

Prognosis.—The prognosis of an untreated perforating wound of the abdomen is even less favorable than that of subcutaneous injury. Death follows from perforative peritonitis or from hemorrhage. Fatal hemorrhage usually comes, not from some vessel of the stomach or intestine, but from some vessel of the mesentery, or from one of the large abdominal vessels. A case which appears in the beginning favorable may terminate fatally on account of the separation of protecting adhesions. This is spoken of in the section on subcutaneous rupture. Late perforation may also be due to injury of the mesentery with secondary gangrene of the corresponding portion of intestine. Fistula of the stomach or intestine follows perforating wounds of these organs more frequently than it follows subcutaneous rupture. Such a fistula may lead to death by starvation.

There is considerable difference between the outcome of gunshot-wounds of the abdomen received in peace and those received in war. For example, statistics of the Anglo-Boer War collected by Treves and others show that only about 40 per cent. of those who received gunshot-wounds of the abdomen and were not operated upon died. Possibly a few of these patients did not suffer from perforation of the stomach or intestine. A serious criticism of these figures is made by Hildebrandt, who points out that only those patients were counted who came under the care of the surgeon, while no account is made of those who died on the battlefield from such injuries or during transportation. If these were also counted, the percentage of mortality of gunshot-wounds of the abdomen not treated by operation would be at least 70 per cent. The fact that so many patients recovered after this severe injury may be due in part to the general emptiness of the alimentary canal in this war, and in part to the fact that most of the bullets were of small calibre. At any rate, the mortality of the patients not operated upon was less than that of the patients treated by operation, most of whom died. It must be admitted, however, that the conditions of the war were unfavorable to operation. The patients had frequently to be transported great distances, a considerable time elapsed between the injury and the operation, and hygienic necessities were difficult to obtain.

According to Makins, the prognosis of a gunshot-wound of the abdomen associated with perforation of the alimentary canal depends a good deal on the direction taken by the bullet. The most dangerous wounds are those which pass through the abdomen in the frontal plane, while the next in point of severity are those which strike the small intestine in the sagittal plane. Bullets which pass through the abdomen obliquely are less likely to produce death since they usually wound the colon instead of the small intestine. Even wounds which perforate both the thoracic and abdominal cavities, or the pelvic and abdominal cavities, are less dangerous than those of the character first mentioned. Makins also calls attention to the relative frequency of wounds involving both the thoracic and abdominal cavities (30 per cent. in this war). This may possibly be due to the fact

that much fighting was done with men in the recumbent or nearly recumbent position.

Makins says that mortality is greatest after perforation of the transverse colon and small intestine on account of the free motility of these parts, while it is less after perforation of the ascending colon and rectum. Mortality after perforation of the stomach, sigmoid flexure, and descending colon falls between these two extremes.

Haga reports a mortality of 77.1 per cent. following gunshot-wounds of the abdomen in his division in the recent Japanese-Chinese War: 40 of these patients died on the battlefield and 33 afterward. Rostowzew reports a mortality of 24 per cent. after operative treatment of gunshot-wounds of the stomach and a mortality of 23 per cent. after the same injury treated without operation. These were in civil life. Ziegler's statistics show a mortality of 46 per cent. following non-operative treatment of 30 abdominal stab-wounds between the years 1876 and 1890; 22 such wounds were treated between 1891 and 1897 with a mortality of 18 per cent. Siegel's statistics include all sorts of perforating abdominal wounds without reference to the abdominal organ which was injured. They show that 532 patients were treated without operation with 55 per cent. of mortality, and 376 patients were treated with operation with 52 per cent. of mortality. He has included, however, under the head of operative treatment all operations whether early or late, but here, just as in subcutaneous rupture, the time of operation is most important. Thus in the same class of cases the mortality after operation performed within four hours is only 15 per cent., while that after operation performed from five to eight hours after injury is 48 per cent., that between nine and twelve hours 64 per cent., and that after operations performed still later is 70 per cent. The mortality after early operation for stab-wounds is only 8.7 per cent. for operations performed within the first twenty-four hours.

Statistics as well as experiments upon animals show beyond a doubt that the chance of spontaneous recovery is considerably better after perforating wounds of the stomach than of the intestine. Hence a differential diagnosis between these two injuries is of practical importance. Unfortunately this can rarely be made unless characteristic fluid escapes from the abdominal wound or there is hemorrhage from the stomach. Even then the intestine as well as the stomach may be wounded. Perhaps in a few cases the situation and duration of the wound may enable the surgeon to make a correct diagnosis.

Treatment.—The treatment of penetrating wounds of the stomach or intestine is purely operative, at least in times of peace. The object of the surgeon should be to find at the earliest possible moment the opening or openings in the stomach or intestine and to close them by suture. Unfortunately this cannot always be done either because the diagnosis is uncertain or for some other reason. If the diagnosis is reasonably certain and the conditions are favorable for laparotomy, it ought to be performed at once. Even in doubtful cases if the conditions for a proper performance of laparotomy exist, an exploratory in-

cision exposes the patient to far less risk than a purely expectant treatment. On the other hand, to open the abdomen when the conditions for successful laparotomy are not at hand will often lessen the patient's chances of recovery.

Whether gunshot-wounds of the abdomen can be successfully treated in war is at least doubtful. The army surgeon will rarely have an opportunity to operate at the most favorable period—that is, within a few hours after receipt of the injury. Furthermore, the conditions for operation cannot be as satisfactory as in time of peace. In view of the further facts shown by the last war, that many patients not treated by operation recovered, and that the prognosis without operation was considerably better than after operation, the rule at the present time for the army surgeon should be to treat such cases expectantly. There are other things in connection with the treatment which greatly affect the prognosis in the case. The ideal treatment of such a patient would be to erect a tent over him and not to remove him for at least three or four days until the openings in the stomach or intestine were closed by peritoneal adhesions. If this plan is impossible, he should be carried the shortest possible distance. Wherever he can have rest, whether in a hut or a palace, his chance for recovery is equally good.

Whether these patients in time of peace should be treated by laparotomy even after peritonitis has manifested itself, is still a disputed question. For answer the reader is referred to the section on Operative Treatment of Peritonitis.

If a patient with penetrating wound of the stomach or intestine is treated expectantly, absolute rest of the body, and especially of the affected organ, is all-important. This implies the withholding of all nourishment by mouth, and the use of opium, etc. In every case treated, however, the wound of the abdominal wall and prolapsed abdominal organ should be closed, prolapsed omentum should be ligated, cut off, and the stump replaced. If there is prolapsed and wounded stomach or intestine, it is to be repaired and replaced, and the external wound drained by a tampon of iodoform gauze. Torn or contused wounds of the abdominal wall should be treated in an antiseptic manner so as to prevent infection, which may spread inward. As long as laparotomy is under consideration the canal of a gunshot-wound had better not be disturbed. A superficial cleansing and antiseptic dressing are sufficient.

Operative treatment is carried out as follows: If it is not apparent whether the wound opens the peritoneal cavity, it should be enlarged in order to determine this point. Such wounds should not be probed on account of the risk of introducing infection within the peritoneal cavity or loosening adhesions. If the peritoneal cavity is opened and perforation of the alimentary canal is suspected, an incision should be made in the median line. This is the most favorable place from which to examine and cleanse the abdomen. If, however, the nature of the injury makes it certain that the lesions are found to one side, a lateral incision may be chosen. A median incision

is in all cases preferable for wounds of the stomach, and if necessary it can be enlarged by a transverse incision. If the wound through the abdominal wall is near the median line, the incision may be made through it. If the wound into the abdomen is large, examination should first be made through it and the surgeon guided thereby in determining subsequent operation.

When an injury of the stomach or intestine has been found, search should still be made for other injuries of the alimentary canal or of other organs. Attention should especially be directed to the possible rupture of large vessels, such as those of the mesentery, greater and lesser omentum, mesocolon, etc.

Perforation of the stomach should be closed by a double row of sutures. The edges of a gunshot-wound are frequently contused and torn, so that it will be necessary to cut them away and so to trim the wound that it can be closed by a linear suture.

If the wound in the abdominal wall is ragged or dirty, it should be suitably cleansed and drained. The question of closure of the abdominal cavity and of after-treatment is discussed under Rupture of the Stomach. (See page 261.)

INJURIES OF THE DUODENUM.

The various traumatism described in the preceding sections may occur in the duodenum. Subcutaneous injuries of the duodenum are relatively more frequent than penetrating wounds on account of the firm attachment of the organ to the vertebral column, and on account of its protected position. For this reason it is very likely to be pressed against the vertebral column and injured by a blow. Contusion rarely leads to serious injury, and most non-perforating subcutaneous injuries are not diagnostic. They may, however, lead to ulcer or stenosis. If the injury affects the orifice of the common bile-duct, stenosis of this duct may also result.

Among the perforating subcutaneous injuries are to be named total rupture of the duodenum. In 3 such cases Jeannel found the intestine torn across near the pylorus and in 2 it was torn across at the juncture of the duodenum and jejunum. The reason why it was severed in these two places is obviously the fact that they are places in which the movable portion of the canal is joined to the fixed portion. Partial rupture may occur in any portion of the duodenum, but chiefly in its lower portion. The anterior wall was 14 times affected in such injuries, while the posterior wall was only 6 times affected. In only 1 of these 20 cases was the line of rupture parallel to the axis of the bowel. The length of rupture varied from a slight tear to one involving two-thirds of the circumference. In some of these cases other portions of the intestine were simultaneously injured.

If the duodenum is opened either as an immediate or a late result of an injury, its contents need not necessarily enter the peritoneal cavity, since a part of its wall is not covered by the peritoneum. This

was true of 5 of the 6 cases of injury of the posterior wall above referred to. There will follow in such a case a retroperitoneal gangrenous inflammation which will ultimately lead to peritonitis. If the rupture leads into the peritoneal cavity, the result will be perforating peritonitis.

Symptoms.—The symptoms of injury of the duodenum closely resemble those of injury of the stomach. Pain is felt more on the right side than on the left, while vomiting of blood and gastric contents occurs in less than half of the cases. The symptoms due to perforation into the peritoneal cavity are exactly like those of perforation of the stomach. If there is retroperitoneal perforation, the symptoms are at first obscure, consisting of continuous pain and extreme sensitiveness in the region of the duodenum, fever, and a more or less rapid development of a septic condition.

The diagnosis may remain obscure for several days or until the patient dies either before or after peritonitis develops.

Treatment.—The treatment of contusion of the duodenum is the same as that of contusion of the stomach. The treatment of rupture is purely operative. Two patients having rupture have been treated by laparotomy and cured, while 3 others who were operated upon and all the patients who were not operated upon have died. No patient with retroperitoneal rupture has yet been operated upon.

Wiart says that in operating upon retroperitoneal rupture it is better to proceed laterally from the ascending colon, instead of making the operation from behind without opening the peritoneum. But a better plan is to make a median incision in order to come directly upon the ruptured organ whether it is a retroperitoneal or an intraperitoneal one. The diagnosis in such cases is at best an uncertain one, and the first step in the operation should be to make it exact, and this can be better done from in front than from behind. If it should be found that the rupture is retroperitoneal, the field of operation can be protected by a temporary tamponade. If the conditions are such that a perfect closure of the intestine cannot be secured and there is probability that the patient will recover with a large duodenal fistula in case the wound is tamponed, it is better to avoid the risk of suppuration by performing gastro-enterostomy or jejunostomy. If an intraperitoneal rupture is satisfactorily sutured, gauze drainage will be unnecessary. This should, however, be employed for a retroperitoneal rupture.

INJURIES OF THE SMALL INTESTINE.

Subcutaneous injuries of the small intestine may result from overdistention, crushing, or jarring. The bowel is most likely to be torn from its attachments at its junction with the duodenum or with the cæcum. If the intestine is ruptured by increased tension from within, the wound is situated opposite to the mesenteric attachment. Contusions may occur in any portion of the intestine. Puncturing wounds of the small intestine are usually multiple. This is particularly true

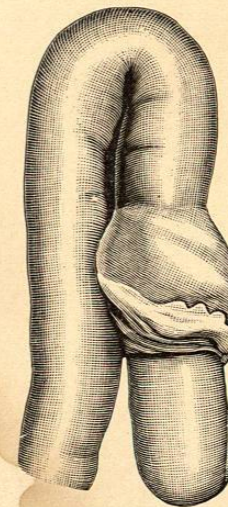
of gunshot-wounds, of which a dozen or more may exist. The appearance of the wound and the effects of the same have been considered in preceding sections. Rupture of the intestine within a hernial sac is discussed under Hernia. Subcutaneous rupture of the intestine if treated by conservative methods generally terminates fatally (149 of 160 cases), according to Petry. If the patient escapes death, it is due to adhesion of the omentum to the wound, and recovery is usually not complete until the fecal abscess has discharged spontaneously or has been opened. Death is due to intraperitoneal hemorrhage in about 10 per cent. of the cases, and a few patients die from late perforation, but the chief cause of death is a rapidly spreading peritonitis. Reports in 28 cases of contusion of the intestine show that 12 patients died from the injury and 16 recovered, 3 of them after the passage of a gangrenous section of intestine. This occurs from one to two weeks after the injury. If necrotic mucous membrane is discharged from the bowel, the diagnosis is absolutely certain, otherwise unless the patient comes to autopsy it is merely a probable one. Four patients recovered from the immediate effects of the injury, but died of cicatricial stenosis.

Treatment.—The treatment of perforation of the small intestine is purely operative whether the rupture is of a subcutaneous character or is due to a puncturing wound. The small openings in the intestine should be sutured either with or without excision of the edges of the wound. The line of suture should be transverse in order to avoid stenosis. If the injury is extensive or if several punctures exist close to one another, circular resection should be performed, and the ends of the bowel brought together by suture or by a Murphy button.

Poppert resected intestine in 5 places for 12 perforations the result of a pistol-shot, and saved his patient. Many instances have been reported in which success has followed the removal of long portions of small intestine, but it is dangerous to resect more than 2 metres (6.5 feet).

The treatment of contusion of the intestine is generally an internal one similar to that of contusion of the stomach. If a laparotomy is performed and only a slight contusion of the intestine is found, it may safely be left alone. If the contusion is so severe that perforation may follow, the damaged bowel should be resected and sutured. In doubtful cases one may suture over the injured portion without previous resection. It has also been recommended to stitch the omentum or neighboring coils of intestine to such an injured spot in

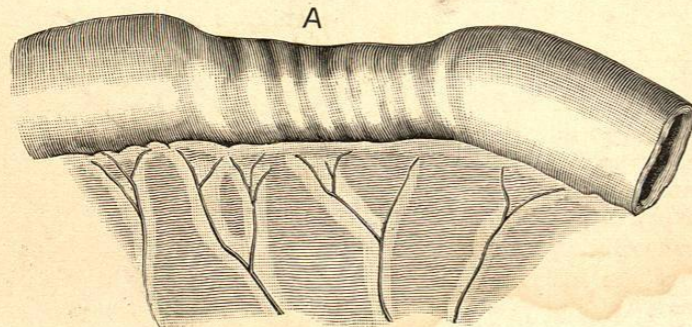
FIG. 70.



Intestine of a dog four weeks after removal of its muscular coats. The dilated portion is that operated upon; adherent omentum is shown at its lower margin. (Schloffer.)

order to guarantee its vitality or to prevent the perforation, if such occurs, from opening into the peritoneal cavity. Non-perforating

FIG. 71.



Intestine of a dog four weeks after crushing: A, the portion crushed is constricted. (Schloffer.)

injury of the intestine may lead to dilatation or constriction (Figs. 70 and 71).

INJURIES OF THE MESENTERY.

Injury of the mesentery requires especial attention because it may threaten the vitality of the intestine. Such injury may be either a contusion, ecchymosis, hæmatoma, or perforating or non-perforating wound. A non-perforating injury involves only one layer of the mesentery. These injuries carry with them the double risk of hemorrhage and loss of nutrition to the corresponding intestine.

A puncturing wound may involve any portion of the mesentery. Subcutaneous injury may result in a cross-tear of the intestine together with the mesentery. In some instances two such tears exist, so that a portion of the intestine with its mesentery is completely separated from the rest of the alimentary canal. The intestine was torn away from its mesentery for a distance of 75 cm. (30 inches) in a case mentioned by Bulteau.

Diagnosis.—The diagnosis of injury of the mesentery can only be surmised before opening the abdomen. The indications for laparotomy are symptoms such as have been described as following injury to other abdominal organs. If the mesentery alone is injured, hemorrhage may produce acute anæmia, or there may be signs of disturbed nutrition of the intestine, such as bloody stools, ileus, or beginning peritonitis (see the section on Embolism and Thrombosis of the Mesenteric Vessels).

Treatment.—Wounds in the mesentery should be sutured lest they lead to incarceration of intestine. Bleeding vessels should be ligated, and if the injury is such as to threaten the vitality of a portion of intestine the latter should be resected. The appearance of the bowel will usually show whether its blood-supply is interfered with. In cases

of doubt it is better to resect the bowel, especially if it also is injured. Under such circumstances a circular resection is less dangerous than suture of the intestinal wound. The technic of these operations is described on pages 468 *et seq.*

INJURIES OF THE LARGE INTESTINE AND OMENTUM.

Subcutaneous injuries of the large intestine are almost always due to rupture or contusion. What has been said on the subject of injuries of the stomach and small intestine is for the most part applicable to injuries of the large intestine. The large intestine is, however, peculiar in that a considerable portion of it is not covered by peritoneum, and injuries of this portion do not directly affect the peritoneal cavity. In this respect the large intestine is like the duodenum. Extraperitoneal rupture of the large intestine is, however, extremely rare. Other characteristics of the large intestine are its thick fecal contents and the virulence of its bacteria, its relative immobility, and its slow peristalsis which favors adhesions. The great virulence of the bacteria in the large intestine adds to the risk of perforating wounds. The wall of the large intestine is thin and does not readily contract so as to block up small wounds, and yet the slow peristaltic action and solidity of the intestinal contents may save the patient from an escape of fecal matter. The conservative treatment of wounds of the large intestine gives equally good or better results than conservative treatment of wounds of the small intestine. Still, if the diagnosis can be made with some probability the treatment should invariably be operative when the perforation is into the peritoneal cavity or behind the peritoneum.

On account of the situation of the omentum immediately behind the anterior abdominal wall it is often injured in penetrating wounds, and it frequently protrudes through wounds of the abdominal wall. In such cases the protruding omentum should be ligated and cut away and its stump cleansed and replaced. Wounds in the omentum may give rise to considerable hemorrhage. Such wounds usually occur in connection with wounds of other organs which give more prominent symptoms than the wounds of the omentum. Subcutaneous injury of the omentum may be accompanied with hemorrhage or a tear may extend completely across the omentum. Injuries of the mesocolon and lesser omentum are spoken of in connection with those of the mesentery.

INJURIES OF THE STOMACH FROM WITHIN.

Injuries of the stomach from within are chiefly of the nature of burns, although the organ is sometimes injured by foreign bodies. The introduction of a sound often produces superficial injuries, such as the tearing off of a bit of mucous membrane, but such lesions heal quickly. Orth, however, mentions a case in which the patient died of gastric

hemorrhage. The use of a stiff sound—for example, an œsophageal sound—has led to perforation of the stomach into the peritoneal cavity at a point in the greater curvature opposite the cardia. Such a patient might be saved from perforative peritonitis by a prompt laparotomy and suture of the gastric wound. In doubtful cases the patient should be treated exactly as a patient in whom the diagnosis of rupture of the stomach is doubtful.

The caustics which so injure the stomach that surgical aid is demanded are the mineral acids, such as hydrochloric, nitric, and sulphuric acids, and the alkalies, such as potassic or sodic or ammoniac hydrate. Oxalic acid, carbolic acid, corrosive sublimate, zinc chloride, and other substances may also cauterize the mucous membrane of the stomach, but the poisonous action of such substances is so prompt that surgical relief is seldom called for on account of their caustic action.

The concentration of the substance swallowed is relatively more important than its quantity. It is also important to know whether the stomach was empty or full. Burns of the stomach are almost invariably associated with those of the mouth and œsophagus. The parts of the stomach especially affected are the upper portion of the lesser curvature and the pylorus. Fluid which passes from the œsophagus into the stomach first comes into contact with the lesser curvature. (See Fig. 123, page 408.) The moment the caustic touches the stomach its muscles contract violently from the cardia to the pylorus and the caustic flows along the lesser curvature to strike against the pylorus. If a great quantity of caustic is swallowed, the whole inner surface of the stomach may be burned.

In rare cases the caustic may pass the pylorus and exert its action upon the small intestine for a short distance.

The effect of the caustic varies in degree from a slight hyperæmia to complete necrosis or even rupture. The sloughs produced are grayish or white and brittle and dry. Nitric acid stains the tissue yellow, and weak caustics stain it brownish or violet. Tissues burned by alkalies are less brittle than those burned by acids. In some instances the caustic burns a hole through the stomach and exerts its action upon neighboring organs such as the liver, spleen, and pancreas. If the caustic action is not strong enough to cause immediate destruction of tissue, hemorrhagic inflammation follows. Thus a necrotic area will be surrounded by a zone of brownish or greenish or blackish tissue. If the patient lives, the dead tissue separates from the living and is cast off.

The first effects of the caustic are intense pain, which is greatly increased by the slightest pressure, thirst and vomiting. In severe cases the vomitus contains blood and shreds of mucous membrane. There is more or less shock, which in severe cases may terminate in speedy death. If perforation results, general or local peritonitis may follow.

Slight burns are followed by perfect repair and deeper ones may be recovered from with a scar. If the cicatricial tissue is very extensive,

it may lead to contraction of the stomach of a marked degree, with atrophy of the whole mucous membrane. Scars of the pylorus often produce stenosis, while scars of the lesser curvature may produce the so-called hour-glass stomach. The ulcer following a burn may refuse to heal and become chronic.

Treatment.—The first step in the treatment should be to stop the caustic action of the material which has been swallowed. Thus if an acid is swallowed, the patient should quickly drink some alkali, such as magnesia, chalk, or milk. Alkalies in the form of carbonates are less serviceable on account of the development of carbonic acid gas. If an alkali has been swallowed, the patient should be given vinegar, acetic acid, or lime-juice. In any case the strength of the caustic can be diluted by water or other indifferent fluids. On account of the risk of perforation, the stomach-tube, if used at all, should be introduced with the greatest caution. If the caustic has poisonous properties as well as caustic ones—for example, carbolic acid or corrosive sublimate—the washing out of the stomach is less dangerous and more important. The subsequent treatment in mild burns is purely internal, similar to that employed in ulcer of the stomach.

Surgical treatment may be demanded in the following cases: 1. In perforation and peritonitis an immediate laparotomy and tamponade may be necessary. Suture of a recent perforation due to caustic is scarcely practicable. 2. If a considerable portion of the stomach is cauterized, it may be necessary to eliminate it until it has time to heal. Several successful jejunostomies performed for this purpose have been reported. If the ulcer has already cicatrized with stricture, a gastro-enterostomy is usually indicated. If only the œsophagus is burned, gastrostomy would naturally be performed rather than jejunostomy. 3. If the cicatrix leads to stenosis of the pylorus, pyloroplasty or gastro-enterostomy is indicated; and if it leads to hour-glass stomach, gastroplasty or gastro-anastomosis may be successful in restoring the normal relations of the parts, or gastro-enterostomy may be necessary. 4. If only the lesser curvature or the cardiac portion of the stomach is burned, gastrostomy is indicated. A burn in this locality often produces stenosis of the cardia, which may be treated by bougies passed through the mouth or passed through the gastric fistula.

Some surgeons do not believe that the healthy stomach ruptures spontaneously. In the cases of this accident which have been reported the stomach was probably the seat of an ulcer or burn or a scar. The treatment of spontaneous rupture, if it occurs, is similar to that of traumatic rupture or that of a perforative ulcer.