slightly soluble in cold water or alcohol; soluble, without leaving more than a small residue, in 150 parts of boiling alcohol; also soluble in 33 parts of boiling benzol, and in solutions of the alkalies."

Chrysarobin taken internally is an active irritant to the alimentary canal, causing violent and persistent catharsis and vomiting. It is eliminated, partly unchanged and partly converted into chrysophanic acid, by the kidneys, which glands are extremely irritated by it, and hæmaturia and interstitial nephritis may follow. It is, however, here never given internally, its use being confined to local applications as an irritant and parasiticide in chronic psoriasis, pityriasis versicolor, and tinea tonsurans. It produces an active acute inflammation, which as it subsides leaves the original malady in an improved condition. Chrysarobin stains both skin and clothing badly. The ointment (*Unguentum Chrysarobin*, U. S. P., strength five per cent.) is of a suitable strength for inunction.

W. P. Bolles.

CHRYSOIDIN. — $C_6H_5N.NC_6H_3(NH_2)_2HCl$—Diamido-azo-benzol hydrochloride. This is a red-brown crystalline powder soluble in water and used in solution as an antiseptic mouth wash. *W. A. Bastedo.*

CHRYSOPHANIC ACID.—*Rheic Acid. Rhein.* $C_{14}H_5(CH_3)(OH)_2O_2$. This is a bright yellow crystalline powder extracted from rhubarb, to which it imparts the yellow color. It is insoluble in water and only slightly soluble in alcohol, but dissolves in both ether and chloroform. It is highly irritant, and has the same properties and uses as *Chrysarobin*, which see. *H. H. Rusby.*

CHUCANDIRO.—Michoacan, Mexico. These waters enjoy a great reputation in the country because of their warmth (which is that of the normal human body), their clearness, and their curative properties. They contain a high percentage of hydrochloric acid in solution.

N. J. Ponce de Léon.

CHYLANGIOMA. See *Angioma*.

CHYLE.—The term chyle is applied to the milk-white, opaque fluid which fills the lacteals, or lymphatic ducts, of the small intestine during the digestion of food containing fat. Since the fluid from the lacteals preponderates in that of the thoracic duct and causes the latter to assume a similar appearance, the term chyle is also frequently applied to the contents of the thoracic duct during the absorption of fats. The physical and chemical properties of this fluid vary at different times and under various circumstances; the most important factor determining its properties is, however, the character of the food in the intestinal canal. In a starving animal or in one which has received only fat-free food, the liquid of the lacteals is not to be distinguished either in appearance or in chemical composition from ordinary lymph.

Much of our knowledge of the character and composition of chyle has been derived from experiments upon the lower animals, and especially from experiments upon the dog. In this animal it is not difficult to insert a cannula into the thoracic duct where it joins the left subclavian vein at the root of the neck; in this manner the chyle may be collected for any desired period and the factors affecting the composition and rate of flow studied. Unfortunately, the fluid collected in this manner is not pure chyle, but consists of a mixture of chyle and of lymph coming from the lymphatics of the liver, kidneys, pelvis, abdominal walls, lower extremities, etc. In large herbivorous animals cannulæ have been inserted into the lacteals directly and pure chyle obtained. The chyle of man has seldom been studied; in rare cases fistulæ connecting with the lacteals or with the thoracic duct have been described and the fluid escaping therefrom examined. Cases are also reported in which the thoracic duct became occluded and ruptured, allowing the chyle to escape into the pleural or peritoneal cavity, from which it was removed by puncture.

Chyle obtained by one of the above methods is, when a mixed diet has been given, a white, opaque fluid; occasionally it is colored slightly red or yellow from the accidental presence of red blood corpuscles. In herbivora it may have a greenish tinge from chlorophyl derived from the food. It has an alkaline reaction due to carbonates and phosphates of sodium. The specific gravity is 1.018 to 1.025. It has a salty taste and the odor (due to volatile fatty acids) peculiar to the animal from which it is derived. It coagulates upon standing, sometimes more, sometimes less, readily. Examined microscopically chyle is found to contain two kinds of formed elements, leucocytes and fat granules. The leucocytes have their origin chiefly in the lymphoid tissue of the intestinal tract and the lymph glands of the mesentery; chyle obtained from the lacteals before they pass through lymph glands is found to contain fewer leucocytes than that from vessels which have passed through these glands. A constant stream of leucocytes thus passes from the chyle into the blood; this forms an important source of the white corpuscles of the latter. The fat, which exists in a state of the finest division, will be discussed below.

Since chyle is but a form of lymph we should expect to find a close resemblance between the chemical composition of these two fluids; the following table from Munk, giving the results of analyses of chyle and of lymph of man, shows that this is the case.

One hundred parts.	Chyle.	Lymph.
Water	92.2	95.2
Solids	7.8	4.8
Fibrin	.1	.1
Proteids	3.2	3.5
Fats (lecithin and cholesterin)	3.3	Traces.
Extractives	.4	.4
Salts	.8	.8

This table shows very clearly that chyle differs from ordinary lymph in but one important point, viz., in containing a larger percentage of fat. In exceptional cases chyle contains a larger percentage of sugar than does lymph; this point will be discussed below. Since chyle, like lymph, is derived from the blood, it is of interest to compare the composition of the blood serum and the chyle of the same animal. The following table is from analyses made by Hoppe-Seyler; the fluids were obtained from a dog.

	Chyle.	Serum.
Water	90.67	93.60
Fibrin	.11	.....
Albumin and globulin	2.10	4.52
Fat (lechithin and cholesterin)	6.48	.68
Other organic substances	.23	.29
Salts	.79	.87

These analyses show that chyle differs from serum in two important particulars: it contains a larger percentage of fats and a smaller percentage of proteids. Lymph similarly contains a smaller percentage of proteids than does blood serum. The amount of urea in the chyle is, according to Grehant and Quinquaud, greater than that in the blood; they found from 46 to 95.5 mgm. of urea in 100 gm. of chyle, and only about one-half as much in blood.

The salt occurring in the greatest abundance in chyle is sodium chloride (.58 per cent.); then come sodium carbonate (.15–.22 per cent.) and the phosphates of the alkalies and alkaline earths (.04 per cent.). Other salts, as potassium iodide and potassium ferrocyanide, are occasionally found in the chyle as abnormal constituents. At times a small amount of lactic acid is present.

The proteids of the chyle are serum albumin and serum globulin: the former is two and a half to four times as abundant as the latter. Cholesterin and lecithin are constant constituents of the chyle: in analyses they are frequently reckoned with the fats in the "ethereal extract."

Some analyses showed from 18 to 102 mgm. of cholesterin per 100 gm. of chyle; lecithin was found in much smaller quantity—only about half as much of this being present, as a rule, as of cholesterin.

It has already been shown that the only important difference between chyle and lymph is the presence in the former of a large amount of fat. If the contents of the lacteals be examined in an animal which has received no food for many hours or only fat-free food, this difference does not obtain, and the contents of the lacteals cannot be distinguished from ordinary lymph. These considerations suggest that fats are absorbed by the lacteals, and that this is the case has long been known. The question is often raised, Are the lacteals the only path for the absorption of fats? While this question is usually answered in the affirmative, the proofs are by no means complete. The amount of fat absorbed from the intestines is easily determined by weighing the amount of fat fed, and that remaining in the digestive tract after a given period; the difference gives the total amount absorbed. The fat absorbed by the lacteals is determined by collecting the chyle as it flows from the thoracic duct and weighing the fat it contains. When the amount of fat obtained from the thoracic duct is compared with that absorbed from the intestines, a marked deficit is always found; the most careful work has failed to recover more than sixty per cent. in this way. The fate of the rest of the fat is not known; there is, however, no evidence that any of it passes into the portal system.

Fat does not seem to be absorbed by the lymphatics of either the large intestine or the stomach, for the contents of these are always clear; the epithelial cells lining these organs are, however, sometimes found filled with fat droplets, but it is not known what finally becomes of these.

The amount of fat in the chyle varies within wide limits, being determined by the amount and character of the fat of the food. It is said that the chyle of the dog may contain as much as fifteen per cent. of fat; the maximum amount found by Munk in man was about five per cent. The time after a meal at which fat appears in the chyle is very variable, being determined largely by the character of the fat fed. Zawilski (Ludwig's "Arbeiten," ii., 1876, p. 147) introduced into the stomach of a dog 150 gm. of fat (the variety is not stated). Two hours afterward fat was detected in the chyle: the maximum amount was found in the tenth hour, and fat was still present after nearly thirty hours. Munk and Rosenstein (to whom we are indebted for nearly all of our knowledge of the absorption of fat in man) carried out a similar series of experiments on a human being (Virchow's *Archiv*, 123, p. 230). These investigators had the opportunity of observing and experimenting upon a girl who, as a result of elephantiasis of one leg, had a fistula in the thigh which communicated through the left lumbar lymphatic duct with some of the lacteals. It was found that when fat was given to this patient, two-thirds of it could be recovered in the fluid escaping from the fistula in the following twelve hours; further, examination of the blood at the height of digestion showed no more fat to be present than when the patient was fasting. Munk and Rosenstein concluded from these observations that nearly all the chyle escaped through the fistula. A unique opportunity was thus offered to extend to man the experiments which had been made upon animals as to the absorption of fats. Some of the more important results will be given below. In one experiment the patient was given 41 gm. of olive oil; the fluid escaping from the fistula, and which had hitherto been clear, became milky in appearance during the second hour and chemical examination showed the presence of much fat. The maximum amount of fat was found in the fluid escaping during the fifth to the sixth hour; the fluid now contained 4.3 per cent. of fat, and 5.6 gm. passed out during the hour. The percentage of fat in the chyle rapidly decreased from this time on, and from the eleventh to the thirteenth hour only 0.8 gm. was obtained. In all, 60 per cent. of the fat fed escaped from the fistula.

When a fat with a high melting point (like mutton fat which is solid at ordinary temperatures) was given, the course of absorption was similar, except that the maximum percentage of fat in the chyle (3.8 per cent.) appeared somewhat later—between the seventh and the eighth hour; that is, the mutton fat was absorbed with more difficulty than was the olive oil. The greatest amount recovered in one hour was 4.7 gm., and of the entire amount 55 per cent. was obtained from the chyle. When cream was given to the patient, as much as 11.2 gm. of fat was obtained in one hour.

From earlier experiments on lower animals Munk had found that when fatty acids are fed they appear in the chyle as neutral fats; he was able to confirm this result on the patient in question. For example, when 17 gm. of erucic acid was given, 8 gm. of the corresponding neutral fat (erucin) was obtained from the chyle escaping during the following ten hours; in other words, a union of erucic acid and glycerin (derived from the tissues) had occurred during the course of absorption. Very little free acid was found in the chyle. Munk also tried experiments with spermaceti, a fat which melts at a temperature (127° F.) much above that of the body, and in which the palmitic acid is combined with cetyl alcohol instead of with glycerin as in ordinary fats. In these experiments the fatty acid appeared in the chyle in combination with glycerin: that is, the spermaceti had been decomposed and the palmitic acid had combined with glycerin during the course of absorption. These experiments also show that fats which are solid at the temperature of the body can be absorbed; the earlier view was that such fats escaped absorption altogether. When a fat containing amyl alcohol instead of glycerin was given, the fat of the chyle was a triglyceride, showing again that a decomposition and synthesis had occurred during absorption. In other experiments oil in the form of an emulsion was given by the rectum; four to six per cent of the fat was absorbed and appeared in the chyle in the course of eight or nine hours.

It is held by some that fats are absorbed from the intestines chiefly in the form of soaps; if this is the case they are transformed into neutral fats very soon after absorption, for soaps are present in but very small quantities in the chyle—only to the extent of about 0.2 per cent. In fact the soaps of the alkalies have been shown by Munk to produce poisonous effects similar to those caused by the albumoses when they are injected intravenously. Very little free fatty acid has been found in the chyle, and the amount is not increased by the ingestion of fatty acids.

Thus the fat of the chyle is almost entirely in the form of neutral fats; it is suspended in the liquid as an extremely fine emulsion. The fat granules are less than 1 μ in diameter and show Brownian movements. This emulsion is much finer and more uniform than that which is formed in the intestine; the fat granules in the latter vary in size from 1 to 20 μ or even more. The emulsion of the chyle also differs from ordinary fat emulsions in that it is not destroyed by acids. There is, however, no protecting membrane, as was once thought to be the case; the fat is easily removed by shaking with ether which causes the liquid to become transparent.

Many experiments have been made to determine whether substances other than fats, such as proteids and carbohydrates, pass from the intestinal tract into the chyle. The numerous experiments upon the lower animals and those of Munk and Rosenstein upon man agree in showing that normally fat is the only food-stuff which takes this path. Water and substances easily soluble in water, such as salts, proteids, and sugars, are absorbed by the blood-vessels. When, however, very large amounts of sugar, etc., are fed, some may be absorbed by the lacteals and so appear in the chyle. Munk and Rosenstein, for example, found that after giving 100 gm. of sugar the percentage of sugar in the chyle rose from 0.1 to 0.33 per cent.; only 0.5 per cent. of the total amount absorbed from the intestine was found, however, in the chyle. These authors found no appreciable increase in

the amount of proteid in the chyle after feeding 103 gm. of albumin. Asher and Barbèra (*Centralblatt für Physiologie*, xi., p. 403, 1897), on the other hand, found that when a very large amount of proteid (200 gm.) was introduced into a dog's stomach, as much as 6.4 per cent. of it could be recovered from the chyle; such results are not obtained when moderate amounts of proteids are used.

The quantity as well as the character of the chyle varies considerably during the course of a day. It increases during the period of digestion and decreases markedly during fasting. Most of the observations upon this point have been made upon the lower animals. Colin, using figures derived from an experiment in which chyle was collected from one of the large lacteals, calculated that in a young bull weighing 200 kgm. about 15 kgm. of chyle was formed per day. There are no observations which allow of more than an appropriate estimation of the amount of chyle formed in man. Munk and Rosenstein found in the experiments described above that from 70 to 120 gm. of chyle escaped, per hour, from the fistula before, and 150 gm. after a meal. Noel Paton (*Journal of Physiology*, ii., p. 109) observed the flow of lymph from the thoracic duct in a case in which this duct had been injured during an operation for sarcoma of the neck; he estimated the normal amount to be from 130 to 195 c.c. per hour. Of course in both of these cases the liquid was not pure chyle, but was a mixture of chyle and lymph from other sources; in Noel Paton's case, moreover, the patient was in a very abnormal condition.

Chyle, in addition to being the medium of the absorption of fats, is the lymph of the small intestines; it serves the same purpose and is formed in the same way as the lymph of other organs. (See article *Lymph*.)

Reid Hunt.

CHYLOUS AND ADIPOSE ASCITES.—Medical literature of the sixteenth and seventeenth centuries abounds in instances of traumatic lymphorrhagia and lymphorrhœa, especially after venesection.[1] Reviewing the records, we cannot avoid the conclusion that a large number of these cases were of chronic pyogenic or tuberculous infection. Nuck[2] and Practicus[3] have recorded (1695) cases of milky saliva, and Rommel one in which a milk-like fluid exuded from the exterior surface of the abdomen. Milk-like discharges recorded in puerperal women are probably pyæmic processes. Dilated lymph vessels, lymphatic varices, have been observed in serous membranes, the heart, lungs, small intestines, liver, spleen, conjunctiva, and tunica vaginalis.

Kamienski (*Jahrbuch für Kinderheilkunde*, 1896, Bd. xli., p. 429) deals with the relation of lymphangioma in the abdominal lymph vessels to chylous ascites. The causes of lymphatic varices are filaria, adenitis, perichitis hæmorrhagica, lymphatic obstruction, and perhaps lymphangitis gonorrhœica. Lymphocele is increasing in frequency both in this country and abroad.[4]

Chylopericardium is extremely rare, there being but two cases on record; one case resulted from leakage of chylous fluid from the pleura, and the second instance was due to rupture of chyle vessels. Hasebroeck[5] reports a case in which albumin 7.0, cholesterin 0.3, lecithin 0.1, fat 1.0, alcoholic extractives 0.2, aqueous extractives 0.2, and salts 0.9 per cent., were found.

Chylothorax is more frequent, about forty-five cases being recorded. Some sixteen (Wiescher, "Zur Casuistik der Verletzung des Duct. Thoracicus," *Deut. Zeits. für klin. Chir.*, Bd. xxxviii., H. 4, 5; also contains account of experimental work upon the thoracic duct; Gjorgevic [Langenbeck's *Archiv*, 1870, S. 653]) resulted from direct trauma to the thoracic duct. Rupture of the thoracic duct is uncommon on account of its protected location, and it heals readily on account of low pressure there, although it has been stated that recovery never follows rupture. Other causes of chylothorax are: chylous effusions (Quinke), altered pus (Guéneau de Mussy), and chyliform fluids distinct from serous, purulent, and serofibrous effusions (Débove).

Effusions into the thoracic cavities are divided according to Rotmann into chylous and chyliform as follows:

I. Chylous.—Rupture or Transudation of Chyle through Vessel Walls.

External violence	8
Carcinoma of pleura	5
Closure subclavian vein	4
Tumors compressing thoracic duct	3
Malignant lymphoma	3
Ectasia, sclerosis of lymph vessels	2
Stopping thoracic duct	1
Filaria (?)	1
Over-exertion	1
Total	26
Leakage through diaphragmatic lymph vessels from peritoneum	1

II. Chyliform.

A. Fatty cells.	
Carcinoma of pleura	5
Tuberculous pleuritis	3
Non-tuberculous pleuritis	3
Lung abscess (?)	1
B. Lipæmia (Débove)?	1
Total	13

The most recent cases of chylothorax are those of Simon (*Mitth. Grenzgeb. Med. und Chir.*, Bd. v., H. 2), in which a lymphangioma of the leg reached the thorax and burst into the pleura; Ceconi, Rassius, Hampbell, Corselli, Frisco, Bayer, and Henssen. Bayer has collected twenty cases of combined chylothorax and chylous ascites.

The peritoneal cavity, more frequently than any other serous sac, is the seat of those unusual exudates and transudates known as chylous, chyliform, lactiform, oily, or adipose ascites. The first authentic case is Poncy's (1699), but during the last two centuries the literature, carefully considered, gives 156 cases. Three have fallen under my personal observation.

Pathogenesis.—Letulle (*Revue de Méd.*, November, 1885, p. 960) holds that chylous and adipose effusions are always formed by peritonitis, independently of any opening or connection with the lacteal vessels. He espouses the view of Guéneau de Mussy, that products of serous or purulent inflammation are slowly transformed by leucocytes into a granulo-fatty emulsion. All cases, then, of chylous ascites are, according to Letulle, mere instances of chronic tuberculous, cancerous, and neomembranous peritonitis. On comparison of pus, chylous effusions, and ascites, he finds that chylous extravasations and pus are quite similar as regards the percentage of albumin, amount of salts, and total solids, and he concludes that chylous fluids are residual, occupying a position intermediate between ascites and pyo-peritoneum. The amount of fat is not sufficient to cause the opacity, which he refers rather to the regressive process. In one of Méher's cases there was only 0.48 gm. of fat per kilogram, yet the fluid was opaque. Laissaigne (*Journ. de chem. méd.*, 1825, t. i.; cit. Gendrin, "Histoire anat. des inflam.," t. ii., p. 548) and Robin ("Traité des humeurs") claim that fat is present in the fibrin of serous exudations, as in chronic pleuritis. Cullen ("Méd. pratique," edit. 1787, t. ii., p. 580) and Gendrin remarked the lactiform appearance of chronic inflammatory serositis. Broussais ("Hist. des phlegmasies ou inflam. chron.," t. iii., ch. iv., Paris, 1831) described a lactiform effusion with thickened peritoneum and De Laharpe (*Archives gén. de méd.*, 1842, t. xiv., p. 358) mentions the occurrence of a milky fluid whose opalescence was due to particles of fat. Méhu (Gjorgevic, Langenbeck's *Archiv*, 1870, p. 653) says that fat and often also cholesterin were found in ovarian cysts, hydrocele of the tunica vaginalis, old cysts, ascites, and very old hæmatoceles. Letulle thinks that this quotation solves the entire problem. Guéneau de Mussy also explains fatty pleurisy by fatty degeneration of endothelial cells (*Clin. méd.*, t. i., p. 658). Veil agrees with Letulle, and Sainton with Débove (Mém. Soc. Méd. des Hôp., 1881, p. 49) claims that ruptures in the chyle system found by others were made by post-mortem violence. The symptoms of chylous effusions are not those of suppurative pleuritis or peritonitis, and he therefore

excludes pyogenic processes from the etiology. These effusions are then a special variety of exudate of whose genesis and pathology we remain ignorant. Perée (*Thèse de Paris*, 1881, No. 382) and Secrétan deny the possibility of lacteal rupture. The French writers have in general hesitated to admit that effusions were chylous, yet Littré early in the eighteenth century published the fourth case on record. Depoix (*Thèse de Paris*, 1889) admits the possibility of rupture. Rokitansky and Oppolzer (1861) in Austria described cases, but until twenty years ago chylous and adipose ascites were regarded in Germany as mythical. Less scepticism has been felt in America and in England where the first case was recorded.

Débove contests that Quincke cannot prove his contention that rupture of the thoracic duct explained any of the cases he reported, insomuch as they were not demonstrable post mortem. To us Débove's objection does not appear wholly valid, since lesion in the duct could well have healed before death. Débove considers it unlikely that fluid passes from the pleura to the peritoneum or from the peritoneum to the pleura. He reports an instance of chyle-like effusion into the left pleural cavity, apparently similar to Klebs' case of ascites adiposus, due to fatty endothelial cells.

Definition of Terms.—Much confusion has arisen from inaccurate nomenclature. Chylous ascites properly designates an effusion of chyle. Adipose ascites includes fluids containing a large percentage of fat with no chylous admixture. Some authors use the term "adipose" and "chyliform" as interchangeable. Boulengier ("Contrib. a l'étude des epanch. chylif," *Presse méd. Belge*, Brux., 1890, No. 3, p. 33, and No. 4, p. 49) prefers the terms "chyliform" and "lactiform" to "chylous," on the ground that the fluid is rarely chyle. While this statement is too sweeping, yet the distinction is well made where the nature of the fluid is *sub judice*. Chyliform ascites is a chyle-like fluid in which lymph or chyle may be mixed with exudates or even transudates. It is often impossible to differentiate sharply, for two varieties may coexist or transition forms may intervene. Ascites and hydrothorax do not mean effusions of fluid into the peritoneal and thoracic cavities, but transudates into said sacs with normal vessels. Transudates are not symptoms, and the term transudates elucidates neither the etiology nor the pathology, hence the term hydrops chylosus is but imperfectly explanatory. The name hydrops adiposus, first employed by Quincke and Oppolzer, is more explicit and refers to fatty degeneration of the cells of an exudate, or implies at least that the lesion has no relation to the lymph vessels nor to their contents.

Etiology.—Excluding unruptured chyle cysts ("Chyle Cysts," excellent summary in Virchow's *Archiv*, Bd. cxxxiv., H. 1., S. 118, by Leydhecker, who also gives exhaustive review of entire pathology of thoracic duct; Weichselbaum [see table], Orth, Ziegler, Gussenrow, *Charité Annalen*, 1890, p. 163), there are one hundred and fifty-five cases of adipose and chylous ascites. They occur from birth to the sixty-seventh year. Winnewarter and Kamiénski report the only cases observed in sucklings. Sex, race, occupation, and social status apparently play no causal rôle. It is striking that a little over one-half of the cases have been observed in the last decade and about three-quarters since 1870.

A. Effusions into Peritoneum.

I. *Chylous.*—Solution of continuity of the vessel wall, from trauma, mural disease with transudation, etc.

Special causes:

Compression of thoracic duct or lymph system by glands, neoplasms, etc	21
Non-tuberculous peritonitis	10
Occlusion of left subclavian vein	7
Pressure, lifting, coughing, etc.	5
Peritoneal cancer	5
Filaria	4
Occlusion of thoracic duct (division thrombosis, etc.)	4
Occlusion of lymph glands	3
Occlusion of lymph vessels	3
External violence	3
Malignant lymphoma	2
Liver disease	5
Syphilis	2
Primary disease (angioma) of lymph vessels	6
Calculus in receptaculum	2
Aneurism of renal artery	1
Calcification with cirrhosis of mesentery	1
Enlarged spleen	2
Pulmonary disease (stasis)	3
Nephritis	1
Heart disease	4
Sarcoma	6
Tuberculous peritonitis	1

Rupture may occur in any part of the lymphatic system; in the thoracic duct (3 cases), receptaculum (3), lacteal vessels (6), lymph gland (4), and chylous cysts (3). Chyle may extravasate into a serous effusion by mural alteration in the lymphatic vessels or by violent contraction of the abdominal muscles of the diaphragm — indeed, by intestinal peristalsis. Busey (excellent article in *American Journal of the Medical Sciences*, vol. xc., p. 373) has written upon the relation of obstructed cardiac action to lymph stasis, while Niemeyer ("Handb. d. Path. u. Therap.," Bd. i., S. 120) and Hertz (Ziemssen's "Handb. des Path. u. Ther.," Bd. xv., S. 382) have also recognized its importance.

II. *Chyliform (Adipose).*—Admixture of fatty cases (endothelial and neoplastic).

Tuberculosis of peritoneum, gland, etc.	12
Carcinoma of glands, peritoneum, and lymph vessels, etc.	13
Liver cirrhosis	6
Heart disease	4
Sarcoma of omentum, mesentery, etc.	3
Non-tuberculous peritonitis	3
Primary fatty endothelial degeneration	1
Lipæmia	1

Busey insists that all abnormalities in the entire lymphatic system must be absent in adipose ascites: "Adipose or chyliform ascites is that variety of milky ascites in which the lymph and chyle vessels, lymph glands, lacteals, and mesentery are free from disease, distention, pressure, or obstruction, and normal in structure, size, and position. . . . We must exclude the effusion of lymph or chyle by transudation or escape by solution of continuity in any part of the lymphatic system. . . . The milky, fatty, chyle-like, opalescent fluid must necessarily be a morbid product." Senator's formula includes as possible sources, fatty degeneration of cellular and other formed elements in effusions, chiefly from endothelial cells, carcinomata, and rarely also from pus cells, fibrin, and inflammatory products. Personal experimental researches have shown that a serous ascites, produced by artificial right-heart disease, may become chyliform, which places the pure hypotheses of the French observers upon a somewhat firmer basis, and may elucidate the pathology of some of the cases reported. A chronic peritonitis may therefore result in an ascites chyliformis or adiposus. In ten cases of chyliform ascites collected from the literature, the fluid at first serous became opaque later. It is too much to say that pus infection was the cause in all instances. (In the above tabulation, it is very often most difficult to distinguish between the two types chylous and adipose.)

Nature of the Fluid.—Straus' case is the clearest example of chylous ascites—chemically typical chyle extravasated through two fistulæ. Ingested butter was recognized in the fluid withdrawn by paracentesis from the abdominal cavity, although Minkowsky (*Archiv f. exper. Pathol. u. Phär.*, 1886, Bd. xxi., p. 381–384) has concluded that fatty acids may reach the peritoneum without lymph-vessel rupture. Senator's latest case gave similar results with the administration of olive oil.

Chylous Ascites.—Diabetes must be excluded. Chylous ascites contains sugar—which fact is a diagnostic datum when diabetes is excluded. Senator, who thinks sugar one of the most constant criteria for the recognition of chyle, admits, however, that its absence is not equally significant. Sugar when primarily present may disappear later (Whitla's case). Its presence is as rare as it is suggestive, having been detected not more than two dozen times. Of late, many writers are inclined to discount the presence of sugar as a diagnostic test. Bock (*Archiv für Anatomie u. Physiologie*, 1873, p. 620) found

sugar (.04 to .07 per cent.) in all cases of hydrops, and Eichhorst (*Zeitschr. f. klin. Med.*, Bd. iii., p. 537) found sugar in ten out of seventeen cases of pleural exudate. Still the copper test alone is not reliable, since boiling of Lion's casein-like substance reduced Fehling's solution.

When sugar amounts to more than .02 per cent. the effusion is chylous. Leydhecker maintains that sugar appears in the transudate only when the lymph vessels of the liver participate in the effusion. As Rotmann suggests, Leydhecker's proposition implies that the lesion of a chylous ascites must be either above the ending of the hepatic vein or that the hepatic lymphatics be assigned as a cause for the appearance of sugar in the ascitic fluid. Rotmann finds that cases in which sugar is found correspond to Leydhecker's hypothesis. Eisenschlitz concludes that the presence of sugar does not make a milky effusion a chylous transudate, since in a case of Moscatelli 0.15 per cent. of sugar was detected in an ascites from liver cirrhosis. A small amount of fat speaks for chyle. Landois estimates the percentage of fat in chyle at nine-tenths of one per cent. Chylous ascites also is rich in solids, especially mineral salts and albumen. Albumen and fat occur conjointly in small punctiform granules susceptible of differentiation by chemical tests. Microscopic examination may differentiate between chylous and adipose fluids by the size of the fat globules or fat and albumen granules.

Adipose or Chyliform Ascites.—Adipose ascites is characterized by the absence of sugar and the higher percentage of fat. The degree of opacity is no index to the amount of fat, since the turbidity may be due to the presence of emulsionized albumin. Fat occurs in most cases; its maximum percentage is 5.25 (Schmidt) and in our case 6.4 per cent., but it may be diluted by venous stasis or inflammation, while concentration of the fluid raises the percentage of fat (Minkowski). Contrary to the older conceptions, milky fluid need not contain fat, as shown by Lion's case in which a proteid, like casein, produced the opacity, as well as in the cases of Quincke, Verdelli, Achard, Sainton, Apert, Ceconi, and Basch. Fat is recognized by the osmic acid, the alkanna stain, and solubility tests. The granules of albumen and fat are much coarser in adipose than in chylous ascites. Hydropic and fatty carcinoma cells may, if numerous, cause a creamy layer, and their microscopic detection favors a diagnosis of hydrops adiposus.

Inflammatory products may obscure the pathogenesis, and hence conclusions cannot be dogmatized from every analysis. Again, the fluid changes with time, the blood absorbing parts of the original fluid—in cachexia, for example. Lymph or chyle may escape into a serous exudate or transudate of earlier origin.

The fluid, of whatever kind, usually clears with ether and caustic potash. It is said to resist decomposition on account of the emulsion of fat and a supernatant fatty layer; to which proposition one of our own cases is an exception. The reaction is usually neutral or alkaline, although it was once recorded as acid. The fluid is opalescent from suspended molecular fat and emulsionized albumen. Some fluids coagulate spontaneously, others do not. Poncy noted the odor of ingested food, while Nickerson pronounced the taste in his case cadaveric. A specimen standing ten days (Quincke, "Ueber Ascites," *Deut. Arch. für klin. Med.*, 1882, pp. 569–587) became acid, due to the formation of fatty acids. Specific gravity varies from 1.007 to 1.026, the average being 1.016. Reaction and specific gravity do not differentiate between the various forms. Macroscopically, nothing is seen except oil globules. Microscopically, fine point-like granules of fat are visible, which often have molecular movement and are soluble in ether. Large fatty cells, lymphoid, endothelial, carcinoma, and sarcoma cells are observable. Red blood discs occur, as do also fibrin (seven times), filaria (Winkel), casein (Straus and Omerod), mucin, sodium alkali albuminate (Oppolzer), bile (Omerod), acetone, hydropsin, peptone (eight times), lecithin (twice), cholesterin (three times), fibrinogen (twice), a diastatic ferment (twice), various inorganic compounds of calcium, sodium, sulphur, phosphorus, potassium, and chlorine. Urea has been recorded three times (Quincke, Remond, Foot). Tubercle bacilli have never been found. The highest percentage of albumen is 6.08 (Ballmann).

Symptomatology and Diagnosis.—The symptoms possible with such a varied etiology are not limited in number or character. The primary disease does not indicate the character of the ascites, for ascites adiposus chylosus is no morbid entity. In conjunction with chyloperitoneum, chylous fluid may be vomited (Sprague, Pellitier, Foot, Nickerson) or discharged per anum (Pellitier, Nickerson). The association of ascites with chylothorax is suggestive, even before abdominal paracentesis. The only conceivable etiological hints relate to diseased lymphatic glands and vessels, affections of the thoracic duct or left subclavian vein (*i.e.*, compression), or chyluria. "The chylous nature of an ascites may be suspected when associated with sudden anorexia, acute anæmia, and emaciation" (?). Rapid recurrence may indicate chyle fistulæ. Temperature is neither frequent nor significant. If transudation through lymph-vessel walls be the cause, the clinical course is less stormy in onset and less rapidly progressive than is observed with antecedent rupture. A diagnosis has never been made prior to puncture, except in the single instance of Morton's early case. The blood varies, of course, with the fundamental disease. Lipæmia was observed once (Popham). The local signs and symptoms do not differ from those of serous ascites. It is probable that many cases diagnosed as the vulgar ascites, healing without treatment, are instances of chylous hydrops, and the increasing frequency of the disease is best explained thereby. It is not easy to differentiate between chylous and adipose effusions as Quincke would have it, and even at necropsy an exact diagnosis is often impossible. Indeed, Senator and Leydhecker have recently spoken of mixed types. In many cases of our classification, even where full details are given, it is often difficult to decide whether the effusion be chylous or chyliform (adipose).

Prognosis.—Reference to the collected cases shows that 81 per cent. died, 8 per cent. were not followed, 11 per cent. recovered. Considering only those in which the ultimate issue is known, 88 per cent. died and 12 per cent. recovered. Bianchi says that the prognosis is better in any rupture than in cases of chylous transudation. Rupture is more likely to heal when it is due to trauma than when caused by mural disease, since thrombosis occurs more readily in trauma. Wiescher ("Zur Casuistik der Verletzung des Duct. Thoracicus," *Deut. Zeits. für klin. Chir.*, Bd. xxxviii., H. 4, 5; also contains account of experimental work upon thoracic duct), reviewing sixteen cases of chylothorax from rupture of the thoracic duct, concludes that rupture is almost invariably fatal. Rupture of the lymph vessels or receptaculum chyli may be compatible with life by the formation of thrombi and establishment of a collateral circulation (experiments of Monro, Lower, Cooper, Dupuytren, Schmidt-Muhlheim, Leichmann, Leuret, Lassaigne, Colin, Flandrin, Magendie, Noeckher, Rogerd, also citation of Wiescher above). Monro stabbed the receptaculum of a pig, but effusion was prevented by thrombosis. If there be no communication left between the blood-vascular and lymph-vascular systems, progressive inanition and death are inevitable. A chylous fistula increases the gravity of the prognosis, as copious and continuous chylous discharge is invariably fatal. I believe the immediate prognosis is better in adipose ascites. Extensive obstruction to the lymph stream is always serious. The prognosis is impressed by concomitant or causative visceral lesions. A close analysis of reported recoveries to determine favorable prognostic characters demonstrates that 3 cases were puerperal and therefore fabulous; 1 was chlorosis; 1 was compression of the thoracic duct by enlarged glands; 1 was filarious disease; 33 were ruptured lymph vessels; 5 were ruptured chyle cysts; 1 was tuberculous peritonitis; 1 was chronic recurrent peritonitis (possibly tuberculous). Only the last 2 cases were adipose, while the first 9 were chylous hydrops. Therefore the ultimate prognosis is better in chylous effusions, the converse being true of adipose accumulations. Chylous ascites is to adipose ascites as $2\frac{1}{4}$ is to 1, while recoveries stand as 5 to 1. Laparotomy improves the prognosis.

Treatment.—Analysis vindicates surgical interference under two restrictions: first, laparotomy is indicated as prophylaxis against possible chylous rupture with consequent constitutional depletion; second, laparotomy for tuberculous peritonitis. Paracentesis should be avoided as far as possible, save, first, as a preliminary diagnostic resort, and, second, as an ultimate resort against compression of the thoracic viscera. Otherwise puncture depletes the organism, especially in the genuine chylous form. The peritoneum should be allowed to resorb all it can of the chylous transudate. A diet readily digestible and absorbable by the stomach is advised (P. J. Murphy), to permit healing by thrombosis of ruptured lymph vessels. The use of water should be restricted. For filariosis, Lancereaux recommends mercurial inunctions and local injections into the diseased lymph glands; Guiteras remarks there is no hope short of the death of the adult worm. Other than mercurial parasiticides are probably useless. The therapy in other directions is absolutely symptomatic. *Arthur R. Edwards.*

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3 Ephemerides Germaniæ, decur. ii., ann. viii.
4 Manson, Lewis, Sonsino, Mastin, Sr. and Jr., Guiteras.
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CHYLURIA; GALACTURIA.—Definition and Etiology.—Chyluria signifies the presence of chyle, and consequently of fat in a state of emulsion, and albumin in the urine. Sugar, a constant ingredient of chyle, is so rarely found in chyluric urine that its presence would warrant the suspicion of coincident diabetes mellitus.

There are two varieties of chyluria, the parasitic and the non-parasitic, the former being by far the more common. It has been customary to speak of these two forms as "tropical" and "non-tropical," but since the demonstration of parasitic chyluria in temperate zones this division is no longer appropriate. It is nevertheless true that in the vast majority of cases of parasitic chyluria the patients have become infected in tropical or subtropical countries. Data regarding the etiological influence of age, sex, and occupation are either scanty or absent entirely. According to Senator, chyluria has not been observed in childhood or in the aged. There is, however, no reason, in the nature of things, why it should not occur at any period of life, for its cause is mechanical obstruction of the thoracic duct and this may be seated within the calibre of that tube, in its walls, or outside of it.

Much the most common cause of chyluria is obstruction of the thoracic duct either by adult or embryonic forms of the *Filaria sanguinis hominis nocturna*. In the great majority of cases of chyluria, embryonic filariæ may be readily detected in a drop of blood from any part of the surface of the body, provided the blood be obtained at night. During the day, the embryos of filaria nocturna are very scantily present in the surface capillaries or are absent from them altogether. Manson, observing the embryonic characters of the circulating filariæ and their presence in the surface capillaries chiefly or solely during the night, came to the conclusion that they must reach a further stage of development outside of the body in the interior of some nocturnal blood-sucking animal. He exposed a patient with "*filariasis*" to the bites of mosquitoes, and found the embryos in the bodies of these insects, in which, in the course of from five to seven days, they attained a length of one-fifteenth of an inch. In the blood of man they measure from one-seventieth to one-eightieth of an inch, and are enclosed in a sheath from which they make their escape in the viscid blood of the mosquito. The mosquitoes with the embryonic filariæ in their interior seek water in which to deposit their eggs. This function accomplished, they perish; the embryonic filariæ are liberated, and through the medium of the water in which they exist, gain access to the human system. Manson's latest researches have practically demonstrated that the filaria may be transmitted directly from the infected to the non-infected by the agency of the mosquito (Culex ciliaris or pipiens) in the same manner as the Hæmatozoon malariæ is transmitted by another species of the same insect—Anopheles claviger (*Bulletin de l'Académie de Médecine*, 22 Mai, 1900). Two or more of the ingested parasites attain maturity in the lymphatic system and continue for an indefinite period (sometimes for many years) to produce swarms of embryos. The presence of filaria embryos in the blood does not necessarily give rise to disease, their transverse diameter ($\frac{1}{315}$ inch) being, as a rule, such as to enable them to traverse the narrowest channels of the blood and lymph. Occasionally, however, they occlude these vessels, and this is believed by Manson to be due to the fact that the embryos are prematurely born enclosed in a sac or sheath of globular form, the transverse diameter of which is about $\frac{1}{75}$ inch. Disease in man occasioned by the filaria is therefore the result of disease in the filaria itself. If the adult female filaria produces the young in a physiological manner they are innocuous to their host; if, through disease or irritation, she brings them forth prematurely, they obstruct the lymph channels and cause one or more of the diseases grouped under the title of "*filariasis.*"

The principal diseases to which the filaria gives rise are abscesses, lymphangitis, dermatitis and cellulitis, erysipelas, orchitis, chyluria, chylous dropsy of the peritoneum, chylous dropsy of the tunica vaginalis, varicose groin glands, lymph scrotum, and elephantiasis. Chyluria is not common even in those countries in which filariasis prevails.

As above stated, obstruction of the thoracic duct from any cause may give rise to chyluria. As stated by Manson, the "cause of chyluria is obstruction of the thoracic duct, and this may be brought about in any climate by pressure on the duct, by tumors, by infarcts, by growths, etc.; but in the form of chyluria endemic in the tropics . . . the cause of the obstruction is the parent filaria nocturna."

A case is reported by Mr. Leigh Hunt in which transient chyluria was produced by traumatism, a fall upon a pile of stones (*British Med. Journ.*, February 22d, 1890).

Symptoms and Signs.—The onset of chyiuria may be preceded by no symptoms whatever. In some cases, however, there is a sense of discomfort or pain in the lumbar region or the groins, the perineum or testes, before the chylous urine appears. The first symptom may be retention of urine due to the intravesical formation of coagula which occlude the neck of the bladder or the urethra.

In the great majority of cases chyluria is intermittent, being dependent, for example, upon posture, digestion, bodily exertion, etc. In one of my cases it first appeared during the expulsive pains of labor, gradually ceased after parturition, and did not return until about two years later at the birth of another child. The influence of posture is shown by the fact that in some cases the nocturnal urine is chylous while that of the day has a normal appearance. The general health is, as a rule, well maintained, although if the discharge of chyle is long continued, emaciation, anæmia, and great debility set in and the patient dies from exhaustion.

The appearance of chylous urine is highly characteristic. On careless inspection it might readily be mistaken for milk, but when examined more closely it will usually be found to contain coagula of a delicate pinkish tinge or more deeply colored like ordinary blood clots. The gross appearances, in a case of my own, are thus described: "The urine, after standing for several hours in a narrow cylindrical vessel, separates into two portions, of which the lower is distinctly hemorrhagic; while the upper has the appearance of milk or cream. Floating on the upper chylous layer are numerous coagula of a delicate, pinkish hue, and almost translucent, while at the bottom are a