

the villi are short and their bases tend to fuse into a honeycomb structure. This persists for a short distance on the caecal side of the valve, together with a few villi.

Lymphoid tissue is found in the tunica propria of all parts of the intestine. It consists of small masses, called follicles or nodules, like those found in the peripheral parts of the lymphatic glands (see article *Connective Tissue*). In the duodenum, jejunum, and upper ileum they are relatively scarce. In the lower ileum they are present in the form of *Peyer's patches*. These are aggregations of lymph nodules. They are from one-half to two inches long by half as wide. They are longitudinally placed, on the part of the intestine away from its mesenteric attachment. The patches ordinarily number about twenty to thirty. In old age they are prone to undergo atrophy.

Each Peyer's patch consists of from ten to sixty nodules. In each nodule a germ centre may be recognized by the fact that here the nuclei are less crowded and take the basic stain more faintly. Evidences of karyokinesis are here found. The nodules are described as "breeding-places" for lymphoid cells, and it is in the germ centres that active cell division occurs. The young lymphocytes so formed either pass into the surrounding lymph vessels or, according to Stöhr, wander through the epithelium, into the lumen of the intestine. The nodules may run together into a mass of lymphoid tissue. As elsewhere in the intestine, the lymphoid tissue of the Peyer's patch lies primarily in the tunica propria, but it encroaches on the submucosa, reaching nearly down to the circular muscle layer. The muscularis mucosae in such cases is interrupted. Villi are commonly lacking over the nodules; or the lymphoid tissue causes the villi to bulge, as it were; and consequently at such points this tissue projects into the lumen of the gut (see Fig. 2936). Over such projecting nodules the epithelium contains an unusual number of leucocytes.

In the large intestine, particularly in the appendix, as already stated, solitary follicles or nodules are very nu-

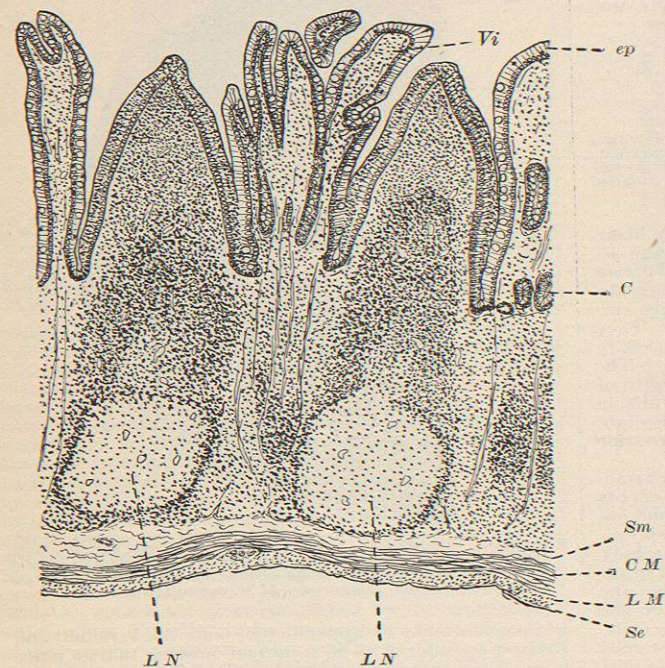


FIG. 2936.—Part of a Peyer's Patch from Cat's Intestine. (From author's own drawing.) Vi, Villus; ep, epithelium; C, crypt of Lieberkühn; Sm, submucosa; C M, circular muscle layer; L M, longitudinal muscle layer; Se, serosa; L N, germ centre of lymph nodule.

merous and usually have germ centres. Over them the crypts are rudimentary or wanting. The nodules generally break through the muscularis mucosae and lie partly

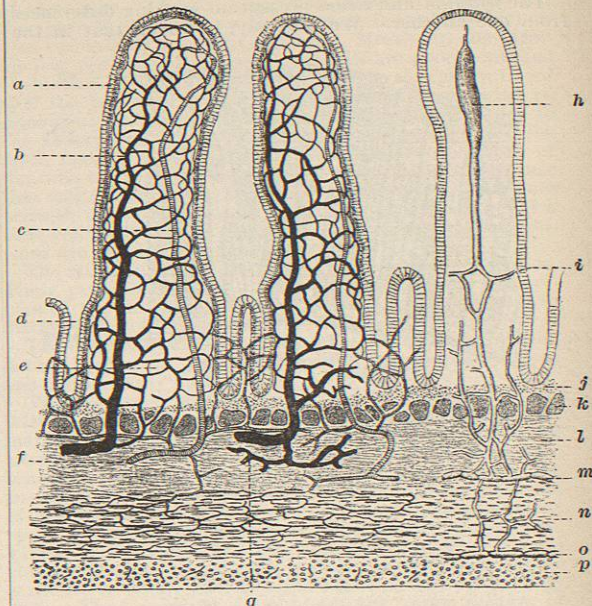


FIG. 2937.—Diagrammatic Cross Section of the Small Intestine of the Human Being. (From Böhm and Davidoff.) a, Epithelium of the villus; b, vein, and c, artery of the villus; d, intestinal gland; e, base of the villus; f, artery; g, vein; h, central chylous radicle of the villus; i, chylous vessel; j, tunica propria; k, muscularis mucosae; l, submucosa; m, plexus of lymphatic vessels; n, circular muscular layer; o, plexus of lymphatic vessels; p, longitudinal muscular layer and serosa.

in the submucosa. In man the solitary nodules make but slight depressions in the general level of the mucous membrane, but in some animals they lie at the bottom of deep depressions. Over the tops of the nodules the epithelium may appear to lose its basement membrane so that the cells are in closer relation to the reticular tissue.

Blood-vessels.—Arteries enter the intestinal wall at its mesenteric attachment. The larger branches lie in the submucosa. The muscular and serous layers are supplied by the vessels in the submucosa and by branches from the main arteries as they pass through the muscular layers. From the submucosa numerous small branches pass through the muscularis mucosae and feed an abundant network of capillaries lying below and about the glands and bring to them the materials from which their secretions are elaborated. Small branches also enter the villi. These enter the villus from below, lying near its centre, and give off numerous capillaries which make an abundant anastomosing network just under the epithelium. They drain into small venules which like the arterioles lie near the central axis, and finally lead into the venous plexus in the tunica propria. The larger veins run along with the arteries. The lymph nodules are surrounded by a fine network of capillaries from which branches enter the nodules. The centres of the latter, however, are often bloodless.

The lymphatics of the intestine will be described in detail in the article *Lymphatic System*. In ordinary histological sections we see, in favorable cases, the lymph space in the centre of the villus, and the evidences of absorption already described. Further than this the only factors which the lymph channels introduce into the histological picture of ordinary specimens is the occasional section of a lymph space in the submucosa and peculiar appearances in the muscular layers where a lymphatic passes through them. This appearance is indicated in Fig. 2934. It is due to the fact that the muscle fibres are pushed a little aside by the vessel passing between them and the direction of section of these fibres is thus changed.

Nerves.—The intestine is supplied from the abdominal sympathetic system by non-medullated fibres which enter at the mesenteric attachment. In the wall of the gut are situated two nervous plexuses. These are the plexus of Auerbach or plexus myentericus, and the plexus of Meissner. They communicate with the entering fibrils from the sympathetic. The plexus of Auerbach is between the two muscle layers (see Fig. 2934). Numerous ganglia consisting of collections of large multipolar nerve cells are united by bundles of non-medullated nerve fibres into a conspicuous network. There are a few medullated fibres. If we macerate and strip the muscle layers from the submucosa, and stain them by the gold process, we get the beautiful picture shown in Fig. 2938. In sections stained by any of the ordinary methods the ganglia may be easily found (Fig. 2939). The cells are characteristically large, irregular in shape, with deeply stained protoplasm and no cell wall. The nuclei are large, round or oval, vesicular in staining and have usually single, large nucleoli. The cells have dendrites which branch and ramify in the ganglia and extend even into the nerve bundles. Their axons form the bundles of non-medullated fibres uniting the ganglia, extending

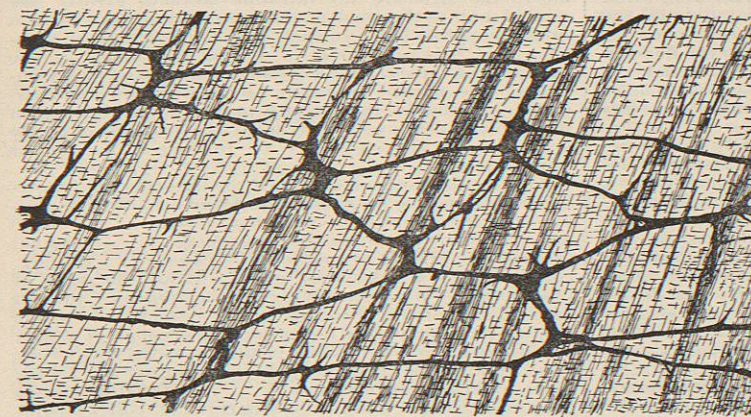


FIG. 2938.—Auerbach's Plexus from Small Intestine of Rabbit. Chloride-of-gold preparation. (From author's own drawing.)

into the muscular layers, repeatedly dividing and branching there and finally ending on the smooth muscle cells. The plexus of Meissner is much less conspicuous. It

forms a network like that of the plexus of Auerbach, but much more delicate. It lies in the muscularis mucosae. It anastomoses freely with the plexus of Auerbach, and non-medullated fibres pass into the muscularis

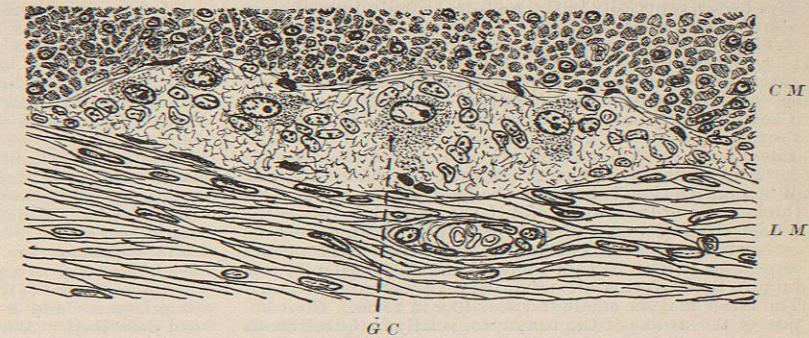


FIG. 2939.—Group of Ganglion Cells of Auerbach's Plexus in Human Small Intestine. (From author's own drawing.) G C, Ganglion cell; C M, circular muscle layer; L M, longitudinal muscle layer.

mucosae, into the tunica propria, and probably to the gland cells of the epithelium. *Ralph C. Larabee.*

INTESTINES, INFLAMMATION OF. See *Colitis*; *Dysentery*; and *Enteritis*.

INTESTINES, INJURIES OF. See *Abdomen*. (*Surgical*.)

INTESTINES, NEW GROWTHS OF.—If we adopt the embryological basis of classification¹ we may say that the following primary new growths occur in the intestines:

- I. *Tumors derived from the ectoderm.*
 - (a) From the epidermis.
 1. Epidermoid carcinoma.
 - II. *Tumors derived from the entoderm.*
 1. Adenoma.
 2. Carcinoma.
 - III. *Tumors derived from the mesoderm.*
 - (a) From the mesenchyma.
 1. Sarcoma.
 2. Fibroma.
 3. Leiomyoma.
 4. Lipoma.
 5. Angioma.
 - (b) From the mesoneurals.
 1. Lymphosarcoma (pseudo-leukæmia).
 2. Leukæmia (lymphatic).

PATHOLOGICAL ANATOMY.—There occur tumor-like structures that perhaps are best regarded as forms of *hypertrophy* of the mucous membrane. They are present in so-called chronic catarrh and in the neighborhood of the chronic ulcerative processes in dysentery and tuberculosis. They are polypoid structures in which the glandular constituents usually predominate. They also occur apparently quite independently of any inflammatory process, even as early as the third year, and are then commonly called *mucous polyps*. They project into the lumen of the intestine and may be as large as a pigeon's egg. When they occur in the region of the anus they may prolapse, and eventually cause prolapse of the mucous membrane also. When the arrangement and structure of the glands

differ considerably from the normal the growths are perhaps best designated as *polypoid adenomata*. There are transitional forms that may be regarded either as results of hypertrophy or as tumors.

Adenomata not conspicuously elevated above the surface occur, especially in the rectum, usually immediately above the epidermis.

The *carcinomata* constitute the most important group of new growths. With the exception of the epidermoid carcinoma occurring at the anus, the fundamental form of most of these is the cylindrical-cell adenocarcinoma. They are commonly annular in form. It is believed that they may originate from primarily benign adenomata. They may be fungoid or otherwise circumscribed in form, or they may diffusely infiltrate considerable areas. When infiltration is marked the wall of the intestine is thickened and indurated, and if the growth involves the whole circumference of the wall, the intestine may be converted into a stiff, thick-walled tube. This occurs especially in the rectum and colon. Ulceration begins early. Some forms are medullary, others are scirrhous. The latter may be small and scar-like in form. Contraction of the stroma of the tumor, especially in the scirrhous form, tends to bring about narrowing of the lumen of the intestine. A relatively common form, especially in the rectum, is the colloid carcinoma. It tends to involve considerable surface and to infiltrate extensively the surrounding tissues. Early ulceration leads to extensive loss of substance, especially when the stroma is soft, and in this way the lumen of the intestine may be considerably enlarged.

Metastases occur in the neighboring lymph nodes, and, at a relatively early stage, appear in the liver and in other organs. In the most common carcinomata—those of the rectum—the sacral, lumbar, and higher retroperitoneal lymph nodes are first involved. The inguinal lymph nodes are involved only when the anal region is concerned.

Carcinomata of the intestines occur most commonly in the rectum, immediately above the sphincter or in the middle region. Next in frequency they are found in the region of the ileo-cæcal valve, in the sigmoid and hepatic flexures, and at the common orifice of the pancreatic and common bile ducts in the duodenum. They are uncommon in the small intestine and here occur most frequently in the duodenum. Males appear to be more commonly affected than females. They may occur as early as the first decade, but, as a rule, they appear in advanced life. The early occurrence is possibly associated with the early appearance of adenomata previously referred to. The common occurrence in the rectum and in the flexures of the colon suggests a mechanical factor in the etiology. On the other hand, the lower end of the rectum is one of the places where complicated developmental processes occur.

The results of carcinoma consist primarily in narrowing of the lumen of the intestine and induration of its walls. This brings about a stasis of the contents and a widening of the lumen above the point of constriction. If the obstruction comes on gradually considerable hypertrophy of the muscular coats above also results. If it comes on acutely there is great and rapid dilatation with thinning of the wall, as a result of the sudden fecal stasis, and death occurs before hypertrophy has developed. Occasionally, as described above, the lumen may become even wider than normal as a result of ulceration with extensive loss of substance. Perforation is most apt to occur in these cases. According to the location of the perforation, this is followed by periprocitis, localized or general peritonitis, and fistulae leading into the rectum, vagina, colon, bladder, etc.

In the anal region of the rectum epidermoid carcinoma occurs, originating from the epidermis. This usually begins as a nodular or papillary growth, and may become annular. It tends to invade the surrounding skin more extensively than the mucous membrane. Melanotic carcinomata are said to occur occasionally.

Secondary carcinomata are common in the serosa of the

intestines, but rare in the mucosa. They may arise by direct extension from the stomach, pancreas, uterus, vagina, or other abdominal organs. Implantation and metastasis perhaps also occur. Apparently any form of secondary carcinoma may be present.

Of the mesenchymal tumors *fibromata* occur in nodular and papillary forms, and are frequently polypoid. They may be as large as a pigeon's egg and may be present even in children. At the anus fibrous tags may result from hemorrhoids, and papillary fibromata in the form of moist condylomata result from gonorrhoeal infection. Polypoid fibromata occur in various parts of the mucous membrane. *Lipomata* originating in the submucosa may project into the lumen in a polypoid form, and occur especially in the jejunum. *Sarcomata* are rare, but nodular spindle-cell sarcomata, as well as alveolar and melanocarcinoma, and round-cell sarcomata of large size, have been described.

Fibromyomata are relatively rare. Polypoid forms may be as large as an apple.

Angiomata are extremely rare, but nodular and diffuse telangiectases and a polypoid cavernous angioma have been described. A multilocular chylangioma cysticum, as large as a goose egg, was found beneath the serosa of the ileum in a five-year-old girl. Dermoids are said to occur in the rectum.

Many of the non-carcinomatous tumors and hypertrophic growths in the mucous membrane are too small to cause any disturbance of function. The larger ones may cause obstruction and, by the aid of peristalsis, even invagination of the intestinal wall. Polypi with narrow pedicles may become free and appear in the feces.

We may regard *pseudo-leukæmia* and *lymphatic leukæmia* as closely analogous to tumor formation. In some of these cases the lymphoid tissue of the intestine appears to be principally involved, and Peyer's patches and the lymph nodules are considerably enlarged.

SYMPTOMS.—“In the first place, the affection may be latent, revealed at autopsy alone, or the early and indeed the chief symptoms may be due to the secondary tumors. . . . The sole objective feature may be the progressive enlargement of the liver.”¹

“The symptoms, in case of obstruction, are very diverse. Constipation gradually comes on, is extremely variable, and it may be months or even years before there is complete obstruction. There are transient attacks, in which from some cause the feces accumulate above the stricture, the intestine becomes greatly distended, and in the swollen abdomen the coils can be seen in active peristalsis. In such attacks there may be vomiting, but it is very rarely of a fecal character. In the majority of these cases the general health is seriously impaired; the patient gradually becomes anæmic and emaciated, and finally, in an attack in which the obstruction is complete, death occurs with all the features of acute occlusion, or the case may be prolonged for ten or twelve days.”²

“In the diagnosis of cancer of the intestine the following points may be taken into consideration. In comparison with the subjects of malignant disease of the stomach very many of the patients are young; . . . intestinal features are present in a majority of cases; . . . gripping, colicky pains are common, even without the signs of obstruction. With narrowing of the lumen of the gut very characteristic features occur—attacks of severe gripping pain, abdominal distention, the presence of active, sometimes visible peristalsis in the distended coils of the bowel, and, if the condition persists, vomiting and all the signs of intestinal obstruction. . . . If fungous masses project and cause more or less narrowing, colicky pains and constipation are inevitable; but, on the other hand, as the tumor grows, if there is necrosis of its surface, with excavation, neither pain nor constipation may be present. Diarrhoea and the passage of much slime with the feces are not infrequent symptoms. Hemorrhage is also common. The blood is not often in large quantities; when the tumor is in the sigmoid flexure it may be bright and very little changed, but in the growths about the cæcum

it is often much altered before it appears in the stools. There are cases in which the constant loss of small quantities of blood is a very special feature, and the patient becomes profoundly anæmic. Sloughy fragments of the tumor may sometimes be passed in the feces.

“A cachexia develops progressively but with variable rapidity. It may, however, be well marked before any features have arisen suggestive of intestinal trouble. The loss in weight may, too, be slight, even after the tumor has persisted for many months. When extensive secondary growths develop, the cachexia may be profound. The tumor in cancer of the intestines may be readily and easily discovered—indeed, evident on inspection. On the other hand, it may not be until the terminal stage of the disease that the growth is found. A small tumor of the hepatic or splenic flexure of the colon may escape repeated examinations. Mobility is a special feature of growths in the large bowel. Large tumors, however, of the cæcum may be quite fixed. The most movable growths are those connected with the sigmoid flexure. Variability in size is also a marked character, and at one examination the mass may appear as large as the closed fist or even two fists, and the next day it appears not larger than a small apple. These variations are due largely to the presence of fecal masses in the vicinity. Two very important features in the intestinal tumor may sometimes be detected on careful palpation—namely, the hardening during contraction of the hypertrophied wall in the vicinity of the growth, and the bubbling of gas through the tumor which may be heard as well as felt.”³

“A thorough rectal and, in women, a vaginal examination should be made, which will give important information as to the condition of the rectal and pelvic contents.”⁴

“The intestinal symptoms above referred to and a progressive cachexia are generally sufficient to warrant a diagnosis.”⁴

PROGNOSIS.—In carcinoma the prognosis is bad. Before the condition is recognized secondary involvement of other organs is usually so extensive as to be beyond operative control. The local condition may, however, be completely relieved by operation, and health apparently restored for a time.

H. S. Steenland.

BIBLIOGRAPHY.

- ¹ Councilman and Mallory: Pathology, Syllabus, Boston, 1900.
- ² Orth: Lehrbuch d. speciellen pathologischen Anatomie, Berlin, 1887.
- ³ Orth: Pathologisch-anatomische Diagnostik, Berlin, 1900.
- ⁴ Osier: Lectures on the Diagnosis of Abdominal Tumors, reprinted from the N. Y. Med. Jour., 1894, New York, 1898.
- ⁵ Osier: Principles and Practice of Medicine, New York, 1901.
- ⁶ Ziegler: Lehrbuch d. allgemeinen Pathologie u. pathologischen Anatomie, Jena, 1895.

INTESTINES, PHYSIOLOGY OF. See *Absorption*; *Digestion*; and *Intestinal Movements*.

INTESTINES, SYPHILIS OF. See *Syphilis*.

INTESTINES, TUBERCULOSIS OF. See *Tuberculosis*.

INTESTINES, WOUNDS OF.—Intestinal wounds depend on the same causes as wounds elsewhere. The injury usually comes from without, but in rare instances the lesion is caused by a foreign body in the intestinal canal.

Each anatomical division of the intestinal tract is liable to injury, but those portions that are most extensive or most exposed are obviously in greatest danger. For these reasons the ileum and jejunum suffer most frequently, the colon occasionally, the duodenum least of all. In contusions, however, the duodenum seems to suffer a little more frequently than the colon. The latter, especially its vertical portions, has but a limited range of motion, and is, therefore, in this respect poorly protected against traumatic influences. It largely possesses, however, the immunity afforded by a deep location, comparatively limited functional activity, and dense protecting structures.

The mobility of the intestines, due to their lax attachments, the peculiar nature of their investing membranes, their elasticity, and the yielding character of the tissues about them, affords the greatest possible natural immunity from violence that is consistent with the proper performance of the functions of the human body.

While in normally developed adults the divisions of the intestine present no decided differences in their relations to the abdominal wall, yet Treves has shown it to be impossible definitely to localize any certain portion of the jejunum or ileum by external examination. In Treves' own words: “There is no systematic arrangement of the coils of the small intestine. There is a disposition for the bowel to follow an irregularly curved course from left to right, but this disposition can never be relied on. Such as it is, it may be expressed as follows: The gut starting from the duodenum will first occupy the contiguous parts of the left side of the epigastric and umbilical regions. The coils then fill some part of the left hypochondriac and lumbar regions. They now commonly descend into the pelvis, reappear in the left iliac quarter, and then occupy in order the hypogastric, lower umbilical, right lumbar, and right iliac regions. Before reaching the latter situation they commonly descend again into the pelvis. The coils found in the pelvis belong usually to the lower ileum, and to the bowel between two points respectively six and twelve feet from the duodenum.”

CAUSATION.—Violence coming from without, or arising within the canal, may be called the *exciting* cause, while the habits, occupation, idiosyncrasy, and surroundings of the patient are the *predisposing* causes. The nature of intestinal wounds usually indicates the cause, though a single form of violence may produce a wound of multi-form characteristics. The direction and degree of the force, and the magnitude and character of the agent transmitting it, determine the extent, and largely also the number and variety, of the wounds inflicted. The direction of a wound of the intestines, and also its size, exert an important influence on the local physical phenomena.

Contused and Lacerated Wounds.—In contusions the intestinal walls are bruised, in lacerations they are torn. These forms are commonly due to external violence, and when thus caused both varieties of wounds may be well marked at or near the same situation. Usually a considerable degree of external violence, sufficient to involve the abdominal wall, is required to cause a laceration or a severe contusion of the intestines, owing to their mobility and flexibility, and also to their elusive nature dependent on their investing tissues. Despite this fact, however, cases of laceration and contusion occur from blows so slight or through agents of seemingly so innocent a character that no injury is done to the abdominal walls, and at first a wound of the intestines is not suspected. MacCormac has reported several such cases, and the writer has met with one. Usually the agents transmitting the force have a blunt outline. The passage of the wheel of a loaded vehicle over the abdomen offers a frequent illustration of the manner in which the violence is inflicted; also a blow from the clenched hand or the kick of a horse or a man, especially if the intestine be forced against the spinal column, or if the violence be received at a point where fecal impaction exists. Partial distention of the bowel, according to Curtis, who made an analysis of 116 cases, diminishes the danger of rupture, while great distention of an isolated loop increases it, even when the loop is not in contact with bony parts. The intestines may be bruised and perhaps lacerated by imprudent manipulations for the reduction of a hernia, and the colon has been torn by the incautious introduction of the hand or an instrument into the sigmoid flexure. Contusions with or without lacerations have been caused by kneading the abdomen to overcome intestinal obstructions dependent on fecal impaction, and rupture has occurred from the force exerted by circumscribed collections of gas generated in morbid obstructive conditions. The force of spent pieces of shell has caused laceration of the small intestine. In 113 of the cases analyzed by Curtis, the duodenum was injured in 6 instances, the