the contents of the dilatation—so far as lies in our power—aseptic. This can be perfectly accomplished only by residence in an atmosphere containing no bacteria. Removal of the patient to a suitable climate is the best means of avoiding the various complications of the affection. When this cannot be done the treatment becomes chiefly symptomatic and largely directed to antiseptic procedures. Inhalations of creosote, turpentine, menthol, eucalyptus, etc., and creosote vapor baths are recommended for this purpose. A number of writers speak favorably of the creosote vapor baths. These are, however, unpleasant and slow in operation, and do not always succeed in lessening the amount of the sputum. The crude creosote appears to be more effective than the various substitutes (vapo-cresoline, refined creosote, soluble cresol, etc.) which have been advised. Other writers have found success with guaiacol vapor baths after failing with creosote. The ordinary methods of giving such inhalations may, however, be a source of infection, as many of the forms of inhalation apparatus used are dirt traps.

Intralaryngeal injections of menthol, guaiacol, etc., have been advised by Rosenberg, Stewart, Campbell, and others, but are condemned by various writers because they give rise to constitutional disturbances, fever, and violent cough.

Subcutaneous injections of guaiacol (1 in 5) and creosote (1 in 5) in olive oil have also been recommended. They may give rise to inflammation and necrosis at the point of injection.

Intravenous injections of formalin (25–50 c.c. of a 1 in 2,000 solution of formalin in decinormal salt solution) have also been tried without success.

Injections of carbolic acid and menthol directly into the bronchiectatic cavity have also been suggested.

Murphy's method of filling the pleural cavity with air or nitrogen to such an extent as to cause a collapse of the bronchial cavity has been tried with some success. The air should of course be thoroughly sterilized. About 170 c.c. of air or nitrogen are injected every second or third day.

Inhalations of oxygen may aid in reducing the odor of the sputum. Symptomatic treatment with expectorants (apomorphine, senega, ipecacuanha, etc.) may at times give relief or temporary improvement. Hemorrhage should receive appropriate treatment.

Inasmuch as the medical treatment is usually without avail, much had been hoped from surgical intervention in the treatment of bronchiectasis. This has now been given a very extensive trial, with complete failure in the majority of cases, and only partial success in the others. These unsatisfactory results are easily understood when we consider the facts that the dilatations are often multiple and bilateral, and that the pulmonary tissue is usually extensively diseased. Dangerous hemorrhages may result, and anæsthesia is in itself attended with danger in these cases. The uncertainty of the physical signs also contributes to the unsatisfactory results. Puncture of the bronchiectatic cavity with a trocar and drainage, incision and drainage, cauterization of the cavity, etc., are among the operative procedures advised. From the cases thus treated which have been so far reported, it would seem that under favorable conditions of life the outlook for patients with bronchiectasis is more favorable without operation than with it. Improvement of the technique of operations upon the lung may lead to better results.

The *postural* treatment of bronchiectasis is strongly recommended by Ewart (*Lancet*, 1901). While not regarding it as curative in advanced cases, he holds that no other treatment is so simple, so rational, and so effective. In a case so treated the relief afforded the patient was striking; the persistent pyrexia stopped, and the gushing character of the expectoration ceased. Ewart advises a continuous elevation of the foot of the bed of from twelve to fourteen inches. For brief periods a greater elevation may be resorted to with benefit.

Prognosis.—In so far as a cure is concerned the prognosis in any well-established case of bronchiectasis is bad. Except in rare cases no method of treatment at present employed is of avail in effecting a cure. Some of the more acute cases in young persons may, however, be cured. In the chronic cases our present methods of treatment can only relieve the distress of the affection and prolong life.

Aldred Scott Warthin.

CAMPHOR, POISONING BY.—An unwarranted belief in the innocuousness of camphor prevails in the community, referable, probably, to the safety with which it is used as an external domestic remedy for minor ailments and to its agreeable odor. This should not, however, blind the physician to its real and serious dangers when taken internally; for it may act as a poison either when eaten frequently in small quantities, as for headaches or colds, or when swallowed accidentally or intentionally once or more in large amount. It is true that fatal cases are very rare, but the symptoms are often most alarming, even when recovered from. The lethal dose of camphor is difficult to determine. The smallest dose known to have produced violent symptoms in an adult is 1.3 gm.; the largest dose known to have been recovered from is 15 gm. (Kunkel, Blyth). Camphorated liniments swallowed by mistake have frequently been the cause of severe cases of poisoning, the fact of the drug being in alcoholic solution allowing it to be absorbed and disseminated through the system more rapidly and in larger quantity than when swallowed in the solid form. The histories which I shall presently cite illustrate further the usual sequence of symptoms, and such relations as the early or late supervention of convulsions to the occurrence or absence of vomiting, this depending upon whether any large proportion of what was swallowed remained long in the stomach in a comparatively insoluble condition, or was promptly taken into the circulation. Attention is also called to the statement that when camphor has been swallowed, what is absorbed undergoes such a transformation that the odor of it is not appreciable in the urine or fæces (Kunkel); sometimes not even in the breath of the patient. Still, other authorities declare that the bodies of those dying smell strongly of the drug.

Full doses of camphor produce markedly exciting effects upon the brain and the medulla, especially when an alcoholic solution has been taken which favors rapid absorption The earliest evidences of this stimulation are flushing of the face, a rapid succession of ideas, perhaps agreeable hallucinations, with a sense of lightness of motion and a desire to dance, in fact an intoxication. These manifestations are transient and may soon be followed by tonic cramps and epileptiform convulsions. To these may succeed sometimes paroxysmal tonic and clonic cramps with movements of rotation, followed by paralysis; or again deafness passing into sopor, coma, and death, the parts of the nervous system which are first excited being apparently finally paralyzed. The temperature is lowered, but the pulse and respiration vary (Brunton, Husemann). If the patient recovers, the memory is apt to be wanting for some hours. There are no characteristic lesions after death.

The following cases are fairly typical of poisoning by camphor: Davies reports being called at 3 A.M to a child of two years and eight months, who had swallowed solid camphor. He found it pale, with blue lips, a rapid pulse, and suffering from severe convulsions. Vomiting was induced and the ejecta smelled strongly of camphor. The child soon recovered in part from its condition of collapse, but the convulsions continued, and in the intervals the patient was semicomatose. A stomach-pump was then used and the stomach washed out with warm water, procuring some relief. In five hours castor oil was given, also bromide of potassium, three grains every three hours. Still no improvement; the convulsions continued all night and the child died at 9 A.M. of the next day. The amount of camphor taken was probably half a drachm. From its being solid the stomach-pump could not act upon it effectively.

Craig reports that a man who was a hypochondriac ate about three drachms of pure camphor. About half an hour after swallowing it he was seized with giddiness and nausea, staggered on rising and seemed likely to fall. Still he was unable to vomit, and was relieved by drinking some water. He was free from pain, and lay down with a drowsy ringing in the ears. In three-quarters of an hour the giddiness and nausea had gone, but he felt as if he had been taken from his feet and were being carried through the air. He sat down at the dinner table, but became suddenly unconscious. He had general convulsions, which soon ceased, and the reporter says there was no deviation of the eyeballs, pupils equal and small and not reacting to light, knee-jerks exaggerated; breathing rapid, cyanosis followed by pallor. He was not unconscious for over five minutes. There was no odor of camphor in the breath. About two hours and a half after taking the camphor he vomited copiously, and brought up no blood and some camphor. There was no retention of urine. His memory was affected for an hour after other symptoms had disappeared.

Honman reports the case of a girl of eighteen, to whom he was called at 11 A.M. She was in the habit of eating camphor. He found her unconscious and irritable, with dilated pupils, cold extremities, pale face, epigastrium sensitive to pressure, pulse thready and uncountable, and the breath smelling distinctly of camphor. The stomach was washed out after an unsuccessful attempt to produce vomiting by sulphate of zinc. Ether was given subcutaneously with immediate improvement. It was learned that she had had camphor in her hand, and had offered it to her roommate at bedtime. She had vomited during the night and had taken brandy and water about 8 A.M. Convulsive movements now began and extended from the lower extremities to the body and upper limbs. The temperature rose to 100.3° F., and the pupils were dilated. She died at about 3 A.M. the next day. At the autopsy the only finding attributed to camphor poisoning was a high degree of congestion of the vessels of the dura mater and surfaces of the brain. The government analyst reported a small quantity of camphor in the stomach, but it is observed that none of the ejecta or dejecta had been saved prior to the doctor's arrival at 11 A.M.

In regard to the treatment of poisoning by camphor, the most important precept laid down is the earliest possible emptying of the stomach by tube, stomach-pump, or emetic. Hypodermic injections of brandy or ether may be used, with perhaps the alternate hot and cold douche.

J. Haven Emerson.

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CANTHARIDES, POISONING BY.—The poisonous action of this drug is ascribed chiefly to the proximate principle *cantharidin*, which is from twenty-five to thirty times as active as the powder. As the unassayed powder or the tincture is the form in which it is most apt to have been taken, it is difficult to determine the fatal dose of cantharidin. Blyth states that a young woman died from twenty-five grains of the powder, probably equal to one grain of cantharidin, while the smallest dose of the tincture known to be fatal (Taylor) is an ounce, equivalent to gr. $\frac{2}{0\,0}$ of the proximate principle. Poisonous effects may also follow from external applications of the drug, in which they result from absorption, especially in feeble persons and children. Blyth says that the popular idea of the influence of cantharides as an aphrodisiac holds good only as to the entire cantharides, and not as to cantharidin, and he considers it probable that cantharidin is not the only proximate principle in the insect. It is also stated that cantharides may be eaten with impunity by fowls, while the flesh of the latter may produce symptoms of poisoning if eaten by human beings. Ogier tells us that a fatal result may follow poisoning by this drug after as long an interval as twenty-four hours; also that proof of the cause of death may be found in the presence in the intestine of minute glistening particles of the insect. Fatal cases are rare.

The symptoms due to poisonous doses are given as follows by Husemann, Kunkel, and Blyth: They are shown in disturbances of respiration and in convulsions from involvement of the nervous system, often with headache, dizziness, stupor, and delirium. In the alimentary canal there appear at once burning in the mouth and throat followed by pain on swallowing, salivation, vomiting, and diarrhœa, while there develop intense irritation, pain, and a condition of inflammation of the kidneys and urinary passages, in consequence of which occur in the urine albumin, casts, pus, and blood, with catarrh and croupous deposits from the vesical mucous membrane. These are associated with strangury, dysuria, painful erections, and priapism. Sometimes pregnant women have aborted.

The following fatal case is reported by Lhôte and Vibert. A man of about sixty took a quantity of cantharidin, estimated at about 75 cgm. He died twelve to fourteen hours afterward, the symptoms presented not being accurately known. Autopsy four days post mortem. The lungs were much congested; there was a little froth in the bronchi. Stomach empty; mucosa actively congested. Kidneys large, turgescent, and extremely congested; several large sanguineous effusions under the capsule; cortical and medullary substances gorged with blood and the mucosa of the calices and pelvis strongly injected. Bladder contained 4–5 c.c. of bloody urine; mucosa strongly congested and of an intense red; no ulcerations but many ecchymoses. Mucosa of the urethra likewise congested. On microscopical examination of the kidneys the glomeruli were found detached from their capsules, and separated from them by an exudate, in the midst of which were seen at certain points numerous round, nucleated cells. In the convoluted tubes the epithelial cells appeared glued together; they filled and distended the tubes. A material extracted from the viscera produced upon animals the effects of cantharidin, and its chemical reactions were characteristic of that substance.

The *treatment* of poisoning by cantharides must be symptomatic. The stomach should be evacuated, the stomach-pump or tube being used for the purpose if the mouth and throat are not inflamed; if they are inflamed, apomorphine should be injected hypodermically or an emetic should be given. Opium and hot sitz baths should be used to allay pain and strangury, and water and mucilaginous drinks given freely, but fats and oils are to be avoided.

J. Haven Emerson.

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CAROTID GLAND.—(Synonyms: Ganglion intercaroticum; Glandula carotica; Glomeruli arteriosi intercarotici; Nodulus intercaroticus.)

This little-known organ lies in the bifurcation of the common carotid artery, generally near the posterior side of the internal carotid just as it comes off the main trunk. In size it is about 1–3 mm. in diameter, varying considerably. Because of its great vascularity the color is pink For some time it was thought to be an epithelial organ developed similarly to the thyroid and thymus from the branchial clefts, but further study showed it to be of entirely different origin and nature. Its embryonal origin is later than the thyroid and thymus, and it is in no

way related to them, for it arises directly from the primary vascular *anlage*, and therefore is not an epithelial but a perithelial structure. The first step in its formation consists of a cellular thickening of the external pos-

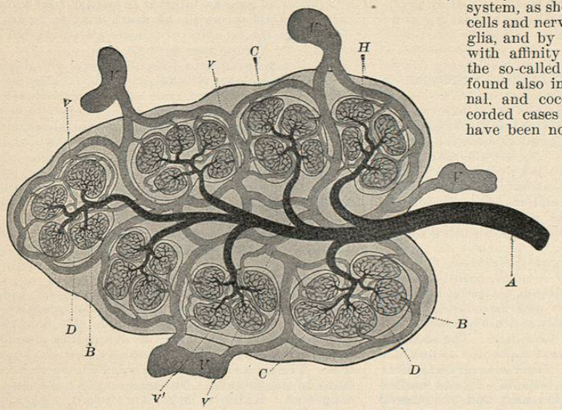

FIG. 5121.—Scheme of Circulation and Structure of the Carotid Gland, showing its Glomerule-like Character. (After Schaper.) *A*, Principal artery with *V*, corresponding vein; *B*, balls of cells; *C*, capillary networks; *D*, secondary nodules; *H*, hilus; *v*, *v'*, smaller veins.

terior portion of the periphery of the embryonal carotid. At this time the cells, of epithelioid type, are not distinguishable from the cells of the vessel wall itself, and the gland anlage is recognized merely as a thickening of the cell mass at this point. This entire nodule is surrounded by the adventitia, and over it run nerve bundles from the vagus and cervical sympathetic. Very early in its development capillary vessels derived from the common carotid at its bifurcation enter the cell mass, and soon form glomerule-like collections, which with the rapidly increasing cell growth soon distinguish the gland from the vessel.

In the adult the carotid gland shows a lobular structure. From the connective-tissue capsule bands pass into the organ carrying many vessels and nerves, and dividing it into lobules, which vary in number from three to twelve. In turn the lobules are composed of small "cell balls," which really form the unit of its structure. These consist of a glomerule-like tuft of capillaries that unite to form a vein. Surrounding the capillaries are the cells of the organ, arranged in cords or trabeculæ, although this arrangement is not at all evident in ordinary preparations. The number of cells about individual vessels varies greatly; sometimes there is quite a wall of epithelioid cells, with finely granular cytoplasm, oval nucleus, and a nucleolus, but often there is but a single layer of cells about a vessel, or the vessels may be separated merely by a loose reticular interstitial connective tissue. In this reticular tissue are frequently single cells of the same type. Often the parenchyma cells show a considerable degree of vacuolization, particularly in the old. It is said that with age the typical structure becomes less and less evident, accompanied by more or less disappearance of these special cells. The structure of the carotid gland is quite similar to that of the coccygeal gland.

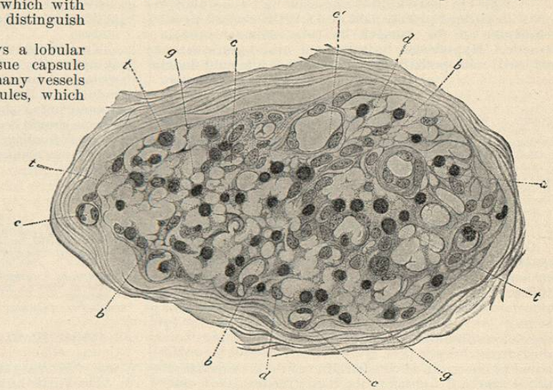

FIG. 5122.—Section of a Lobule of the Carotid Gland. × 520. From a man fifty years of age. (After Schaper.) *a*, Smallest arteriole; *b*, connective-tissue reticulum; *c*, capillaries; *d*, nuclei of stroma; *g*, protoplasmic network; *t*, nuclei of gland cells.

The function of the carotid gland is altogether unknown. It seems to have been the subject of but little investigation except by histopathologists. It is undoubtedly closely related to the sympathetic nervous system, as shown by the number of ganglion cells and nerve fibres from the cervical ganglia, and by the presence of the same cells with affinity for chromic acid and its salts, the so-called "chromophile" cells that are found also in the sympathetic glands, adrenal, and coccygeal gland. In the few recorded cases of tumors of this gland there have been no symptoms that could be considered indicative of any function, and the unilateral resection of the gland in these cases has been followed by no symptoms whatever. Extracts from the gland are said to raise the blood pressure greatly.

PATHOLOGY. — Except for tumor growths there seem to be no records of pathological alterations in this organ, probably because it escapes observation through its location and its minute size. There are in the literature eight cases of tumors of the carotid gland, all primary. They are characterized by their location in the crotch of the carotid, and by their peritheliomatous structure. They have appeared mostly about the thirtieth year, in either sex. In one instance the onset seemed closely related to fracture of the lower jaw in a tooth extraction. The growth is usually slow, in one about thirty years, and in none have metastases or recurrence been noted. All eight cases were observed through operative procedure, and there seem to be no records of such tumors discovered at autopsy. Subjective symptoms in these cases have been vague, such as headache, local pain, and tenderness. The tumor is quite fixed, because of its relation to the carotids, and for the same reason it frequently transmits pulsation which has led to a diagnosis of aneurism. In the other cases tuberculous cervical glands and thyroid tumor have been suspected.

Operation usually involves ligation of the carotid, which in one case led to death subsequently through the ligature cutting through the artery. In another case death resulted from broncho-pneumonia, which probably developed because of section of the vagus. The other six recovered completely, and seem to have remained well thereafter. In the two cases that were fatal, autopsy revealed no metastases whatever.

The malignant tumors of the carotid gland testify to its origin in the perithelium, for they form quite typical peritheliomas. The tumor is generally highly vascular,

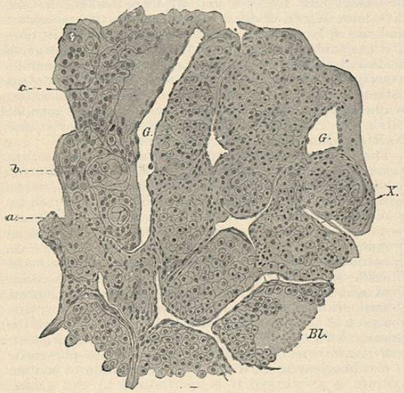

FIG. 5123.—Perithelial Tumor of the Carotid Gland. (After Paltauf.) *G*, Vessels; *Bl*, blood extravasation; *a*, hyaline degeneration of cells; *b*, hyaline degeneration; *c*, hyaline masses.

and about the capillaries are layers of epithelioid cells, with a strongly staining oval nucleus, and considerable finely granular cytoplasm. The thickness of these walls seems limited by distance from blood supply, and the perithelial cells tend to form cords with central spaces lined solely by the tumor cells. The lobular structure of the gland is retained, as well as its richness in vessels and nerves.

Usually the tumor lies in the crotch of the carotid, "like a meal sack." The largest tumor reported is that of von Heinleth, which measured $3.5 \times 5 \times 8$ cm., and was 21 cm. in circumference.* *H. Gideon Wells.*

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CHYLOTHORAX.—This is a condition in which the pleural cavity contains chyle, due to a break in the continuity of the wall of the thoracic duct or its branches, or to some pathological condition of their walls whereby the contents may be transuded into the pleural cavity. Other writers give the name chyliform to those fluid exudates, in the pleural cavity, which contain fat in smaller amount than is found in the cases belonging to the class first mentioned. Furthermore, as these so-called chyliform fluids accompany tumors of the pleura in many cases, these writers believe that the fat comes from a fatty degeneration of the tumor cells. In a third class of cases the fat of the pleural fluid is supposed to result from lipæmia. In the latter cases the amount of fat contained in the fluid in the pleural cavity is small. Nevertheless, in many cases it may be difficult to differentiate these fluids from true chyle containing a small amount of fat and resulting from some definite lesion of the thoracic duct.

As stated, true chylothorax results from some definite lesion of the thoracic duct or its branches; but since lesions of this organ are not common, and since all lesions of the duct are not followed by chylothorax, the presence of chyle in the pleural cavity is an unusual condition.

Many of the older writers confused chylothorax with empyema or with the fibrinous exudates accompanying certain cases of pleuritis, and consequently some of the cases reported by these men, when studied carefully now, are found to be of a nature different from true chylothorax. It being assumed that this statement is correct, it appears that only forty-seven cases of genuine chylothorax have been reported, besides about fifteen others which are doubtful cases.

ETIOLOGY.—In the undoubted cases the age varied from 2 to 62. Two cases occurred in patients under 10 years of age; 8 in patients from 11 to 20; 7 from 31 to 40; 8 from 41 to 50; 3 from 51 to 60, and 2 after 60. From this it can be seen that the greatest number of cases occur between the ages of 11 and 51. This is explained by the fact that individuals between these ages are more exposed to injuries, or are more subject to new growths—conditions which are frequent causes of chylothorax.

In 41 of the undoubted cases in which the sex was given, 31 were males and 10 were females.

Chylothorax may result from obstruction to the flow of chyle through the thoracic duct, due to pressure from without by new growths or by tuberculous lymph nodes in the mediastinum. The obstruction may also be due to occlusion of the lumen by secondary new growths or to the presence of thrombi in the duct or in the left subclavian vein—in the latter case obstructing the mouth of the duct. Finally, it may be due to the presence of filaria. In other cases chylothorax results from pathological changes in the duct wall or from traumatic injuries to its walls.

Of the undoubted cases 16 resulted from injury to the chest; 9 from pressure exerted upon the duct by new growths outside the duct or by tuberculous lymph nodes; 9 from secondary growths in the duct; 4 from thrombosis of the left subclavian vein; 2 from proliferating lymphangitis; 2 from aneurism-like dilatations of the duct, and 1 each from the following: thrombosis of the duct, operation for removal of carcinomatous lymph nodes of the neck, obstruction to the radicles of the duct from inflammatory thickenings in the mesentery, mitral disease, and filaria. All of these causes either produce a break in the continuity of the endothelial lining of the duct or put the endothelial cells under such abnormal conditions that their nutrition is impaired, and consequently they allow the transudation of the chyle.

SYMPTOMATOLOGY. — The symptoms of chylothorax which result directly from this condition are not characteristic. For the most part they resemble those of hydrothorax or a pleuritic effusion. In most cases the chief, and sometimes the only, symptom is a gradually increasing dyspnœa. In fatal cases this may be accompanied by a rapidly progressing emaciation, although the patient may have a good appetite and may eat well. A few of the patients complain of pain in the affected side if the chylothorax is unilateral, and of a general, indefinite, dull pain in the chest if the condition is bilateral. On inspection lagging of the affected side will be noticed and the intercostal spaces will be more or less obliterated. If the quantity of fluid is large, the heart may be displaced away from the fluid. Palpation reveals a lessened or entirely absent vocal fremitus, depending upon the amount of fluid

*Since this article was written there has appeared still another report of a tumor of the carotid gland by Reclus and Chevassu, (Revue de Chirurgie, 1903, xxiii., Nos. 8 and 9). This article also includes a full review of the subject to date, with particular reference to operative intervention, which these writers consider, is not indicated unless the tumor is causing much disturbance, since it is probably not malignant and resection involves injury to such important structures.

present. Percussion always gives a dull note on the affected side of the chest, both laterally and behind, the line of dulness being higher in front and lower in the back when the patient sits up, and reversed when the patient lies down.

In seventeen of the forty-seven cases chylothorax was accompanied by chylous ascites, and in one instance by chylopericardium. In one case there was chyluria, and in another milky diarrhœa.

The symptoms referable to other organs are usually due to the same pathological alterations as those which have brought about the chylothorax. In cases of external injury to the duct very few symptoms other than those mentioned appear.

Diagnosis.—The only evidence upon which a positive diagnosis of chylothorax can be based is that afforded by an examination of the fluid. This fluid, as withdrawn by an aspirator, is usually semitranslucent, milky, and opalescent. Its specific gravity is 1 020 in most cases. If allowed to stand, the fluid separates into two layers, an upper, slightly more yellow in color, and resembling cream in consistence, and a lower one, watery in character. If the whole is well shaken and extracted with ether or treated with sodium or potassium hydrate, the fluid becomes clear and loses its milkiness. Chemical examination of the fluid shows that from ninety to ninety-nine per cent. is water. Of the solids, the fat varies from 0.02 to 0.92 per cent.; salts and albumins, and sometimes a small amount of sugar, forming the remainder.

Prognosis.—In many cases the prognosis of chylothorax is good. In those which are due to obstruction, the anastomoses of the thoracic duct may do compensatory work, and thus the condition may be relieved. In cases due to injury to the duct from external causes, proper treatment frequently brings about a cure.

Treatment.—For those cases in which the chylothorax is due to some chronic obstruction, aspiration of the fluid, accompanied by rest and nourishing food, is about all that can be done. Cases due to injuries of the chest are treated in a similar manner.

In cases due to injury inflicted during an operation for the removal of carcinomatous or tuberculous lymph nodes in the neck, the duct may be ligated, resected, or packed, all of which procedures have been used.

Frederick A. Baldwin

Most of the literature of chylothorax is given by Bargebuhr, Deutsches Archiv für klinische Medicin, 1895, liv., 410, and by Shaw, Journal of Pathology and Bacteriology, 1900, vi., 339.

DISSOCIATION, DIFFUSION AND ACTION OF SALTS.—The advance of physical chemistry in the last fifteen years has thrown a new light upon the behavior of salts in the tissues, and promises to form the basis of the explanation of their presence in all forms of living matter, as well as of much of their therapeutic value. The chief phenomena bearing on biology and medicine are the dissociation of salts and their relation to diffusion and osmosis, and before the results of the application of physical-chemical methods to the biological sciences can be appreciated some knowledge of the recent advances in the theory of these phenomena is requisite.

Dissociation, Ions.—It was formerly held that common salt dissolved in water remained in the same form as that which is familiar in the dry state, the only difference being that crystals divided into molecules. It is now recognized, however, that not only are the molecules isolated from each other, but that a certain number of molecules undergo still further division. The products of this molecular division are known as *ions*, and in the case of common salt are Na ions and Cl ions. The amount of dissociation that occurs varies with the strength of the solution; the weaker the solution the greater the percentage of salt undergoing dissociation. In a one-per-cent. solution of sodium chloride only about one-fifth of the salt is present in the form of molecules, the rest having dissociated into the two ions. These ions are not to be confused with atoms, for although sodium and chloride ions are present, the solution of course possesses none of the properties of metallic sodium or of free chlorine. The ions differ from the atoms in carrying a charge of electricity, the charge of the sodium ion being positive, while that of the chloride ion is negative.

If a battery be connected with the solution the sodium ions hurry to the negative pole or cathode, while the chloride ions give up their charge at the positive or anode. The sodium ion is therefore known as the *cation*, the chloride as the *anion*. At the moment at which the charge of an ion is given up the ion changes to an atom, but it immediately forms fresh combinations with the water, in the present instance NaOH and HCl.

Other salts undergo a similar dissociation in solution in water: KBr forms K and Br ions; $NaNO_3$, Na and NO_3 ions, K_2SO_4 divides into three ions, two potassium and one SO_4; ammonium oxalate forms two NH_4 ions and one oxalate anion, and so forth. The dissociation of acids and alkalies is of great importance, but resembles exactly that of the other salts, acids forming hydrogen cations and the rest of the molecule forming the anion, while alkalies divide into a hydroxyl anion and a metallic cation; HCl thus becomes hydrogen and chloride ions; NaHO, sodium and hydroxyl (HO) ions.

The ions in a solution are in constant motion, and the anions and cations of a substance in solution lose the connection which they possess in the solid state. Thus, when potassium bromide and sodium chloride are dissolved together in a sufficient amount of water, it is no longer correct to designate the result as a solution of potassium bromide and sodium chloride, for the potassium ions are in no closer connection with the bromide than with the chloride ions. The bodies present are really the potassium and sodium cations and the bromide and chloride anions. In the blood serum, for example, the phosphate ions present are not combined with the potassium nor the chloride with the sodium, but all four are independent, and it is incorrect to speak of the potassium phosphate of the blood serum. When a dilute solution of sodium hydrate is swallowed it is neutralized by the gastric juice, and the reaction is often stated as the formation of sodium chloride and water. In reality the hydrate solution contains sodium and hydroxyl ions, the gastric juice hydrogen and chloride ions, and the resultant fluid contains sodium and chloride ions. The change consists in the disappearance of the hydrogen and hydroxyl ions which have formed water, the chloride and sodium ions having been present to begin with and remaining unchanged.

Dissociation occurs in salts, including under this term acids and alkalies, but it is not developed equally in all salts. Those acids and bases which are generally considered to be the "stronger" dissociate more readily than the weaker combinations, and the monovalent salts more readily than the bivalent. The inorganic salts dissociate more readily than the organic, and the same holds true for the bases. All of those bodies in solution serve as electrical conductors; in fact, the passage of electricity through watery solutions is only possible through the presence of ions, and the conductivity of solutions is thus a measure of the degree of dissociation. Those substances which are dissociable are therefore known as electrolytes. On the other hand, many organic substances are incapable of conducting electricity and are also incapable of dissociation. Thus alcohol contains an hydroxyl (— OH) in combination with ethyl (C_2H_5), as sodium hydrate contains an hydroxyl in combination with sodium. Alcohol is, however, incapable of forming ions, and therefore is a non-electrolyte in aqueous solution, while sodium hydrate dissociates readily into hydroxyl and sodium ions, and these are capable of conveying an electric current.

Sodium hydrate has a characteristic action in the tissues, causing corrosion. This might be due to either the sodium or the hydroxyl ion. As a matter of fact, however, the sodium ion is present in many solutions which are devoid of corrosive effects, for example, in solutions of sodium chloride. The conclusion, therefore, is that the hydroxyl ion is the corrosive in this case. Alcohol has no such corrosive action as sodium hydrate, and this corresponds with the fact that alcohol is not an electrolyte, *i.e.*, does not liberate the hydroxyl ion, although it contains hydroxyl. Many other similar examples might be cited, all going to show that in many instances the therapeutic effects of a body are due, not to the molecule administered, but to the ions into which it dissociates in the fluids of the body. In fact in administering an electrolyte, the physician gives not one but two or more substances, which may each effect changes in the organism. As a general rule in therapeutics one ion is so powerful that the other may be neglected; for example, in morphine sulphate the alkaloidal cation is so active that the sulphate ion may be ignored, and the sulphate has therefore the same effect as the hydrochlorate of morphine. When the two ions are more equal in pharmacological activity, however, each has to be taken into consideration; for example, magnesium sulphate dissociates into magnesium and sulphate ions, each of which has a retarding influence on absorption in the bowel, while magnesium chloride similarly forms magnesium and chloride ions, of which the latter is indifferent in the bowel. The sulphate of magnesium has thus a more powerful purgative action than the chloride, and is also more active than sodium sulphate, which forms the purgative sulphate and the indifferent sodium ions.

Another example of the importance of ions to the understanding of therapeutic action and to its successful practice is offered by the bromides. Potassium and sodium bromides have a depressant action on the central nervous system, and as this is absent in the case of the chlorides of these metals, it is obviously due to the bromide ion. Bromated camphor also contains bromine in chemical combination, and attempts have been made to substitute it for the bromides as a depressant. But bromated camphor does not dissociate and no bromide ions are formed, so that whatever properties it may possess, it cannot be compared with the bromides of potassium or sodium.

The action of salts depending on the ions, the intensity naturally varies with the rate of dissociation. This is well exemplified in the local effects of the heavy metals; such salts as the chlorides and nitrates, which dissociate readily, are much more active locally than the sulphates and organic salts which divide into ions less rapidly, provided, of course, that all are equally soluble and have no special characteristics, such as deliquescence. The newer views as to the dissociation of salts and the important rôle of the ions explain why such bodies as the ferrocyanides have the effects neither of iron nor of cyanides, for neither iron nor cyanide ions are formed from them in solution. Similarly the cacodylates differ from arsenous salts because they do not liberate the arsenous ion except after decomposition in the body. Now in the case of potassium arsenite, the arsenite ion is the active constituent, and the cacodylates can possess this only when they are broken down in the tissues into arsenous salts. The slowly dissociating salts are thus often used to avoid the local action of the more irritant metals; for example, many of the recent compounds of iron have the advantage over the older salts of causing less local irritation, while they have practically the same effect on the blood formation. Similarly several new preparations of mercury have been introduced with the view of lessening the local action on the stomach and bowel, or of lessening the irritation induced by the hypodermic injection of mercury. These compounds, when soluble, are more slowly dissociated than corrosive sublimate, and, there being fewer mercury ions present at any one time, the local irritant action is accordingly reduced.

The disinfectant action of the heavy metals also depends largely upon ionization, for the destruction of the germs is due to a chemical reaction between the metal and the protoplasm of the microbes; and the larger the number of free ions the greater the tendency to union. The attempt has been made to obtain germicides devoid of the local irritant action by forming less readily dissociating salts than those in ordinary use. A large number of preparations have thus been introduced, partly compounds with organic acids, partly with proteid bodies. But as the irritant and the germicidal action of most metallic compounds depend on the same factor, namely, the free ions, it seems likely that the lesser degree of irritation induced by these is obtained only by the sacrifice of much of the disinfectant value.

The double salts are much less readily dissociated than the simple, and not infrequently appear to liberate somewhat complicated ions, as in the case of the ferrocyanides noted above. They are therefore largely devoid of the local action of the parent substances, and this may be taken advantage of in therapeutics occasionally.

When two salts which have one ion in common are dissolved together in water, the dissociation is considerably reduced. For example, if corrosive sublimate be dissolved along with sodium chloride, the former is less dissociated than if it were dissolved alone in the same amount of water. In accordance with this general rule, it is found that the addition of sodium chloride to a mercuric perchloride solution lessens both its irritant and its germicidal power, and in cases in which it is desirable to mitigate the former, and in which the latter is of no importance, as in the treatment of syphilis by the hypodermic method, this mixture may be used instead of the pure mercuric salt.

The complete treatment of the dissociation of salts would involve a large part of pharmacology and therapeutics, in which the importance of the phenomenon is daily becoming more evident. The inorganic materia medica is more dependent on the principle than the organic, as the dissociation is much more complete in the former. It is possible to exaggerate the importance of the new law, however, for many of the facts and principles of therapeutics remain unaltered by its introduction. For example, it is undoubtedly more in accord with modern theory to attribute the effects in epilepsy to the bromide ion than to the bromides, as was formerly done, but this is after all a matter of nomenclature, and it is perhaps necessary at the present time to remember that there was a science and practice of therapeutics before the ion theory was broached. On the other hand, there can be no question that it has thrown much light on many questions, and removed many misconceptions. In the case of the bromides, for example, it is scarcely possible to maintain at the present time that the bromide of ammonium is superior to that of sodium, except possibly in regard to the local action on the alimentary tract, for in each case the active constituent is the bromide ion, and this is equally readily furnished by either salt.

In physiology and biology generally the theory of ions is of great importance, as is at once apparent from the fact that the fluids and tissues of the body can only conduct the electric current through the presence of ions. Every electric stimulus causes a change in their distribution, and every electrical discharge (and electrical changes accompany every movement and every other form of activity) is intimately connected with the presence of free ions, and in fact is possible only in their presence. The whole of electro-physiology, and naturally of electro-therapeutics, has thus to be based on the ionic theory, and the fact that every life process so far investigated has proved to be accompanied by electric changes indicates that the presence of free ions is necessary to life itself. This of course agrees with the fact that inorganic salts are present in every living tissue.

Not only do living tissues require the presence of free ions, but even dead colloid material is altered very remarkably by them. And certain facts have recently been brought out in regard to the dependence of the proteids on certain ions which promise to have a far-reaching influence on biology and hence on medical science. It has long been known that many proteids, notably the globulins, are precipitated from solution when such salts as the sulphates of magnesium or ammonium are added to them. But Hardy has recently shown that the precipitation and solution of colloids, such as the proteids, depend largely on the valency of the ions present in the solution. Thus