas is admitted to the air of a room slowly, the headache, dizziness, nausea, and muscular weakness are the prominent symptoms, and they are remarkably persistent. The condition of the patient often seems to remain constant for days after the accident; and when entire unconsciousness has occurred, recovery is very unusual. We should distinguish between asphyxia by illuminating gas and poisoning by carbon monoxide obtained by breathing the diluted gas. The first is produced by a rapid displacement of the air of the room with the gas, while the second results from a slower and very gradual admixture of gas with the air.

Fresh air and stimulation will usually suffice to restore the patient in the first case; but in the second, while these measures should not be neglected, they are much less useful, and, when the time of exposure has been considerable, of slight benefit. It may be well to name here some of the sources of coal-gas poisoning other than leakages directly from fixtures in the room.

The odor of the gas is so characteristic that this will in most cases give its warning. Repeated instances, however, prove that people may be killed by this gas without detecting the odor.

Cases of poisoning have occurred when the leak in the pipes occurred in an adjoining room, or in a cellar or other room underneath. Most of such accidents occur in the night while the victims are asleep, even though they were exposed to the same influences during the preceding day.

It should be known that these poisonous gases may diffuse themselves through walls, soil, and partitions. It should also be remembered that the odorous vapors may be almost entirely removed by diffusion through a thick wall or several feet of soil. The gas deprived of its odor may thus pervade the air of a sleeping- or sitting-room, and give no warning of its presence.

In winter, when the ground is frozen, and the upper layers are impervious to the gas, this may diffuse itself several feet laterally from a broken street main, reach the cellar, pass thence to the rooms above, and so do its deadly work unperceived. That this accident has frequently occurred is shown by abundant evidence taken from the statistics of any large city. Aside from the fatal cases of poisoning from this source, we can easily see that there must be a much larger number of cases in which headache, dizziness, loss of appetite, general debility, anæmia, etc., may be dependent upon a smaller amount of the same gas continually finding its way into the air of houses.

It is evident, from the above, that cases of poisoning may occur in houses where gas is not used, and where the pipes do not even enter the house.

There has been, at various times, not a little discussion as to the relative poisonous effects of coal gas and water gas. This question has been made the subject of a great number of investigations. We may note that of Commissioner Raymond, of Brooklyn, N. Y., Health Department, 1883, and that of the Committee on Manufactures of the Massachusetts Legislature of 1884.

The weight of experimental evidence, however, goes to show that *water gas* is decidedly more dangerous than *coal gas*.

With a given amount of gas, the danger line is reached sooner with water gas; and, indeed, in many rooms it is not easy to get a fatal mixture of *coal gas* and air with the escape from a single burner jet, owing to natural ventilation through walls, floors, windows, etc. That is, dogs, cats, rabbits, and pigeons will endure almost indefinitely an atmosphere containing one per cent. of coal gas, while the same animals die in from five to eight hours when exposed to an atmosphere containing one per cent. of water gas.

The post-mortem appearances, in cases of poisoning by illuminating gas, are similar to those found after poisoning with carbon monoxide. There is generally an odor of the gas about the body, especially on compressing the chest, so as to expel the residual gas from the lungs.

The countenance may be pallid, pink, or purple, varying in different cases. Frequently more or less froth will be found issuing from the mouth, due probably to the nausea which precedes death, and which is one of the marked symptoms. Occasionally, rose-colored patches will be found on the thighs or other parts of the body.

When the body is opened the blood will generally be found everywhere in a fluid condition, and uniformly of a light red color on both sides of the heart. It shows the spectroscopic bands of carbon-monoxide hæmoglobin see Fig. 1116, p. 662). The lungs will usually have a brilliant red hue, while the bronchial tubes will be filled with a frothy mucus. The venous sinuses of the brain and the vertebral nervous system will be found engorged with blood.

The above appearances are not always found, however, for there is great variation in this form of poisoning, both as to the symptoms and as to the post-mortem appearances. These variations are probably explained by the fact that in some instances the cause of death is a true asphyxia, while in others it is CO poisoning. In the former we may expect a livid hue of skin, dark, clotted blood, and engorgement of the venous sinuses; while in the latter we may expect the light, fluid blood, the rose-colored spots upon the skin, a lingering death, etc. More careful observation is needed upon these points.

Treatment.—We have incidentally mentioned nearly all that can be said of the treatment of coal-gas poisoning. If the case is one of suffocation, and the time of exposure has not been too long, fresh air, stimulants, and rest will usually suffice to restore the patient to consciousness.

No antidote for poisoning by the gas is known. Transfusion of blood has been tried with apparent success.

In experiments upon the lower animals the introduction of normal salt solution into the veins has occasionally been successful in saving life.

Inhalations of oxygen have often been tried, with temporary benefit, but it does not seem to expel the carbon monoxide from the blood. If persisted in, it may save life when the blood is not too nearly saturated with the gas. *Elias H. Bartley.*

CARBON TETRACHLORIDE.— *Tetrachloromethane, Chloro-carbon:* CCl_4. This body is a colorless, thin, ethereal fluid, of a pleasant aromatic smell, insoluble in water but miscible freely with alcohol and ether. It has been tried as an anæsthetic and has been found to operate after the general manner of chloroform, but with such a depressing effect upon heart action that it is little likely ever to come into practical use. *Edward Curtis.*

CARBONIC-ACID WATER.—"*Soda water.*" Carbonic-acid water is the product of the solution of carbon dioxide (carbonic-acid gas) in water. In such solution there is a chemical union between the gas and the water, molecule for molecule, producing the body *carbonic acid* proper

(H_2CO_3), which is known only in solution. At the ordinary pressure of the atmosphere water dissolves about one volume of carbon dioxide, but will take up increased quantities under artificial increase of pressure in direct proportion to the pressure. The carbonic-acid water of commerce contains from five to ten volumes of gas forced to dissolve by pressures varying from five to ten atmospheres. Such supercharged solutions appear as colorless aqueous fluids, effervescing briskly on release from confinement, from spontaneous evolution of the excess of carbon dioxide. The reaction is acid and the taste pleasantly acidulous and pungent. For obvious reasons commercial carbonic-acid water must be kept strongly confined in well-stoppered vessels, and special care is necessary that there be no exposed surface of lead or copper in the storing vessel, else contamination of the water with those metals will result. A carbonic-acid water charged with five volumes of gas was formerly official in the United States Pharmacopœia, but was dismissed in the revision of 1880.

Carbonic-acid water is valuable medicinally as a drink, and as a vehicle for medicines. As a drink its virtues are that, like all acids, it tends to excite the secretion of saliva and buccal mucus, and so relieve thirst more permanently than plain water, and that it is peculiarly grateful to the stomach, tending to expel flatus and allay nausea. As a vehicle for medicines, carbonic-acid water is especially adapted for the solution of mawkish salts, such as the purgative salts and alkaline carbonates, bromides, and iodides. Not only is disagreeable taste thus disguised, but the salt, whatever it be, is much less liable to disorder the stomach.

It is almost needless to say that all effervescing drinks —mineral waters and sparkling wines or malt liquors— owe their effervescence to carbonic acid formed by the solution in the liquid of carbon dioxide under pressure.

Edward Curtis.

CARBO-SAPOL is a mixture of 50 parts of carbolic acid, 25 parts of yellow soda soap, and 25 parts of potash or soft soap. These substances are heated together on a water bath until they form a clear solution. Carbo-sapol is miscible with water in all proportions, and has a strong antiseptic action. The combination of soap with carbolic acid makes it decidedly useful for cleansing the skin before an operation, or for soaking the hands. A one-per-cent. solution may replace creolin or lysol as a vaginal or intra-uterine douche. It may be used for instruments in one- to five-per-cent. solution, and these must be rinsed off before they are employed, as the soapy solution makes them slippery.

W. A. Bastedo.

CARBUNCLE.—*Carbunculus simplex seu benignus.* (See also *Anthrax* and *Boils* in this HANDBOOK.)

[Some eminent authorities consider simple carbuncle to be a form of anthrax (*Anthrax furonculeux*), and apply this designation to the local lesion. This seems calculated to create confusion, as the nature and course of the two diseases are widely different; and the essential element of malignant pustule—the bacillus anthracis—is not found in the fluids or tissue in cases of simple non-malignant carbuncle.]

Carbuncle is an inflammation of the skin and connective (cellular) tissue of a greater or less degree of severity, accompanied by the loss of a certain amount of tissue, and exhibiting a tendency to mortification of the skin.

Carbuncle commences in the subcutaneous structures and works its way through the planes of connective tissue, as well as toward the surface. A brawny inflammation around an acutely inflamed central tumor is formed, with multiple points of suppuration, with a strong tendency to lateral extension. It is this latter tendency, and the consequent much larger size of the carbuncle, and the multiplicity of the points of suppuration which distinguish the carbuncle from the boil. Carbuncles are chiefly situated on the nape of the neck, and on the back or buttock, but they may also occur on the extensor surface of the forearm, and on the scalp or face, or in other locations.

The symptoms belonging to carbuncle are of a much graver character than those attending furuncle (see under heading *Boils*), and are accompanied by more or less significant signs of constitutional disease, such as fever, headache, anorexia, etc. The formation of a carbuncle is always preceded by more or less serious impairment of the general health, by a feeling of malaise, and sometimes by successive chills. These symptoms become intensified until the local disease is manifested by elevation of temperature, and by redness and swelling of the part, accompanied by a feeling of deep, and at times ill-defined, induration.

ETIOLOGY.—Carbuncle is now generally believed to be caused by the infection of the site of the disease by means of a bacterial germ, which gains admission to the subcutaneous tissues through some wound of the skin, such as a minute scratch, a slight abrasion, or possibly by finding its way downward through the follicle of a cutaneous hair, without previous injury of the skin. The organisms most frequently found in the pus of a carbuncle are the Staphylococcus pyogenes aureus and albus (Warren). A state of general debility places the tissues in a condition to furnish a favorable soil for the growth of the bacteria. Certain constitutional diseases, such as diabetes, are frequently accompanied by carbuncle. Carbuncle is rarely observed in childhood. It is most frequently seen in persons over forty years of age. It first appears as a minute papule on the surface of the skin, which is usually the seat of considerable irritation, and sometimes of acute pain. From this point the area of commencing inflammation gradually enlarges, extending laterally, and involving also the deeper tissues of the part, until a cone-shaped area of the tissues is involved in the process. Warren explains the peculiarities of carbuncular inflammation by reference to the anatomy of the skin in the regions most frequently the seat of the disease. He says (*op. cit.*): "The skin in this region is extremely thick (neck, back, etc.), probably thicker than in any portion of the body; it forms a mass of dense fibrous tissue, well calculated to sustain burdens, or to protect a comparatively defenceless portion of the body. The hair follicles being those supporting downy hair only, and therefore shallow, project downward only a short distance into the uppermost layers of the subcutaneous tissues. Communication with the adipose tissue is by oblique columns of fatty tissue which extend upward from below. These fat columns [first described by Warren] are found beneath each hair follicle. They contain besides loose connective tissue, fat cells and vessels, and a coil of sweat gland suspended midway in the shaft. At the point where these columns open into the parts immediately below this dense sheet of cutis is found a broad band of fibrous tissue, given off from one side and extending obliquely down into the subcutaneous structures, finally to be attached to the fascia, beneath which lie the muscles. These fibrous bands which interlace in various directions, are very different from the delicate cellular tissue underlying other portions of the skin, and form a dense network which holds firmly in place the tough hide to which they are attached." When further developed, the carbuncle presents a broad, flattened surface of round or oval outline, elevated to a greater or less degree above the surface of the surrounding skin, which is of a bright or dull red, or sometimes of a tawny color, and which is very tender to the touch. The skin is tense and hard, and the density of the surrounding tissues is greater than in ordinary inflammations of these structures.

COURSE OF THE DISEASE.—When the inflammation has involved an area of a certain diameter, its periphery becomes fixed, and it rarely afterward progresses beyond this boundary. Soon a slight elevation of the epidermis is noticeable, which speedily ruptures and gives exit to a clear gelatinous or sero-purulent discharge, which quickly dries and forms crusts about the orifice of exit. This is not accompanied by amelioration of the pain,

redness, heat, or swelling, nor does it in the least check the progress of the disease.

As the carbuncle increases in size, the distress, which at first is usually not excessive, becomes gradually more intense, until it reaches a stage when it can be compared to nothing but a violent burning pain located deep in the tissues, and accompanied by throbbing and often by agonizing exacerbations, owing to the fact that the skin is held down firmly to the fascia by the fibrous bands already described. The dense cutis vera also does not yield to the pressure from below; the disease therefore advances from one columnar interspace to another and thus gradually implicates the deeper tissues. The pus makes its way to the surface through the points of least resistance, these points being the columnæ adiposæ, and thus the carbuncle becomes the seat of numerous small openings scattered irregularly over its surface, which lead down to the seat of the disease in the deeper tissues of the part. After a time the centre of the carbuncle usually becomes gangrenous.

The infiltration and disintegration of the tissues and the overlying skin are often so complete, and coagulation necrosis is so extensive, that large sloughs are formed. The centre of the carbuncle thus becomes an open crater. This may be confined to a small portion of tissue, and does not always lead to any considerable destruction in the part; but it usually occasions a loss of substance to a greater or less amount, sometimes reaching an area of 25 to 30 cm. in diameter. This stage is often accompanied by a notable relief from the pain.

Irregular fragments of necrosed connective tissue or aponeurosis are often separated during the process of healing, and appear at the orifices upon the summit of the carbuncle, where they are discharged spontaneously, or may be extracted by operative measures. When the necrosed tissues are retained beneath the skin, they frequently give rise to abscesses in the periphery of the original seat of disease, and thus increase the severity of the local lesion and augment the danger to the patient, as well as enlarge the surface to be subsequently healed. The change of the livid color at the border of the induration to a yellowish hue is an indication that the disease has reached its limit in extent.

When the gangrenous tissue which forms the centre of the carbuncle has been entirely eliminated, the process of repair commences, by the gradual formation of a cicatrix over the seat of the disease. This is generally a slow process, and in some cases is not completed on account of exhaustion of the healing power of the system.

In the milder cases there may be little or no fever; but large carbuncles are usually associated with considerable cachexia, and the condition of the patient at times becomes critical.

The duration of the disease varies according to the age and condition of the patient, and the means employed in its treatment. If the carbuncle is early and thoroughly incised, a complete cure may sometimes be attained in from one to three weeks, although cases often require six months for healing. The average duration of the disease is considered by competent authorities to be from one to two months.

DIAGNOSIS.—In its early stages it may be impossible to differentiate carbuncle from the ordinary furuncle; but the diagnosis would soon be rendered positive by the course of the disease. The furuncle is quite superficial, affects only a limited amount of tissue, may be located upon any part of the body, is not accompanied by grave constitutional symptoms, is developed quickly, is not limited to any particular period of life, and is relieved by spontaneous opening or by surgical incision. The carbuncle, on the contrary, is situated in the deeper tissues, especially in parts like the neck, back, scalp, etc., in which are broad aponeurotic expansions. It usually occurs in patients already the subjects of diminished vitality from other causes, and should excite suspicion of diabetes, alcoholism, or marked uric-acid diathesis. Carbuncle is accompanied by grave and often alarming constitutional symptoms, by high fever, and by extreme restlessness; it is the seat of great and continuous pain, which is not relieved by the formation of an opening. The inflammation extends a considerable distance beneath the surrounding tissues, and is sometimes followed by extensive gangrene of the superficial structures or by phlegmonous inflammation of the adjacent parts, and is, *par excellence*, a disease of advanced life.

The simple non-specific carbuncle may properly be regarded as a group of deep-seated furuncles, situated beneath a dense and resisting cutaneous surface, which undermine and cause necrosis of a relatively large amount of tissue, with subsequent gangrene of the overlying skin, sometimes to a very alarming extent. The simple furuncle has a tendency to heal as soon as an opening occurs; the carbuncle shows no such tendency.

Carbuncle may be confounded with commencing erysipelas, and with a simple phlegmon of the subcutaneous connective tissue; but these diseases lack the localized character, the surrounding induration, the punctated surface, and the extensive sloughing of a circumscribed portion of connective tissue. Phlegmon is more boggy and diffused than is commencing carbuncle, the pain and fever are not so marked or constant, and the course of the symptoms is more rapid. Erysipelas is accompanied by intense febrile reaction, a more diffused swelling of the skin, vivid redness, and a clearly marked boundary of the disease, with lines of inflammation over the lymphatic channels and infiltration of the lymphatic glands. There is usually no tendency on the part of a carbuncle to extend beyond its original limit.

Carbuncle often presents a striking similarity to anthrax (malignant pustule), and might sometimes be mistaken for this malady, during its early stages, at the time when a small phlyctenular elevation of the epidermis upon an indurated and swollen base is the only visible variation from the normal condition. But carbuncle is rarely accompanied by the glandular enlargement, by the peripheral or extended œdema, or by so profound signs of constitutional disturbance as is the more grave disease. Aside from these points in diagnosis is the important fact that malignant pustule is observed chiefly, if not exclusively, among those who have been in some way brought in contact with some substance containing the infection, and therefore is more especially confined to those persons who are obliged to handle the flesh, hair, wool, skins, etc., of animals, or to those who are engaged in the care of animals already diseased, as grooms and shepherds (in the grazing regions of North America the disease might be expected among cowboys). The dried hides of animals, particularly those received from South America, frequently contain the virus of malignant pustule, and constitute a source of infection to curriers, tanners, and others employed in their manufacture; and in persons following these occupations any form of boil or carbuncle should be regarded with suspicion until anthrax can be excluded.

The more frequent seat of carbuncle is the neck and back; then the scalp, thorax, face, and limbs. Cases have been reported in which the eyelid and the lip were the seat of carbuncle, but these must be exceedingly rare.

PATHOLOGY.—Carbuncle may be regarded as the manifestation of a septic invasion of the affected tissues with subsequent coagulation necrosis and gangrene of the infected structures, accompanied if not preceded by a depraved condition of the general system. It has been noticed that other signs of a constitutional affection are often present in carbuncle. Thus Prout observed, in 1840, that the outbreak of the local disease was frequently accompanied by the urinary symptoms of diabetes; though it is quite possible that the diabetic phenomena and the carbuncle may belong to the outward manifestations of some grave constitutional affection, possibly of some department of the nervous system. The local features of carbuncle are essentially those of a septic infection, and are to be regarded as such so far as prognosis and treatment are concerned.

PROGNOSIS.—In speaking of the lesion of carbuncle,

allusion was made to the ordinary furuncle as the mildest form of this affection. In prognosis the same relation holds true. The furuncle is superficial in location, runs its course without fever, and is uniformly followed by rapid recovery, leaving a small cicatrix, which is usually but slightly depressed below the level of the surrounding skin. The prognosis of carbuncle, however, depends upon three factors, viz.: the age and vigor of the patient; the gravity of the constitutional symptoms, the amount of pain, etc., and the degree of interference with the process of alimentation; and the situation and extent of the local disease and the degree to which gangrene of the skin or sloughing of the deeper tissues occurs.

Death may occur from exhaustion, or from the development of secondary abscesses in the vicinity of the original carbuncle, especially if these take a phlegmonous course. A fatal issue also results in some cases from profound depression of the vital powers, apparently due to the absorption of the toxic poison of the disease. Hemorrhage and embolism have also been the cause of death in carbuncle. When the disease is situated on the neck or scalp, septic meningitis has not infrequently been a fatal complication.

When the carbuncle is situated upon the neck it may produce dyspnœa by pressure upon the air passages; when it is located upon the chest or abdomen the pleura or peritoneum may become inflamed; when upon the face, distortion of the features may ensue; and when situated upon the scalp it may be followed by meningitis.

TREATMENT.—Carbuncle is believed to arise from an infection of the skin and subjacent tissues by a definite bacillary organism, and is accompanied by a depraved condition of the general health; and therefore the first indication would be to restore as far as possible the normal vigor of the system and to bring about a better nutrition of the body. Some of the most celebrated authorities recommend the employment of active emetics, followed by cathartics, for the purpose of increasing the eliminative function of the digestive canal, and possibly, also, as a means of derivative action upon the seat of the disease by assisting in the removal of the toxins produced by the bacillus. When we consider, however, that the patient with carbuncle is generally already in a state of impaired vigor, any active depletory measures should either be entirely abstained from or should be adopted with great caution, lest they induce a dangerous degree of exhaustion or be followed by sudden collapse.

A careful regulation of the food, in regard both to quality and to quantity, is generally necessary, and at the same time active tonics and stimulants must be administered. The distress is frequently so great as to require the use of anodynes, and often the degree of febrile reaction is an indication for the employment of large doses of quinine. Cod-liver oil has also been found useful. If rapid exhaustion supervenes, the administration of champagne has sometimes been followed by great benefit. When convalescence is established, iron should be given, a generous and strengthening diet should be ordered, and, if possible, sea bathing or a change of climate and surroundings should be advised.

Locally, the treatment must depend much upon the symptoms belonging to each particular case. At times the application of cold is of great service in relieving the pain and modifying the severity of the inflammation, but generally hot and moist applications are most comfortable to the patient. These may consist of simple hot compresses, but the most common mode of treatment is by means of large poultices which should be frequently changed. At times the local abstraction of blood by means of leeches affords temporary relief, but the bleeding is liable to be excessive in amount, and may induce a condition of collapse.

The surgical treatment of carbuncle should have for its object the liberation of the sloughing tissue in the centre of the carbuncle, and the free exposure of all suppurating parts. For this purpose many methods of procedure have been advised, such as the circular incision around the base of the carbuncle; the cauterization of the summit of the swelling by means of potash or ferrum candens; the crucial incision of the entire carbuncle, the subcutaneous stellar incision through its substance; and the treatment by compression of the entire carbuncle; or of its peripheral portions, by means of firm or elastic bandages.

All operative measures should be carried out with the strictest attention to antiseptic precautions. The seat of the disease should be previously rendered as nearly aseptic as possible.

The treatment by circular incision consists in cutting a channel quite around the base of the carbuncle, so as to divide the skin and the superficial blood-vessels, and has for its object the diminution of the vascular supply, with the result of relieving the tension and reducing the febrile action in the part, and thus modifying the severity of the process and hastening the recovery. It is more especially to be employed in the early stages of the disease before gangrene has occurred, and while the central slough may yet be quite small.

The application of caustic potash or the hot iron to the summit of the carbuncle has the aim to provide a path for the release of the sloughing centre of the diseased part, and at the same time to avoid the unnecessary loss of blood from hemorrhage. The tissue to which the cautery is applied is destroyed without bleeding, and the interior of the carbuncle is rendered accessible to direct treatment. This mode of treatment is not often employed, as it is painful in its action and the resulting benefit is not greater than that from other and less distressing methods. During the last few years the antiseptic treatment has superseded all other forms. In cases of great debility or in aged patients, as well as in mild forms of carbuncle, the use of carbolic acid in dilute solution, either as a lotion or on compresses as a poultice, is of service.

The crucial incision of the entire carbuncle from base to summit is doubtless the most useful and effectual manner of exposing the interior of the swelling to view, and of liberating the sloughing centre in the most rapid manner. When the operation is completed the carbuncle presents four deep incisions radiating from the centre to the periphery. By this means the whole interior of the diseased part is made accessible to direct treatment and the most favorable conditions for rapid and complete recovery are at once established. The incision of the skin over the inflamed part, however, may be attended with a considerable loss of blood, which in the debilitated condition of many of the subjects of this disease is of no small importance. To obviate this, and thus to save the strength of the patient, the method of subcutaneous stellar incision has been adopted in many cases of extensive carbuncle.

This mode of treatment consists in the internal division of the seat of disease into many small sections, and has for its object the rapid and easy evacuation of the sloughing tissues of the centre of the carbuncle and the liberation of purulent matter, with the avoidance of excessive hemorrhage.

In performing this operation the surgeon makes use of a long and narrow knife, which is inserted into the perforated centre of the carbuncle and carried directly to the bottom of the disease. Its point is then directed outward toward the periphery of the carbuncle, and when the external boundary has been reached the edge of the knife is turned toward the skin, and the tissue is carefully cut from below toward the surface. The incision should not be allowed to reach the skin, on account of the bleeding which would ensue, but should comprise all the diseased tissues below the skin. This process should be repeated in all directions until the carbuncle consists of only a superficial covering of sound skin overlying the thoroughly divided and broken-up mass of the carbuncle, which should then be removed by curetting or in some other effective manner. The amount of hemorrhage is usually very slight. If the strength of the patient is not too much reduced, recovery is usually rapid and complete.

Warren maintains that a more radical form of operation should be carried out in many cases. He says: "The most radical treatment consists in total excision of the carbuncle. A circular incision should be made round the edge of the infected portion of the skin, and all the diseased tissues should be removed. The effect is immediate. The fever and delirium disappear and the pain is relieved."

Carbuncle of the lip often causes very grave symptoms. Evacuation of the contents and extirpation of the infected tissues should be carried out, and any simpler mode of treatment is here usually insufficient. This should be done from inside the mouth when possible on account of the diminished scar or deformity thus secured.

The application of heat, preferably by dry or moist compresses, should follow any operative measures. Should the necessity for disinfection arise, this may be accomplished by the use of chlorinated soda, which is preferable to carbolic acid on account of the somewhat greater danger of poisoning by this agent in carbuncle than in ordinary surgery, owing to the more extensive surface for absorption and the age and weakened condition of the patient. If it should become desirable to employ an antiseptic, a solution of mercuric bichloride or some other efficient agent of this nature, of which we now possess a considerable number, may be used in the wound.

The cicatrix following carbuncle is generally more or less depressed, and may at times become so retracted as to produce deformity, and occasionally to interfere with the functional activity of parts or organs (neck, jaw, eyelid, etc.).

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CARCINOMA.—The carcinoma is a tumor which arises from epithelium and is formed of masses of epithelium growing in a connective-tissue stroma. It is further characterized by unlimited local growth and by giving rise to the formation of tumors of a similar structure in other parts of the body. The tumor may arise from the surface epithelium of the exterior of the body, from the epithelium lining the alimentary canal, from that lining the lung, or from the various involutions of epithelium constituting the glands. Tumors having all the characteristics of true carcinoma may also arise in places where no epithelial structures are normally present. Such tumors do not form an exception to the general rule of origin, for they arise from embryonic epithelium which in the course of development has become included in mesodermic tissue and cut off from connection with the epithelial surface. Examples of such tumors are found in carcinoma of the deep tissues of the neck originating from the epithelial remains of the branchial clefts, in carcinoma arising in the walls of dermoid cysts, etc. Tumors having a structure very similar to that of carcinoma may arise from the endothelium of blood and lymphatic vessels. The carcinoma may also arise from the germinal tissue of the ovary and the testicle.

It has long been known that all epithelial surfaces are not equally liable to carcinoma. In general, we find that the tumor is more likely to form about the orifices of the body where skin and mucous membrane come in contact, as in the lips and anus, or where the course of embryonic differentiation has been complicated, as in the lower third of the œsophagus. Carcinoma arising from the glands is particularly apt to occur in those glands which are generally inactive but which have the power of extreme proliferation and functional activity, as the mammary gland and the uterus. In certain places the occurrence of carcinoma is probably to be explained by the action of repeated traumatic stimuli, but the influence of trauma in producing carcinoma as well as other tumors, has probably been greatly overestimated.

On microscopic examination the carcinoma is found to be composed of two kinds of tissue: first, epithelial cells arranged in masses which vary in size and form, and which are enclosed in spaces called alveoli; secondly, connective tissue which surrounds the alveoli and bears the blood-vessels for the nutrition of the cells in the alveoli. This connective tissue is called the stroma. Neither stroma nor blood-vessels penetrate the epithelial masses. Normal epithelial structures show a similar arrangement of tissue, epithelial cells growing in the closest juxta-

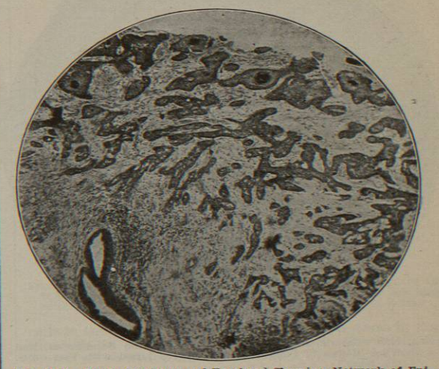

FIG. 1117.—Small Carcinoma of Forehead Showing Network of Epithelial Cell Masses Surrounded by Connective-Tissue Stroma. (No. 3 Leitz, without eyepiece.)

position with connective tissue, but the latter never penetrating between the cells. Whether we consider the covering epithelium or the glandular epithelium the arrangement of the tissue is the same.

If, in the normal epithelial structures, the cells at some point begin to multiply and penetrate into the adjoining connective tissue, the structure of carcinoma is produced. The mere proliferation of the epithelium does not produce the carcinoma. Epithelial tissues are the most active of any tissues of the body. Both the covering and the glandular epithelium are constantly used up in the course of their physiological activity, and the loss is as constantly repaired by the formation of new epithelial cells. This power of regeneration is sufficient not only for the ordinary wear and tear of the tissues, but also for the repair of even extensive losses. Furthermore, the epithelium may be excited to greater activity by various means, and large masses of tissue composed principally of epithelium may be produced. Such a growth of epithelium is constantly accompanied by a growth of young connective tissue bearing blood-vessels. An epithelial growth of this character repeats in a general way the structure of the normal tissue and is called typical, but there is no normal prototype for the structure of the carcinoma. The penetration of the connective tissue by the epithelium is atypical. It is possible, however, to have such an atypical growth of epithelium giving the general structure of the carcinoma without the other characteristics which constitute the tumor. When the proliferating epithelium comes in contact with a loose cellular connective tissue, such as is produced by chronic irritative conditions, it may grow down into it, thus constituting an atypical growth. Such conditions are found around the edges of chronic ulcers of the skin and in other conditions. The growth of the epithelium may be very active, but it will extend only to the limits of the altered connective tissue.

When we compare the epithelium in different parts of