

from twenty to thirty for females. There are two types of subjects addicted to the disease, the obese and the thin, and they represent two kinds of causes. The obese are addicted to the pleasures of the table, suffer from a certain kind of indigestion, and are given to sedentary habits. In the thin and nervous subject the disease comes on after some excitement, chagrin, business failure, or other cause of cerebral disturbance. Among the exciting causes must be placed mechanical shock, concussion of the whole body, or of the brain and spinal cord, blows upon the hepatic and renal regions, etc. Mental shocks, profound moral impressions, especially anxiety and chagrin, are, in the author's experience, very common causes in the class of subjects mentioned above; but, in the obese class, errors of diet, the consumption of a large proportion of farinaceous food and of malt-liquors are chiefly responsible. The occurrence of acid indigestion and the probable formation of lactic acid in the intestinal canal (the duodenum) are elements to be considered in this connection. To these exciting causes must be added exposure to cold and wet while the body is heated, sexual excesses, extreme fatigue, etc.

Pathological Anatomy.—There are two groups of morbid alterations: those which stand in an apparently causative relation to the disease; those induced by it. In the intestinal canal the changes consist in a proliferation of the epithelial layer of the mucosa throughout the whole tract, in hyperæmia and thickening of the mucous membrane, and also sometimes of the muscular layer. The muscular tissue of the heart is relaxed and fatty, and the vessels, especially the median and small-sized vessels, are atheromatous, the atheroma being more decided in the cerebral vessels at the base than elsewhere in the body. The blood is altered by a great increase in the amount of fat in the serum, which may even have a milky appearance from this cause. Atrophy, cystic degeneration, and, according to some, hypertrophy of the pancreas, have been observed, but atrophy occurs in one half of the cases—a fact of great pathological importance. More significant changes occur in the liver, but these are by no means constant, for the liver has sometimes appeared to be quite normal. In twenty-seven cases examined by Dickinson the liver was healthy in six. In Seegen's cases at the Vienna Hospital, thirty in number, fifteen presented obvious changes in the liver. In some cases which have been reported, the liver was enormously enlarged. The most constant changes consist in an active hyperæmia, generally diffused, the acini appearing as well-defined rose-colored spots surrounded by distended capillaries; in enlargement of the hepatic cells with rounding of their contour, and occasionally in hypertrophic enlargement of the connective tissue of the organ. The kidneys are in an obvious pathological condition in more than one half of the cases—usually enlarged and decidedly hyperæmic, without being otherwise altered. More or less fatty change

ensues in some instances, the infiltration of fat occurring in the cortical portion chiefly, giving to it a pale-yellowish appearance, and increasing its thickness. This fatty infiltration is no doubt due to the persistent hyperæmia. Various morbid changes have been discovered in the brain and spinal cord, but they are by no means uniform in position or character. Hyperæmia, dilatation of the perivascular lymph-spaces, remains of old extravasations, pigmentations, fatty degeneration of cells, tumors, etc., have been found in various parts of the brain, cord, medulla, pons, etc. Important lesions, also, have been made out in the semi-lunar ganglion, solar plexus, and splanchnic nerves; they have been seen much enlarged, thickened, and of almost cartilaginous hardness. These changes appear to be the cause of the extraordinary wasting of the pancreas which so often takes place. The lungs are frequently far advanced in phthisis. In only two of twenty-seven diabetics under the observation of Dr. Dickinson were the lungs free from the various alterations of phthisis at some stage of its development. The body at death is extremely emaciated. Remains of ulcers, abscesses, and gangrene sloughs are to be seen in the skin of various parts. The muscular tissue is dry, anæmic, relaxed, and its color pale, but it is sometimes of a reddish-brown.

Symptoms.—There are two distinct types of subjects who are affected by diabetes: the obese and phlegmatic; the thin and nervous. The onset and the behavior of these two varieties are very different. A recognition of the peculiarities of each is necessary to a proper comprehension of the malady. In the obese subjects the onset of the disease is gradual; they experience, for a long time previous to the beginning of the malady, disorders of digestion; they suffer from acidity, pyrosis, and a sense of epigastric weight and uneasiness. Notwithstanding the obvious derangement of the digestion, they have a keen, almost an insatiable appetite, and a strong thirst, and they constantly increase in weight up to a certain point. They pass, at this period, an excessive amount of water, and the urine occasionally contains sugar, but not constantly by any means. They are troubled with boils or carbuncles, and often have hard, inflammatory swellings, which slowly suppurate, and discharge with a considerable slough, leaving an indolent ulcer behind which shows but little tendency to heal. In the thin, nervous type, the opposite conditions obtain. These subjects are nervous, suffer from attacks of neuralgia, and are rather hypochondriacal. With them, digestion is never active; they are rather constipated, and the functions of the gastro-intestinal canal are as a rule performed with a certain feebleness, without there being any pronounced derangement. The disease usually comes on abruptly. There may have been headache, neuralgia, or mental despondency, but these symptoms have no necessary connection with diabetes. After some business troubles, anxiety, grief, or other moral cause, it is ob-

served that there is an unusual urinary discharge, that the strength is exhausted by the least effort, and that a sense of fatigue is constant. When the disease has really begun, there are present constant thirst, dryness of the mouth and tongue, an unusual appetite, and frequent discharge of urine, in large amount at a time. In other cases the vision is impaired, and the diagnosis is made by the oculist, to whom the patient has repaired for advice about his eyes. The thirst is excessive, and the amount of water and of other fluids drunk is enormous; the appetite becomes voracious, insatiable, and the individual, who previously had been rather indifferent to food, now gloats over the viands placed before him, and thinks only of satisfying his appetite. A frequent desire to micturate comes on with the thirst, the patient is disturbed repeatedly at night, and in the morning the vessel contains a much larger quantity than usual. The aggregate amount passed in twenty-four hours may reach 80 to 100 ounces or more; it is acid in reaction, and has a specific gravity of 1020 to 1040, even 1050. The bowels are confined, the fæces hard, and voided with difficulty. The saliva is acid. The tongue is pasty, deeply fissured, sometimes blackish, dry, and hard. The gums may be soft and spongy, the teeth loose and apparently elongated, because of the retraction of the gums. The breath has a peculiar mawkish, disagreeable odor, likened to that of new hay or of new apples. The skin becomes dry and rough and is attacked by herpes or eczema, and, when emaciation proceeds to a considerable extent, is wrinkled and inelastic. The eyelids may be swollen. In one of the author's cases, ptosis appeared with the first symptoms. Headache, vertigo, double vision, neuralgia, wakefulness, deep dejection of mind, abnormal sensations in the skin, formication, are nervous symptoms, especially apt to occur in the thin, nervous type of subjects. The sexual appetite early declines, and is soon wholly absent, the erections ceasing permanently. Itching at the orifice of the urethra is an early symptom in both sexes, but especially in women. The itching may extend from the meatus to the vulva generally, and produce intolerable torment. Whenever this symptom occurs in obese women, the urine should always be examined. The prepuce and the vulva, also, are excoriated by the passage of the saccharine urine so frequently. Such are the symptoms of the disease in its process of development. It is necessary now to indicate with somewhat more detail the chief features of the malady at its maximum.

The remarkable increase in the urinary discharge is the most striking phenomenon. We have already mentioned eighty and one hundred ounces as a not unusual quantity, but these figures have been largely exceeded in some cases, e. g., Bence Jones, who reports a case passing seven gallons. On the other hand, the urine may not be increased above the normal, or may fall below it. Toward the end

there may be a notable decline in the quantity of urine, and this fatal symptom may be entirely misconceived. The amount of urine discharged stands in a nearly constant ratio to the amount of water drunk. The apparent exceptions to this are cases of patients unable to swallow much fluid, the surplus over that taken into the body being formed by the oxidation of the hydrogen, or supplied from the water stored up in the tissues. The urine of diabetes is clear, of a faint greenish tinge, and is free from sediment. If it stand for some time in a warm place, it is covered with the *Torula cerevisiæ*, or yeast-fungus. The urine is acid in reaction. The specific gravity, as already stated, ranges from 1020 to 1050, but it may contain sugar, and yet fall below normal. The variety of sugar present in the urine is *grape-sugar* and not *cane-sugar*, the variety in domestic use. The former differs from the latter in the readiness with which it ferments, in turning the plane of polarized light to the right, and in its source, the grape-sugar of commerce being obtained from starch by the action of sulphuric acid. Grape-sugar is also less sweet than cane-sugar, and is harder in texture. The actual amount of grape-sugar present in urine ranges from a mere trace to ten, even fourteen per cent. Dickinson reports an extraordinary case of a man who excreted in twenty-four hours fifty ounces of sugar. The quantity of sugar stands in a certain ratio to the amount of urine—the larger the flow of urine the greater the quantity of sugar voided; and to the character of the food, for the more sugar and starch in the food the more sugar in the urine. The high specific gravity of the urine is not wholly due to the presence of sugar, but is also influenced by the quantity of urea, which may rise to a proportion two or three times greater than the normal. This increase of urea is due to the largely increased consumption of nitrogenous diet, and to the greater metamorphosis of the nitrogenous tissues. As the formation of urea is one of the hepatic functions, the increased production of this substance may be due to the heightened functional activity of the liver. Albumen is present in a proportion of cases not definitely settled. It may be due to the increased blood-pressure. Irritation of a spot on the floor of the fourth ventricle causes albumen to appear in the urine, as irritation of another spot below causes an excretion of sugar. *Inosite*, or muscle-sugar, has taken the place of grape-sugar in some rare cases. *Acetone* has also appeared in the urine in a few cases. Various affections of the special senses occur during the course of diabetes. Ptosis has been mentioned. Amblyopia, paralysis of accommodation, and amaurosis, also occur. The most striking phenomenon connected with vision is the occurrence of cataract, which is encountered in the proportion of one in twelve to one in forty-five cases. The cataract is of the soft variety, and both eyes are usually attacked, that in the right eye developing more rapidly. The formation of cataract is simply a failure of the nutrition of the lens in consequence of the state

of the blood. Owing to the same cause, boils and carbuncles appear among the prodromic symptoms and also at the maximum of the disease. Carbuncles may indeed be the cause of death. Gangrene of the skin, and gangrene of a toe, foot, or leg, may also occur. The great loss of material continually going on must necessarily cause wasting, emaciation, and a sense of fatigue. A rapid accumulation of flesh—of adipose—takes place in the obese subjects of diabetes when the disease begins, for then the retrograde changes through the channels of excretion are not so active as the source of supply. But presently the waste exceeds the supply, and then a rapid loss of weight is observed. Patients going through this process present a very characteristic appearance: they have an old look, and may be much wrinkled; the skin is rough, cracking at the ends of the fingers, and the countenance wears an anxious expression. The lips are pallid, the mouth dry, the tongue dry and hard, and constant smacking of the lips and sucking of the tongue, in the vain effort to moisten the parts, are characteristic of diabetics. As the nutritive functions are so depressed, it is not surprising that the temperature of the body should remain below the normal. It has been found as low as 93.2° by Dickinson. Foster* has pointed out the very curious fact that the temperature of the fluids drunk exercises an influence on the temperature of the diabetic patient. His figures show that, when all fluids drunk were warm, the temperature of the axilla was one degree higher than when the fluids were cold.

Course, Duration, and Termination.—In the obese type the prodromes may continue over several months, even years. There may be occasional glycosuria, of variable duration, occur several times, before the persistent presence of sugar constitutes the case one of diabetes. On the other hand, in the nervous type, the preliminary symptoms are of brief duration. So long as the appetite and digestion are equal to the supply of all the material excreted, the patient holds his own. When, however, the loss is in excess, the decline is rapid. The cases vary greatly in the rate of progress. Those diabetics, in whom the proper regulation of the diet causes a disappearance of all the symptoms, apparently recover, and the duration may therefore be much prolonged, but they ultimately succumb, because they at length reach a period when they can no longer prevent the formation of sugar. Those cases proceed rapidly in whom the changes of diet make but little difference in the formation and excretion of sugar. The average duration is about two to three years. Under proper management favorable cases, not curable, may continue for many years, the patient meanwhile enjoying good health. Age has much to do with the rate of decline. The disease makes very rapid progress in children. The

* "Clinical Medicine," by B. Foster, M. D., Philadelphia edition, p. 264.

most acute cases terminate in a few weeks. The prognosis is most unfavorable as regards cure, and gloomy in respect to retardation. The reports of recovery are discredited by those of greatest experience. While cures may not be hoped for, in a considerable proportion of cases decided amelioration may be accomplished and a retardation of great length effected in a small number. Much depends on the influence of the changed diet over the excretion of sugar; for, if, on a nitrogenous diet, the sugar disappears from the urine, the case wears a decidedly more hopeful aspect than if the formation of sugar continues despite the change. In the further progress of the case, the condition of the patient will depend largely on the behavior of the digestive organs as confined to an animal diet. If he can not persist in this diet, and his digestive organs are upset by the nitrogenous food, a prompt development of the worst symptoms will ensue. The mode of dying is various. Death by exhaustion is not common. In some cases, apparently doing well, the most serious symptoms, known as *diabetic coma*, suddenly appear. Great restlessness, precordial uneasiness, and pain are quickly manifest; somnolence, with general agitation, loud cries and groans, and then a deepening coma, come on, during which the pulse grows weaker, the respirations more and more shallow, the temperature lower and lower, and soon the patient expires in a condition of profound insensibility. These symptoms of such formidable character, and arising suddenly, wear an aspect of poisoning, very like that caused by acetone in animals. As this substance may be produced in the blood by the decomposition of the diacetate of ethyl—a product of the reactions of grape-sugar—it is assumed that diabetic coma is an *acetonæmia*. The most frequent cause of death is phthisis. This may develop very slowly and escape detection until far advanced, or it may proceed very rapidly and with pronounced symptoms from the beginning. Gangrene of the lung rarely occurs, and it presents the remarkable peculiarity that the sputa are without odor.

Diagnosis.—Diabetes exists only when sugar is permanently present in the urine. In *diabetes insipidus* there is a large flow of water, but no sugar; in glycosuria of the temporary kind sugar is only occasionally present. It is not the quantity, but the persistence of the sugar, which constitutes diabetes. As Senator well expresses it, "a saccharinity of over *two per cent.* certainly occurs in diabetes, but a lower saccharinity does not exclude diabetes." The urine of diabetes has certain physical peculiarities by which it may be recognized, but not with the certainty of chemical reactions. It is free from sediment, has the appearance of water of a very pale-greenish tint; has an acid reaction, and a specific gravity of 1025 to 1050 or higher. The importance of a high specific gravity depends on the fact that the quantity of urine is also large. The presence of sugar is the important

point, and this must be determined by the applications of chemical tests:

Trommer's test is the most generally applicable. A few drops of a dilute solution of sulphate of copper are added to some urine in a test-tube, or sufficient to give to the urine a blue color, faint but yet distinct. Then the same quantity of *liquor potassæ* as there is urine is added. If sugar be present, the precipitate at first formed is redissolved, and the mixture assumes a deep-blue color. If, now, heat be applied, a yellow or orange-red precipitate of oxide of copper is thrown down. If the heat be applied to the upper part of the liquid, the vivid yellow color of the oxide of copper appears bright and distinct by comparison.

Fehling's test solution must be kept prepared, and, as it rapidly spoils by keeping, frequent renewal of the solution is necessary. This test consists of a sulphate-of-copper solution, mixed with a solution of tartrate of soda and potassa (Rochelle salt) and caustic soda. Some of this test is added to the urine in a test-tube and boiled, the reaction being the same as in Trommer's.

Fermentation Test.—Some brewer's yeast is added to the urine in a bottle and kept at a proper temperature (60° to 80° Fahr.). The bottle must be well corked and have a bent tube connected with it, so that the carbonic acid can be collected for examination.

Moore's test consists in simply boiling together equal parts of urine and *liquor potassæ*. The sugar is decomposed, and one of its products is melassic acid, which may be recognized by its odor, and which, with glucic acid, another product, converts the mixture into a brown, almost a black color. The change of color is rendered all the more evident by confining the heat to the upper portion of the mixture.

Treatment.—The most important points in the management of this disease are diet and exercise. Medicines are secondary. As the presence of sugar in the blood is the great cause of mischief, our efforts must be directed to prevent its formation. This can be accomplished only by systematic disuse of all articles of food convertible into sugar. Bread, potatoes, beans, peas, rice, carrots, turnips, parsnips, etc., and all articles containing flour, sugar, or starch, must be excluded. Greens, cabbage free of the stock and stems, lettuce, tomatoes, and spinach, may be substituted. A bread made of powdered almonds and gluten bread may also be substituted for ordinary bread. Milk may be allowed, especially buttermilk. Donkin reports cures made by confining the patient to an exclusive diet of skimmed milk—six to eight pints daily. Brunton objects to the skimmed milk because some die of inanition, although he says others do recover. All kinds of flesh, fresh or salt, fish, including oysters, eggs, gelatine, fats, almonds and nuts, except chestnuts, are allowed *ad libitum*, unless the too great consumption

of animal food induce the excessive excretion of urea and uric acid. Koumiss may be taken—also light acid wines and a little spirit with meals. Water may be taken to satisfy thirst, but a large quantity of fluid at meals must prove detrimental to digestion and should not be indulged in. Walking exercise is of the highest moment. There is a strong sense of fatigue proper to the disease, and the muscles are actually unequal to much effort. Surprising results may be accomplished by active walking exercise, especially in the case of the obese diabetic. The strength is improved, and the formation and excretion of sugar are diminished. The functions of the skin should be maintained by warm clothing. It is probable that pilocarpine will prove beneficial by increasing the secretion of the sweat and saliva. Of the medicinal remedies but few have proved beneficial. Opium, and especially the alkaloid codeine,* exercises a great influence over the excretion of sugar, but unfortunately the effect is not maintained. Large doses are well borne and are required. Next to opium is arsenic, which, especially in the form of the bromide of arsenic, has proved highly useful. The alkalies are also useful, especially the phosphate of sodium, which the author has found in some cases, those of full habit especially, to exercise an apparently curative effect. The weak alkaline waters of Wisconsin (Bethesda), drunk in large quantities, seem to have a very beneficial influence. The Carlsbad water of Germany and Vichy of France have had a reputation for generations in the treatment of diabetes. Saratoga Vichy, and our native lithia waters, may be substituted for the foreign waters. The bromides have proved useful in some cases, and the best results have been obtained from the use of bromide of ammonium. The carbolate of iodine (carbolic acid ʒj, tincture of iodine ʒij, given in the dose of one or two drops well diluted three times a day) has seemed to have excellent effects in some cases, and therefore deserves more extended trial. Lactic acid has proved very useful in many cases, and in the author's hands, in the form of lactophosphate of lime, has seemed to benefit the thin, nervous type of diabetics remarkably. In this class of cases the lactophosphate of lime and cod-liver oil have been even more advantageous. Lactic acid often produces rheumatism, which is an objection to its use, and may require its suspension. Foster holds that the good effects of the skimmed-milk, whey, and buttermilk cures are due to the formation of lactic acid from the lacticin. Other drugs employed on theoretical considerations are ethereal solution of peroxide of hydrogen and valerian. Any good effects derived from the former are attributed by Foster to the ether. Valerian slightly influences the excretion of sugar, but has a remarkable effect on the urea, the excretion of which lessens considerably under its use. To these drugs must yet be added the

* Pavy especially eulogizes the good effects of codeine.

fluid extract of ergot. This drug has not been of any real utility in diabetes, but has apparently cured cases of diabetes insipidus.

DIABETES INSIPIDUS.

Definition.—*Diabetes insipidus* is a disease having for its chief clinical feature the passage of a very large, often an enormous, quantity of pale, watery urine, free from albumen and from sugar. It is also known as *polyuria*, *polydipsia*, etc.

Causes.—Occasional examples of hereditary transmission have been reported. The disease occurs at all ages, but is most frequent from twenty to forty-five. Men are more subject to the disease than women. Among the exciting causes are injuries and diseases of the brain, including concussion, tumors, exostosis, psychical impressions, etc.; exposure to draughts of cold air, the body perspiring freely; drinking freely of cold drinks; sudden variations of temperature; fatigue, convalescence from fevers, etc. According to the author's experience, the most usual cause of the disease is syphiloma of the brain.

Pathological Anatomy.—But infrequent opportunities have occurred for a study of the changes proper to this disease. Two classes of lesions have, however, been ascertained: of the brain and sympathetic ganglia; of the kidneys. In the brain, changes have been found in the fourth ventricle—inflammatory and degenerative—tumors in this region and in the cerebellum, tubercles, syphilitic tumors, etc. Degeneration of the solar plexus has been observed by Dickinson. The changes observed in the kidneys are various—sometimes the organs are enlarged and hyperæmic; sometimes the only change is dilatation of the tubules. Other lesions, which must be regarded as accidental, have been noted, as cancer of the liver, tumor of the uterus, and disease of the mesenteric glands.

Symptoms.—It is rare for the disease to begin in perfect health without any warning. The rule is, that the nervous disturbances associated with the various lesions of the brain occur. In the author's observation there were the usual symptoms of cerebral syphilis preceding the outbreak of polyuria. The large flow of urine is the growth of several weeks. When the maximum is attained the flow is prodigious, but it is by no means the same in all cases, for it varies from one to five gallons daily. The single discharges are large, because the urine is not stimulating, and can, therefore, be longer tolerated by the bladder. The specific gravity of the urine is as low as 1002, and does not go above 1007. The urine is pale, usually clear, faintly acid in reaction, and readily decomposes. The solid constituents are somewhat increased. The excretion of urea is slightly greater than that of a healthy individual consuming the same amount of animal food, and is simply

due to the increased waste of the nitrogenous elements produced by the passage of so much water through the tissues. Uric acid is diminished, as might be expected, because of the increased formation of urea. The sulphates, phosphates, and chlorides, are also increased. There is no sugar present. The reported cases of diabetes insipidus with albuminous urine were, doubtless, examples of fibroid kidney.

When there ensues such a strong outflow through the kidneys, the results of the loss of so much fluid and solid material are the same as those of similar fluid discharges. There occur excessive thirst, a dry mouth, dry skin, and constipation. The increased excretion of urea explains the diminution of body-weight which takes place in this disease, notwithstanding the appetite and digestion remain at the normal. Sometimes a decided lowering of temperature is observed, but this may be due to the ingestion of a large quantity of cold drinks. Instead of dryness of the mouth, there may be ptyalism. The skin, although usually dry, as stated, may be normal, and there may be profuse perspirations.

Course, Duration, and Termination.—The onset of the disease may be preceded by the symptoms of cerebral disturbance, due to the existing lesions of the brain and sympathetic ganglia. The increase in the flow of urine and the consequent thirst may develop slowly, and be observed only when they are very pronounced. In still other cases, during convalescence from some acute malady, or after some violent mental or moral shock, or some severe blow on or concussion of the brain, the disease begins abruptly. In most cases the disease is rather an inconvenience, owing to the frequent calls to micturate and the incessant thirst, than a dangerous malady. Death has resulted in as short a time as four months, but here the fatal result was due rather to associated lesions than to diabetes insipidus. Death may result from the disease, the continual loss of material leading to fatal exhaustion, but it is usually due to some intercurrent disease or cerebral lesion. Although death is rarely due to the disease, the prognosis is not favorable as to cure, unless caused by syphilitic disease of the brain.

Diagnosis.—Those temporary states in which a large quantity of urine is voided for a few days are all separated from diabetes insipidus by the lack of permanence. From diabetes mellitus it is differentiated by the specific gravity of the urine and by the presence of sugar. Diabetes insipidus is most apt to be confounded with fibroid kidney, for in the latter disease a quantity of pale, watery urine is passed, but it contains more or less albumen and hyaline and waxy casts, which are not present in the former.

Treatment.—Several remedies have been of real service; many others of no value. The iodides and mercury have quickly cured cases