

the urine becomes alkaline, in colourless prismatic crystals of various sizes, most of them slightly modified and tending to the ordinary coffin-lid shape. These crystals are freely soluble in acetic acid, a property by which they may readily be distinguished from the oxalate of lime, which is not soluble in acetic acid; this is a reaction of some importance, as the phosphatic crystals, when very small, resemble closely those of the oxalate of lime.

Of the lower organisms found in the urine should be noticed the *rod bacteria* which always accompany fermentation of the urine, and *sarcinae*.

VOMITING.

When the ramifications of the pneumogastric nerve in the mucous membrane of the stomach and pharynx are subjected directly or indirectly to any abnormal irritation, reflex and very energetic contraction of the diaphragm and abdominal muscles is set up, whereby the stomach is firmly compressed on all sides and its contents discharged upwards. The stomach itself is not *actively* concerned in the act of vomiting, except in so far as it contributes by the opening of its cardiac orifice; its muscular coat contracts very little, if at all.*

The irritation of the sensory nerve-terminations in the stomach may be direct or indirect. *Direct* irritation is produced by emetics, poisons, nauseous substances, violent shocks, or by merely overloading the stomach; in all gastric diseases, from simple catarrh to the malignant new formations, and often also in simple hyperæsthesia of the gastric nerves, unaccompanied by any anatomical change, the stomach is more or less directly irritated. There is no disease of the stomach in which vomiting, transient or persistent and recurrent, may not appear as a symptom in some part of its course, though in many cases it is entirely wanting from beginning to end; it is only in cancer, especially when it causes stricture of the pylorus, that vomiting comes to be an absolutely constant symptom.

* It is necessary that the cardiac orifice of the stomach should be opened before vomiting can take place. The abdominal pressure alone is not sufficient to effect this, as there are certain conditions, difficult and painful defæcation, for example, in which, notwithstanding the amount of pressure brought to bear on the stomach by the abdominal muscles, the contents of the stomach are not ejected, simply because the cardiac orifice of the organ remains closed; on the other hand, vomiting is not unfrequently observed in animals on exposing the stomach and injecting tartarated antimony into the veins, though in this case the force exerted by the walls of the abdomen is completely eliminated as a factor in the process.

In diseases of the stomach vomiting takes place more readily when the organ is full than when it is empty; it is occasionally brought on also in such circumstances by every variety of solid food, sometimes even by the blandest fluids, at other times only by taking things which are difficult to digest or by special articles of diet; it may occur immediately after eating or only after the lapse of some time. In certain cases it is possible to form some idea as to the seat of the disease from the interval which elapses between the taking of food and the starting of the vomiting; thus, in cancer of the stomach the patient rejects his food almost directly after a meal when the cardiac orifice is contracted, but if the disease be located about the pyloric end, producing stenosis of the pylorus, the vomiting does not begin till several hours have passed.

The irritation of the gastric nerves may be *indirect*, the organ itself being perfectly healthy in structure. This is sometimes due to abnormal excitation of the vagus at its origin in the brain,—hence the frequency of vomiting in cerebral diseases and in certain affections of the nervous system,—or to reflex irritation of the vagus through some of the abdominal plexuses of the sympathetic, with which it is connected by anastomoses. In some cases the vomiting which so often attends affections of the abdominal organs may be explained by the relation which subsists between these two portions of the nervous system; in many other cases, however, this explanation is not so satisfactory.

EXAMINATION OF THE VOMITED MATTERS.

This is generally made with the naked eye, which in most instances is quite sufficient for diagnostic purposes; in certain circumstances, however, a microscopic examination becomes necessary.

According to the stage of digestion at which vomiting has occurred, the matters brought up, consisting partly of fluids and partly of solids, are more or less acted upon by the gastric juice, and have a more or less powerful acid odour. When the stomach is empty, or after repeated evacuation of its contents, vomiting expels only a ropy, viscid, mucous secretion, with which are sometimes mingled biliary matters from the duodenum, which give to the discharges a greenish coloration. The bile is pressed out of the duodenum into the stomach by the energetic contraction of the abdominal muscles, particularly when the vomiting is severe and accompanied by much straining,—as it always is when the stomach is empty.

Of the abnormal elements which may present themselves in the vomited matters the most important is *blood*. In some cases the proportion which appears among the vomited materials is small, in others the blood is rejected nearly pure, almost always coagulated and blackened by the action of the acids of the stomach, when it resembles black coffee-grounds. Hæmatemesis is observed most often in the ulcerative affections of the stomach, and is perhaps most abundant in round ulcer; the bleeding is very free also in the ulceration which is due to corrosive poisons. Hæmorrhage may take place even in the absence of any anatomical lesion of the stomach, from congestion of the gastric veins, from engorgement of the portal system (as in cirrhosis of the liver), or from overloading of the gastric vessels from other causes; of this last-mentioned variety is the periodical recurrent hæmatemesis met with in certain cases of amenorrhœa.

Sarcinæ are frequently found in the vomited matters in chronic gastric catarrh, and particularly in cases of dilatation of the stomach. They are developed in all conditions in which the food remains for an unduly long period in the stomach and in this way undergoes various abnormal modifications (fermentation, &c.).

Sarcinæ consist of small four-sided cells, measuring about 0.01 mm. in diameter, which are usually united in fours to form a single element; these elements, again, often combine similarly in fours to form still larger squares presenting sixteen separate subdivisions; all further increase also is made in fours.

Ascarides lumbricoides sometimes find their way from the bowel into the stomach, and may then be mingled with the vomited matters. Besides these abnormal constituents, microscopic examination reveals many other substances derived from the food taken, all more or less altered in appearance by the action of the gastric juice.

THE INTESTINAL DISCHARGES.

Alteration in the frequency and in the appearance of the alvine discharges are the principal objective signs of functional intestinal disturbance. The motions may be fewer than normally (*constipation*), or more frequent and liquid (*diarrhœa*).

CONSTIPATION.

Slight constipation, in which the bowels are moved about every two days, and a severer form also in which the interval between

the motions is prolonged to 3—4 days, are very common phenomena; in many instances such a disorder is periodical in its recurrence, and in some persons habitual. Constipation lasting 5—6 days is seldom met with, as therapeutic measures intended to remedy the condition are generally adopted before it has continued so long, while still longer intervals, 2—3 weeks, for instance, are very exceptional.

Constipation is most commonly to be ascribed to *sluggish peristaltic action of the bowel*, and in a smaller number of cases to the presence of some *obstruction within the bowel*, which mechanically opposes the onward progress of the intestinal contents, and which may, in certain circumstances, offer an absolute barrier to their passage.

The *peristaltic movements* of the bowel are rendered *sluggish* by very many different causes, which are in part connected with the manner of life of the individual, and which in the more marked forms of the affection are invariably of a pathological nature. These causes may be grouped together in the following way: want of active physical exercise, slowness of digestion and tissue-metamorphosis, unsuitable diet (consisting especially of very solid and unstimulating substances), distension of the bowel by gas; peristaltic action is slackened also when bile, a normal stimulant of the bowel, is wanting in the intestinal contents, a fact which explains the frequency of constipation in obstruction of the bile-duct, from duodenal catarrh and other causes; the muscular coat of the bowel may, further, be temporarily enfeebled through over-exertion and simple fatigue, induced by severe diarrhœa or the action of medicines,* or it may be permanently weakened by repeated drastic purgatives;† the peristaltic movements are also retarded by diminution in the contractile power of the muscular tunic of the intestine, such as that

* When in disease the peristaltic movements of the bowel become abnormally active they may be moderated by the use of remedies which soothe the irritability of the sensory nerves of the intestinal mucous membrane or which diminish the secretion from the internal surface of the bowel; to a slight degree also this may be accomplished by a properly-regulated diet, consisting of bland mucilaginous substances which cover and protect the sensitive mucous surface.

† Many who suffer from habitual constipation aggravate their malady by the misuse of drastic purgatives, the effect of which is that an ever-increasing degree of irritation, obtained either by adding to the dose or by the employment of more energetic drugs, is needed to awaken peristaltic action in the bowel; the natural stimulus, the mere presence of the intestinal contents, is of very little avail in such cases, though its influence is soon in great part restored on withholding the purgative.

observed in inflammation of its peritoneal investment, or by deficient innervation, as in diseases of the brain and spinal cord, perhaps also by spasmodic contraction of the intestinal muscles and consequent narrowing of the alimentary canal, as in lead colic.—In some cases several of the above-named causes may be in operation simultaneously; their recognition is usually a matter of no difficulty.

The onward movement of the contents of the bowel may be rendered slower or may be absolutely arrested, and constipation of various degrees of severity, or even impassable obstruction, may be set up, by the presence of some *mechanical obstruction* which compresses or completely closes the bowel; constipation, however, is much more seldom due to this condition than to feeble peristaltic action. This encroachment on the lumen of the intestine is dependent on causes some of which lie within, others without the bowel. Among the *internal* causes should be reckoned strictures, invaginations (intussusceptions), twisting and flexion of the intestine; large, hard faecal masses, and large biliary calculi, lodged at various points in the intestinal canal, particularly above strictures, where they distend the bowel and form diverticula, constitute mechanical obstacles of the character described. To the group of causes *external* to the bowel belong compression by the uterus in the gravid state or when pathologically enlarged or retroverted, by ovarian tumours, by very marked hypertrophy of the prostate, and by strangulation of the intestine (strangulated hernia). If these obstacles produce merely a narrowing of the lumen of the intestine, they may always be overcome by drastic purgatives, by exciting powerful peristaltic action; but if the closure of the canal be complete, as in strangulation, no advance of the retained intestinal contents is possible,—they rather travel backwards in the bowel if no operative measures be adopted for the removal of the obstruction, and eventually, on reaching the stomach, are discharged by vomiting. This (stercoraceous) form of vomiting is often observed in ileus.

DIARRHŒA.

Diarrhœal discharges are more fluid and are usually also more abundant than those of health. It sometimes happens that a person is seized with a sudden but transient attack of diarrhœa,

one or two thin watery motions following closely one on the other, the disturbance then subsiding and stools of natural consistence making their appearance; this is usually caused by some short-lived irritation of the intestinal mucous membrane by errors in diet, by cold in those who are so predisposed, by sudden change in the habits of life, &c. Wherever actual disease of the mucous membrane has given rise to diarrhœa the frequency of the motions is invariably increased; 3—4 evacuations of the bowels in the 24 hours are a moderate number in acute intestinal diseases, while in the intestinal catarrh of children, in typhoid fever, dysentery, and cholera they may number 20 or more in the 24 hours. This stage of the affection, however, in which the stools are so loose and so frequent, does not last long,—a few days or even a shorter time. In chronic diseases of the intestine diarrhœa is never, except incidentally, so severe as in acute diseases; occasionally, indeed, it is varied by longer or shorter periods of constipation.

Diarrhœal evacuations are sometimes perfectly painless; at other times they are preceded by a peculiar painful sensation, known as *colic*, which generally originates about the middle of the abdomen and radiates towards the other parts. Painful and painless stools may alternate with each other in the same patient; the presence or absence of pain therefore, in the majority of cases at least, offers no diagnostic indication of the special form of disease in which the bowel is involved. Nevertheless pain before or at stool, if associated with tenderness to pressure on the abdomen, generally warrants the inference that the bowel is probably the seat of an ulcerative affection.

The alvine discharges always assume a diarrhœal character when from any cause the *peristaltic movements* of the bowel are *increased* in rapidity and energy, so that the intestinal contents are carried more quickly onward, so quickly that they are expelled before their fluid constituents (dissolved alimentary matters and fluid derived from the intestinal vessels) have been to a sufficient extent absorbed.

The *causes of the increased peristaltic action* are many and varied, but they all admit of one of two interpretations,—the sensory nerves of the intestinal mucous membrane are either subjected to abnormal irritation or they are unduly sensitive; both classes of causes are frequently present. The mucous membrane is irritated by various articles of diet, particularly if they are taken in

large quantity or injudiciously combined. The lining membrane of the bowel becomes abnormally sensitive when it is attacked by disease; all intestinal affections, from simple, transient catarrh to the severe ulcerative processes, are usually accompanied by diarrhœa, which in chronic diseases may for a time disappear and be replaced by marked constipation. This increased sensibility may in acute intestinal diseases become so intense that even the intestinal secretions, which in such cases are greatly augmented in quantity, act as powerful irritants.

Peristaltic movements, excited in any part of the intestine by any of the above-named pathological causes, travel onward in undiminished intensity through the whole length of the bowel, so that, for instance, in catarrh of the small intestine they may be transmitted from their starting-point there to the perfectly healthy colon.

If the increased activity of the peristaltic movements in catarrhs of the small intestine were limited to this portion of the alimentary tract, the movements of the large intestine continuing normal, the intestinal contents would remain long enough in the colon to permit of the absorption of their fluid constituents, and the properly diarrhœal discharges would be wanting,—which, however, is not the case.

The loose diarrhœal motions also which follow the therapeutical use of drastic purgatives, are produced by the increased energy of the peristaltic movements.

EXAMINATION OF THE INTESTINAL DISCHARGES.

In examining the motions attention should be directed specially to the following points: their quantity, consistence and form, colour, odour, and the presence in them of abnormal constituents.

The *quantity* of fœcal matters passed in health depends on the amount of food taken and on the proportion of indigestible elements which the various articles of diet contain. It is always increased in diarrhœa, by the addition of the intestinal secretions and of such portions of food as have escaped absorption. In acute intestinal diseases,—acute catarrh, European and Asiatic cholera, dysentery, for example,—the evacuations may be enormous, consisting in great part of watery transudation from the mucous surface and to but a slight extent of excrementitious matters.

The *consistence* of solid motions is proportionate to the time

taken by the intestinal contents in travelling through the bowel to the rectum; the slower the rate of transmission the more completely will their fluid constituents be removed by absorption and the firmer will be the fœces. In those who suffer from constipation, accordingly, the motions are usually hard and dry. The *form* of the motions depends on their consistence; only such as are solid are “formed”, semi-solid discharges being described as pultaceous, those which are more fluid as soup-like, &c.

The *colour* of the dejecta, which in health is brown, is owing to the admixture of the colouring matter of the bile, hydrobilirubin. When the bile is prevented from entering the bowel, as when the ductus choledochus is closed, the motions have a dirty greyish, clay colour.

It is only in duodenal catarrh that discharges absolutely destitute of bile are seen, as it is only in this affection that more or less complete closure of the bile duct takes place; in diseases of the liver and biliary ducts, though the flow of bile into the duodenum is often impeded it is never entirely arrested. If, in the course of a duodenal catarrh, the fœces begin to show again a brownish coloration, it may with confidence be inferred that the bile is again escaping into the duodenum even though the jaundice show no sign of abating.

Diarrhœal motions also, like those of semi-liquid consistence, are yellowish-brown, but turn clearer and paler the more abundant they become, as the bile which enters the duodenum is diffused through a much larger mass of fluid. If the discharges be exceedingly profuse, as in Asiatic cholera, the quantity of bile poured out remaining the same or even being reduced, their yellow colour is lost by degrees till eventually they exhibit no further trace of the presence of bile; they are then perfectly colourless or dirty white, and are composed only of the rice-water fluid exuded from the intestinal vessels.

In young infants the motions, which normally are of a clear yellowish brown colour, often become greenish, especially when dyspepsia is present; the cause of this coloration has not yet been satisfactorily made out, though it is probably to be sought in a metamorphosis of bilirubin into biliverdin. The dejecta acquire a similar grass-green hue on the internal administration of calomel.

The motions take on an abnormally deep brown colour in

constipation of long duration. They are blackened by the internal use of the preparations of iron, of which only a small portion is absorbed, the remainder being mixed up in the intestinal contents.

Fluid motions are stained reddish-brown or brownish-black (chocolate-colour) when they contain large quantities of blood derived from the upper part of the intestinal canal; in such cases the oxyhæmoglobin of the arterial blood is transformed into methæmoglobin and hæmatin. When the blood comes from the rectum it does not remain long enough in contact with the fæcal matters to permit of this round of changes beginning, so that the colour it imparts to the motions is a clear, well-marked red. The presence of even a slight trace of blood is indicated by the colour it communicates to the evacuations.

The *odour* of the motions is characteristic; it is due essentially to the volatile products formed in connection with the decomposition of fatty matters. It is of very little practical importance, as the differences which it presents are only differences in intensity, not in kind. The simpler and plainer the food, as in infants still nursed at the breast, the less powerful the smell. When the motions are very fluid and succeed each other rapidly their odour diminishes very considerably. The rice-water discharge observed in cholera is almost entirely devoid of odour, as it contains practically no fæculent materials. In inflammatory and ulcerative affections of the bowel, particularly of the rectum (cancer, for example), the motions sometimes have an extremely offensive and penetrating smell.

ABNORMAL SUBSTANCES IN THE INTESTINAL DISCHARGES.

The appearance of any abnormal constituent in the motions is, as a general rule, of practical or diagnostic importance only when the admixture of the foreign element is so large as to be plainly obvious to the naked eye. Occasionally, however, the presence of the morbid material cannot be satisfactorily determined without having recourse to microscopic examination.

The abnormal substances found in the alvine discharges, recognisable usually by simple inspection, are the following:

Blood. Motions which contain a large proportion of blood

are more or less fluid, as the diseases which give rise to intestinal hæmorrhages are also usually accompanied by diarrhœa. Smaller quantities of blood may be mingled with fæculent matters of a semi-solid consistence or disposed in streaks on the surface of the motions. Blood may also be voided perfectly pure and unaltered. In certain circumstances the blood which is seen in the stools comes from the stomach, as, for instance, when the blood poured out in cases of perforating gastric ulcer is not got rid of by vomiting but passes downwards through the intestine; such discharges commonly take the form of masses of coagula of a brown or blackish-red colour, resembling tar. In all other cases the blood is derived from the intestine, such hæmorrhage being caused usually by ulceration of the mucous membrane; blood is therefore very frequently present in the evacuations in typhoid fever and dysentery.—But the existence of an actual lesion of the mucous membrane of the bowel is not necessary to the appearance of blood in the motions; the hæmorrhage may take place from ruptured capillaries or from the bursting of the dilated and tensely engorged veins of the rectum. It is to the occurrence of bleeding of the latter variety that the disease known as hæmorrhoids owes its name.

But the dilated hæmorrhoidal veins are not the only source of intestinal hæmorrhage; in those cases in which circulation through the liver is impeded all the abdominal veins which join the portal system, and among them those of the rectum, are overcharged with blood, and in this way intestinal vessels of small calibre are often ruptured. Hæmorrhage from this cause is not unfrequently observed in cirrhosis of the liver and in cases in which the portal vein is compressed by tumours.

Pus is found in the motions, or is passed in small quantities pure and unmixed, in ulcerative affections, particularly of the rectum, and in chronic rectal inflammations; or it may come from abscesses situated close to the rectum and opening into it.—*Mucous secretions* also, usually mingled with pus, are discharged in various rectal diseases.

Tissue-elements from the intestinal mucous membrane occur in the stools in violent enteritis and ulcerative affections of the bowel; they are composed for the most part of detached epithelium, sometimes of shreds of mucous membrane. The intestinal epithelium is separated freely in cholera.

Fungi appear abundantly in the rice-water motions in cholera. In the intestinal or infectious disease designated mycosis intestinalis, to which attention has recently been directed, innumerable fungous elements and bacteria have been discovered not only in the dejecta but also in the wall of the intestine, in various other tissues, and in the blood.*

The motions, particularly those observed in the diarrhœa of children, often contain fragments of undigested food.

Worms are frequently voided with the intestinal discharges, sometimes spontaneously, but usually, and in greatest number, after the administration of anthelmintics. The eggs of the worms are often expelled with the fœces, occasionally in such abundance that several may be seen in every drop examined under the microscope.

The worms which inhabit the human intestine are: the *ascaris lumbricoides*, the round worm, whose habitat is the whole of the small intestine; the *oxyuris vermicularis*, the thread-worm, which lodges in the large intestine, chiefly in the rectum; both of these are most commonly found in children. The *tricocephalus dispar*, the whip-worm, lives in the cœcum and colon, and occurs in both children and adults. There are three varieties of tape worm, *tœnia solium*, *tœnia saginata* (or *mediocanellata*), and *bothriocephalus latus*; these parasites are met with principally in adults, and occupy the small intestine. *Bothriocephalus latus* is rare in Germany, and is seldom observed in countries in which *tœnia solium* abounds.

Calculous formations, (*gall-stones and intestinal calculi*), occasionally appear in the motions. The former may be detected in the fœces after the patient has suffered for a longer or shorter period from gall-stone colic; but small calculi, biliary gravel, very often escape observation. Gall-stones enter the duodenum through the ductus choledochus, or sometimes through openings formed between the gall-bladder and the bowel by inflammatory adhesion and subsequent perforation, a process which explains satisfactorily the voiding of concretions so large that they could not possibly have passed through the common bile-duct. Biliary calculi are composed chiefly of cholesterine, and are therefore soluble in alcohol and ether.—Intestinal concretions are formed in the bowel itself, certain salts, particularly

* According to all the latest observers (Buhl, Waldeyer, E. Wagner, Leube and Müller, &c.) this disease is simply a local manifestation of that known as splenic fever.

phosphate of magnesia, ammoniaco-magnesian phosphate, and various organic combinations, being accumulated round some solid body (such as a fruit-stone) as a centre; in some cases organic concretions, blood clots, undigested fragments of food, or very hard fœcal masses, serve as the nucleus round which the different constituents of the stone are deposited.