The surgical treatment of wounds and obstruction of the intestines / by Edward Martin and H.A. Hare.

WOUNDS AND OBSTRUCTION OF THE INTESTINES.

MARTIN AND HARE.

THE

SURGICAL TREATMENT

OF

WOUNDS AND OBSTRUCTION

OF THE

INTESTINES.

BY

EDWARD MARTIN, M.D.,

INSTRUCTOR IN OPERATIVE SURGERY UNIVERSITY OF PENNSYLVANIA,
SURGEON TO THE HOWARD HOSPITAL,
ASSISTANT SURGEON TO THE UNIVERSITY HOSPITAL,

AND

H. A. HARE, M.D.,

CLINICAL PROFESSOR OF DISEASES OF CHILDREN AND DEMONSTRATOR OF THERAPEUTICS IN THE UNIVERSITY OF PENNSYLVANIA,
PHYSICIAN TO ST. AGNES HOSPITAL.

Dr. Morris Longstreth
from
H. A. Hare

PHILADELPHIA:
W. B. SAUNDERS,
913 WALNUT STREET,
1891.

PHILADELPHIA:

COLLINS PRINTING HOUSE,

705 JAYNE STREET.

TO

D. HAYES AGNEW, M.D., LL.D.,

PRESIDENT OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA;

HONORARY PROFESSOR OF SURGERY IN THE UNIVERSITY OF PENNSYLVANIA,

This Work is Dedicated,

AS A TRIBUTE OF AFFECTION AND RESPECT

BY TWO

OF THE MANY YOUNG MEN HE HAS

BEFRIENDED.

PREFACE.

In presenting this essay upon the Surgical Treatment of Wounds and Obstruction of the Intestines to the Trustees of the Fiske Fund, it is proper to outline the scope of our work and to state briefly the facts and lines of original research upon which our conclusions are based. For over two years we have made experiments in the laboratory upon these subjects, and have carried out with every detail all the methods and modifications of operations that have been published, or which occurred to us in the course of our own studies. It is for this reason we feel some confidence that the opinions expressed by us in the following pages are not without a firm basis, and that they are stated with the positiveness of one who is sure of the ground on which he stands.

In addition to the original work involved in studying so important a branch of surgery as the one before us, and which will be found represented graphically, in part at least, by a number of tracings, we have collected and placed before the reader what we believe to be the fullest statistics yet collected upon gunshot wounds of the abdomen.

Our tables of intestinal obstruction fully recorded in the original manuscript we have summarized, appending to the various forms of acute obstruction the result of analysis of our own cases.

CONTENTS.

WOUNDS AND OBSTRUCTION OF THE INTESTINES.

INTRODUCTION.

INTESTINAL OBSTRUCTION.

UNDER the heading of intestinal obstruction are commonly classed not only such conditions as strangulation, which by a direct primary effect produces a mechanical impediment to the outward passage of the intestinal contents, but also certain pathological states, as peritonitis or enteritis, which, by engendering a paralytic condition of the intestinal walls, favors primarily stasis, with resultant fermentation of the contained matter and the development of the typical symptoms of obstruction, accompanied by those of either inflammation or septic absorption.

From the clinical standpoint all authors agree in classifying the cases of intestinal obstruction under the headings acute and chronic, though no sharp distinctive line can be drawn between the two, and either is liable to merge into the other.

The further general classification of conditions causing acute intestinal obstruction is as follows:—

1. Congenital malformations.
2. Invagination, or telescoping of one portion of the bowel within another.
3. Internal strangulation, by bands, diverticula, membranous adhesions, through apertures, or by means of the abnormal attachments of organs not in themselves diseased.
4. Volvulus, or twisting of the bowel.
5. Impaction of foreign bodies, gall-stones, etc.

To these headings should be added still another, namely:—

6. Obstruction from intestinal paralysis and distention.

The causes producing chronic obstruction are—

1. Stricture.
2. Neoplasms.
3. Pressure of tumors external to the bowel.
4. Impaction of fecal masses.

CHAPTER I.

CONGENITAL MALFORMATIONS.

UNDER this heading are considered anomalies or malformations of the bowel itself rather than of its environments, though upon a fissure or defect of the diaphragm, or upon abnormal persistence of the omphalo-mesenteric duct, may depend an occlusion no less absolute than that characterizing closure or absence of a part of the bowel.

The obstruction is, in the great majority of cases, dependent upon malformation, or absence of the rectum or anus.

In the rare cases of coarctation, or atresia (imperforation), in the continuity of the intestinal canal, the lesion may be situated at any portion of the alimentary tract, though as a result of the study of many cases the seats of preference seem to be, in the small intestine, the duodenum, and the region of the ileocæcal valve; in the large intestine, the sigmoid flexure.

Apitz[1] records a case of imperforation of the œsophagus, the latter ending in a blind *cul-de-sac*. Cases of atresia at or about the region of the pylorus are on record. Turner[2] describes the autopsy of an infant in which there were two portions of the jejunum reduced to fine impermeable bands. Pied[3] has observed the complete separation of the duodenum from the jejunum. The absence or stricture of portions of the ileum (Blat.,[4] Andrews,[5] Lobligeois[6]), or colon (Cohen,[7] Thomas,[8] etc.) has been occasionally recorded. Thomas notes the complete absence of jejunum, ileum, and the greater part of the colon.

[1] Allgemein. Deutsch. Hebammen. Zeitung, 1.
[2] Edinburgh Med. Jour., 1863–4, ix.
[3] Jour. de Méd. Chirurg. et Pharm., 1802, iii.
[4] Bulletin Soc. Anat. de Paris, 1849, xxiv, 1856.
[5] Peninsular Med. Jour., Ann Arbor, 1853–4.
[6] De l'Oblit. Congen. des Intestines, 4°, Paris.
[7] Med. Zeitsch., Berlin, 1838, vii.
[8] Lancet, London, 1884.

At times the symptoms of obstruction can be traced to a strangulation, an incarceration, or a volvulus due to malposition. Price[1] gives an instance of transposition of the stomach and duodenum, with the colon placed behind the latter. As a consequence of this the colon was strangulated, the case terminating fatally.

The cause of congenital coarctation, or atresia of the intestinal canal, is usually a pre-natal inflammation, either primarily interfering with growth, or by the deposit and organization of inflammatory exudate, producing such disturbance in nutrition that wasting and contraction take place.

It is of importance to bear in mind the fact that the stricture or defect is in many cases not limited to one part of the bowel.[2]

The more common congenital formative defects of anus and rectum are classified with reference to the method of development of these parts. The anal opening is continued upward until it finally unites with the rectum in its downward extension. From arrested development, or inflammation, there may be narrowing (partial occlusion), atresia (complete occlusion), or absence (imperforation) of anus, of rectum, or of both these structures. Again, there may be a stenosed opening in an abnormal position. Goodman[3] reports a case of imperforate anus and rectal atresia unsuccessfully treated by colotomy, in which, at the autopsy, the rectum was found to communicate by means of a minute orifice with the urethra at the base of the Caput Gallinaginis.

The frequency of associated narrowings in other parts of the alimentary canal must be considered in dealing with these abnormalities. A child operated upon by Darien[4] for imperforate anus was, at the autopsy, found to have a dilatation of the duodenum, imitating a second stomach; this was due to occlusion on the intestinal side by à complete spiral valve.

Symptoms.—The symptoms of obstruction dependent upon congenital stenosis, or atresia of the intestinal canal, are, of course, not developed until after birth, and the taking of food by the mouth. They do not differ from those of acute obstruction dependent upon other causes. There is no passage of fecal matter from the anus;

[1] Am. Jour. Med. Sc., 1853.

[2] Gaertner, Jahrb. f. Kinderheil, 1883.

[3] Medical Register, Feb. 25, 1888. [4] Bull Soc. Anat. de Par., 1881, lvi.

there is obstinate and continued vomiting of all food taken; this vomited matter is more or less feculent in odor and appearance, depending upon the seat of obstruction and the time which has elapsed since the symptoms developed. There is often violent peristalsis to be detected through the belly walls. There may be much tympany. Symptoms of pain, and straining efforts at defecation are common. Death is inevitable if the case is not treated surgically.

The immediate cause of the fatal issue is inanition or exhaustion. Perforative peritonitis occurs at times, but is not so common as in acute obstruction of a more advanced age.

With such symptoms following hard upon birth, the diagnosis of obstruction from either congenital malformation or internal strangulation would be positive, and, as either would demand the same treatment, the differential diagnosis between these two is not absolutely essential.

Diagnosis.—Since the most common seat of this form of congenital malformation is about the anus and rectum, a careful search should be made in this region, the finger being carried into the anal aperture, if patulous, in the hope of finding the seat of occlusion. By means of a bougie, exploration can be carried some inches further than the finger can reach.

It must be remembered that, the rectum and anus being normal, the next probable seats of obstruction are at or about the duodenum, the ileocæcal valve, or the sigmoid flexure of the colon.

In the new-born child the colon is a foot in length, and normally occupies the same anatomical region as in the adult. The sigmoid flexure is ten inches long, and lies mainly in the pelvis.

The condition of the colon can readily be made manifest by means of injection of either air, hydrogen, carbonic acid gas, or any unirritating liquid, preferably normal saline solution (.7 per cent.). Neither gas nor liquid should be passed into the bowels by means of a force-pump, or any kind of injecting syringe.

If gas is used it should be passed from a bag, and the pressure, not exceeding a pound and a half, should be kept under observation by means of a manometer attached to the supply tube.

The best way of introducing water is by means of gravity. The ordinary fountain syringe answers every purpose; the nozzle should

be wrapped tightly, an inch and a half from its extremity, with a narrow roller bandage, thus forming a shoulder which can be pressed against the anus, preventing a premature discharge of the injected liquid. The receiving bag should not be elevated more than three feet above the level of the patient. This gives a pressure of, approximately, one and a half pounds to the square inch, and is, in all probability, sufficient to overcome the resistance of the ileocæcal valve, if steadily and continuously applied.

By either gas or liquid injection the colon, if permeable, can be distinctly and unmistakably outlined, and by slightly increasing the pressure (three pounds) the ileocæcal valve may be made to yield, if healthy. If the colon is not permeable throughout its whole extent, the point where the injection is arrested is at once demonstrated.

The quantity of liquid required to fill the extent of the colon permeable from below is also of diagnostic significance, since, if it be but an ounce or two, the obstruction must be low down, while if many ounces are received, this indicates a seat much nearer the ileocæcal valve.

The character of the vomit would probably suggest the location of atresia at or near the pyloric valve. In addition to this, where the atresia is located in this region, the tympany is mainly confined to the epigastric region, the lower part of the bowel by contrast appearing to recede.

The passage of the injection through the ileocæcal valve for the further localization of the seat of obstruction is not to be recommended in this relation, since the information to be derived from it is of little value, and it is a method which might produce serious results upon the delicate intestinal walls of children.

Prognosis.—If the case is not treated surgically, the prognosis is absolutely unfavorable. That there is a possibility of nature effecting a cure, under certain circumstances, is shown by the remarkable case reported by Theremin,[1] which, though finally perishing, lived for six months. At the autopsy the upper part of the duodenum terminated in a blind pouch, the inner surface of which was so deeply invaded by an ulcer that a minute opening was

[1] Deut. Zeit. f. Chirur., viii. 3, 34.

formed into a *cul-de-sac* of the ileum. Practically, death is certain, and usually occurs on the third day, though it may be postponed till the fifteenth or twentieth day.

With a mortality of a hundred per cent., for expectant treatment there should be no hesitation in resorting to the knife, but even here prospects are gloomy, and the prognosis must be distinctly unfavorable.

Of 49 cases, in 14 (28 per cent.) there was more than one point of obliteration.

Of 37 more elaborately reported cases, malformation was so great in 4 that no operation could possibly avail. In 10 enterotomy and the establishment of an artificial anus would have been indicated; in 20, as far as the anatomical relations were concerned, a lateral approximation might have been practised.

Putting aside, for the moment, the risk attendant upon laparotomy as performed upon such young children, the operation will, from these figures, be inevitably unsuccessful in 10 per cent. of cases, and can accomplish nothing more satisfactory than an artificial anus in 21 per cent.

TREATMENT.—Having located the seat of obstruction in the anus, the rectum, some portion of the colon, or, these parts being normal, somewhere in the continuity of the small intestines, the question of treatment arises.

This should invariably be operative. Where the anus is completely occluded or is imperforate the condition of the rectum, or even its presence, cannot be positively ascertained, though a bulging in the ischio-rectal region, observed during straining or crying, would denote a *cul-de-sac* of bowel not far from the surface. It is universally agreed that in these cases, unless the cause of obstruction be simply a membrane or a thin wall of tissue, a careful search should be made for the gut, carrying the incision into and through the anatomical region in which the bowel should lie. The obliquity of the pelvis in children must be borne in mind by the operator, and since it exhibits, compared to the size of the child, very small measurements, from the top of the coccyx to the pubic symphysis but little more than an inch, Verneuil has proposed resection of the coccyx in these cases as a means of giving room in

the direction in which the search should be carried, *i. e.*, backward and upward.

If the rectum is found, it should be brought down to the skin wound and stitched in place. Allingham distinctly advises against the latter procedure on the ground that it prolongs the operation, that the stitches cut out, as a rare exception only, effecting the object for which they are placed, and that the formation of abscesses is more common; but it not only has received the concurrence of Amussat, of Verneuil, and of the profession at large, but is more in the line of modern antiseptic work, seems rational, and has to its credit many brilliant successes.

If the rectum cannot be found by this incision, followed by careful dissection upwards and backwards to the depth of an inch, or an inch and a half, the cut for left inguinal colotomy should be made. If the finger, passed into the peritoneal cavity, shows that the perineal incision can be safely deepened, with a condition of the rectum which will allow of its being drawn through the opening, the operation first undertaken should be completed, and the peritoneal incision should be closed.

If, however, the conditions are such that an attempt to form a new rectum and anus is inadmissible, as, for instance, where there is complete absence of rectum and atresia of the sigmoid flexure, then left inguinal colotomy should be performed. The gut should be held in place, after suture of the skin to the parietal peritoneum, by a piece of rubber catheter passed across the wound and through the mesentery close to the bowel, or by a harelip pin, as described by Kelsey, used in a similar way, except that it transfixes each edge of the parietal wound. Stitches should, of course, be added. Before securing the bowel in this way a digital examination should be made in the region of the ileocæcal value and the duodenum, since these are the commonest seats of congenital malformation.

Many cases have been illustrative of the danger of depending upon left or even right inguinal colotomy without making further exploration of the abdominal contents. Depault[1] formed, by means of colotomy, an artificial anus in the case of a child suffering, immediately after birth, from obstructive symptoms. After death the ileum was found to end as a *cul-de-sac* a very short distance from the ileocæcal valve. Laborde[2] performed a similar operation, but

[1] Gaz. de Hôpit., 1856.

[2] Gaz. de. Par., 1861.

found at the autopsy a complete occlusion of the jejunum nine and one-half inches from the pylorus, together with five other atresiæ of the small intestines.

If the obstruction is found to depend upon an atresia of neither anus nor rectum, the surgeon should advise an exploratory abdominal section in the hope of finding the seat of trouble and remedying it by colotomy, enterotomy, or lateral anastomosis.

Now that an exploratory abdominal section can be safely performed, it would seem rational in cases of imperforate anus, or rectum, or both, where there was no succussion or bulging to be detected in the ischio-rectal region during crying or straining efforts of the child, to at once enter the peritoneal cavity by an incision as for colotomy, and examine the condition of the sigmoid flexure and rectum. If the operation from below were then practicable, it could be rapidly and safely performed, the operator being guided by the knowledge obtained by his exploratory incision, and by the finger passed from above to the seat of operation. If colotomy were indicated, it could be performed at once. This would save the prolonged and trying dissection necessitated by ignorance as to the seat and condition of the rectum or sigmoid flexure.

The treatment of this condition by trocar and canula, with subsequent dilatation, has little to recommend it beyond the ease of its application. It is not devoid of danger. In at least one instance the iliac vein was wounded, and even if no viscera are injured, the outlet thus provided is insufficient.

Though the mortality of abdominal section in children is high the operation is not, as is the disease it is intended to combat, absolutely fatal.

In case of invagination the surgeon has far more right to hesitate, since here there is a fair percentage of spontaneous cures or assisted cures without operation. In congenital occlusion from malformation, however, there should be no alternative.

Nor is the statement that children are easily and profoundly shocked by operative procedures entirely true. Chilling and loss of blood they stand not at all, but any one with wide experience in the treatment of their diseases is frequently astonished at the rapidity with which they react from tedious and severe surgical operations, provided there has not been much hemorrhage, they

have not been chilled, and that the anæsthetic has been carefully administered.

Given then a case of congenital occlusion, which may be located in any portion of the small or large intestines, the abdomen must be opened, and the sooner this is done the greater are the chances of success. There should be no waiting after the diagnosis is clearly established.

If the constriction is in the colon and its seat has been recognized by the gas or water test, an incision in this region is indicated, since, should the obliterated portion of the bowel be of limited extent it could be carried out of the wound, in the method described for left inguinal colotomy, with a prospect of subsequently closing the artificial anus thus created by a plastic operation. Or, should the condition of the child make a somewhat more prolonged procedure justifiable, the continuity of the colon could be restored by a colostomy. The incision for exploration, where the seat of obstruction is not known, should be in the middle line of the belly, either just above or just below the umbilicus.

Bearing in mind that the duodenum and the ileo-cæcal valve are the regions commonly affected, it is here that search should be made. If the cause of trouble is found at the duodenum, gastro- or duodeno-jejunostomy will be indicated; if at the ileo-cæcal valve the condition of the patient must determine the choice between ileo-colostomy and enterostomy. If, however, there are multiple seats of atresia, if a large portion of the intestinal canal is atrophied or absent, all operative treatment must be abandoned.

Chloroform should be used as an anæsthetic in these cases, because it is not followed by the vomiting which characterizes ether. The abdominal parietes and the exposed viscera should be kept warm by means of light, thin-ribbed, rubber hot-water bags at 110° F., and hot flannel cloths. Every endeavor should be made to hasten the operation.

There is reason to believe that, should this method of treatment be adopted, some cases at least can be saved. A high percentage of cures cannot be hoped for, but each successful case is a triumph to surgical skill.

When no operation is undertaken, the withdrawal of all nourishment by the mouth, the administration of digested nutrient enemata by the bowel, and the subcutaneous injection of weak solutions of alcohol (10 per cent.) should be advised.

SUMMARY.

1. The congenital malformations which cause intestinal obstruction are mainly due to prenatal inflammation, and may involve any portion of the intestinal canal.

2. Excepting atresia or imperforation of the anus and rectum, the common seats of this malformation are at or near the ileocæcal valve; in the duodenum, or at the juncture of the duodenum with the jejunum; in the sigmoid flexure of the colon.

3. In 28 per cent. of these cases the malformation is multiple, and in over 10 per cent. is of such a nature (atrophy, extensive obstruction) that it is mechanically irremediable.

4. The symptoms are those common to obstruction (absolute constipation, fecal vomiting, pain, and tympany). If the trouble is in the colon, its seat can be located by gas or water injections; if near the pyloric valve, by the peculiar epigastric distention and the character of the vomit. The prognosis is absolutely bad, death usually taking place on the third day, though life may be prolonged for weeks.

5. The treatment is surgical. For imperforate anus, the coccyx may be excised, and the bowel sought for by cutting upward and backward. If this fails, or as a first resort where there is absence of bulging in the anal region when the child cries, the incision, as for left inguinal colotomy, should be made with digital exploration of the regions commonly malformed. If the conditions justify it, an attempt to form a new anus and rectum in the normal position of these structures should be made, the finger from above being used as a guide.

Finally, if this is not possible, and no other seat of narrowing has been found, the surgeon should resort to left inguinal colotomy.

6. Where the seat of obstruction is unknown, exploratory abdominal section is indicated, followed by either gastro-enterostomy, entero-enterostomy, entero-colostomy, enterostomy, or colostomy, as indicated by the special lesion and the condition of the patient. With chloroform as an anæsthetic, attention to the preservation of the body heat, and rapidity of manipulation in completing the operation, fair results may be expected.

CHAPTER II.

INTUSSUSCEPTION.

By intussusception is meant the invagination or turning of one portion of the gut within the lumen of another part immediately adjoining.

The invagination is made up of three layers of bowel.

The *intussusceptum* is composed of the entering and returning layers, while the receiving layer constitutes the *sheath* or intussuscipiens. The ring formed by the entering layer as it is turned sharply upon itself to form the returning layer is called the *apex*. By the *neck* is meant the ring which results from the flexure formed by the returning layer as it merges into the sheath.

Classification.—Intussusception is usually considered under the two general heads, acute and chronic. Rafinesque, for purposes of clinical study, has still further elaborated this classification into—

1. Ultra acute, death taking place within the first twenty-four hours.
2. Acute. The case terminating between the first and seventh day.
3. Subacute. Lasting one month and upward.

The invagination, if named from its seat, is termed—

(a) *Enteric*, involving the small intestines only.

(b) *Ileocœcal*, in which the ileum and cæcum, together with the ileocæcal valve, are turned into the colon.

(c) *Ileocolic*. In this the ileum is prolapsed through the ileocæcal valve, the latter retaining its proper position till, as a result of secondary changes, it, together with the cæcum, is more or less displaced.

(d) *Colic*. The invagination involves the colon only.

(e) *Rectal*. Here the seat of trouble is situated entirely within the rectum.

Usually the upper segment of the gut is received into the lower; where the reverse condition obtains it is called retrograde intussusception. Rokitansky,[1] Harrison, Ulmer and others have reported cases. This was observed in 1.5 per cent. of Leichtenstern's 593 cases, and occurred in both the small and large intestines. As a secondary effect of a descending invagination there may be formed a retrograde intussusception which, involving the sheath of the former, surrounds the intussusception with five layers of gut. Spry[2] and Stainet[3] state that this is due to a loose intussuscipiens which becomes folded upon itself. Leichtenstern states that this is observed only in the colon.

Double and triple intussusceptions have been occasionally noted. In these cases the intussusception plays the part of a foreign body, thus producing reduplications of its encircling sheaths. It must be remembered that these invaginations are double and triple only in a very limited portion of their length.

Causes of Intussusception.—The cause of chief importance is irregularity in the nervous mechanism of the intestines, which allows of a sudden spasmodic contraction of a portion of the bowel, while its adjoining continuation may be entirely relaxed. This would seem to account for the intussusceptions so often observed upon the autopsy table, and which, there is every reason to believe, developed either during or immediately after the death struggle. These invaginations are frequently multiple and very limited in extent, and exhibit none of the effects of venous congestion, obstruction, or inflammation. The facts that obstructive invagination occurs in children, is associated with colic, is observed after abdominal injuries, and sometimes follows typhoid fever or enteritis, would all strongly suggest, as a probable causative factor, disordered innervation.

Nothnagle[4] has elaborately studied this question from an experimental standpoint. By means of the faradic current he vigorously stimulated a small portion of the bowel. At the point of stimulation the bowel became so firmly contracted as to lose its natural color, this contraction was continued upward for some distance, and

[1] Praktische Heilk., 1873–4. [2] Lond. Med. Journ., vol. iii.
[3] Bull. de la Soc. Anat. de Par., 1850, p. 314.
[4] Beitrage zur Physiologie und Pathol. des Darm., p. 42. Berlin, 1884.

not infrequently slight temporary retrograde intussusception was observed, from the relaxed portion of the bowel, which was not influenced by the electric current, slipping down somewhat over the upper portion of the seat of contraction. From immediately below the seat of firm contraction the bowel was observed to ascend in the form of a sheath, thus producing a descending invagination which progressively increased till the stimulation was removed, when nervous control being regained, the intussusception underwent spontaneous resolution. Nothnagle further asserts that stimulation of the bowel above the intussusception is without effect, but if the electric current, or any sufficient stimulus be applied below this point, the parts are promptly restored to their normal position by the ascending contraction.

We have made repeated experiments on dogs to confirm Nothnagle's conclusions, but our results varied greatly from those he has published.

We readily produced the firm ring-like contraction of the bowel segment to which the current was applied, but observed no attempt at invagination. To a Dubois-Reymond coil connected with two cells, and drawn out to twenty on the scale, were attached the electrodes. The segment of bowel stimulated was not upwards of a quarter of an inch in length. The current was used in all strengths, but without other effect than a local spasm so violent as to make the area involved resemble cartilage both in appearance and to the touch.

As other causes of invagination, secondary or exciting in their nature, may be mentioned, ingesta (28 cases in 593), polypi (5 per cent. of Leichtenstern's cases were dependent upon this cause), inflammatory affections of the bowels, traumatism (263 cases out of 593), and exposure to cold.

Pathological changes.—Cruveilhier and Gorham have observed that there is strong reason for believing that in many cases of severe colic, especially when dependent upon imprudent diet, slight temporary invagination is of frequent occurrence. This form probably resembles that called by the Germans *agonie invagination,* and found so frequently upon the autopsy table.

In the marked cases of invagination, profound pathological changes take place. As the intussusception increases at the expense of the intussuscipiens the mesentery is subject to constantly in-

creased tension; as a result of this, the whole of the involved gut and particularly the intussusceptum assumes a sickly-shaped curve, with its concavity toward the mesentery. The opening of the intussusceptum becomes simply a slit and is turned inward away from the lumen of the bowel. This incurvation involves the colon only slightly, and the rectum not at all; when marked it is undoubtedly a factor in producing obstruction, with its attendant symptoms.

That invagination, in itself, does not entirely occlude the lumen of the bowel is shown by the record of cases where life has been prolonged for weeks and months. The other causes operative in producing obstruction are; the lodgment of undigested food, of hardened fæces, or of a foreign body, and swelling of the involved area from venous congestion and inflammation dependent upon the constriction at the neck of the sac. There is usually an extravasation of blood into both the mucous membrane and the mesentery; inflammation is set up and the serous surfaces of the entering and returning layers become adherent to each other. Treves states that in acute cases these adhesions are more frequently absent than present. If they exist and are extensive, the best that nature can do is to strengthen the growth between the neck and upper portion of the intussusceptum, and discharge the lower portion of the latter by the process of ulceration.

The sloughing of a portion of the intussusceptum is an exceedingly common termination of this form of intestinal obstruction. It is sometimes discharged as a tube, but more commonly in the form of irregular fragments. The extent of bowel discharged is at times extraordinary. Dampier[1] records a sloughing bowel segment measuring 124 cm. and Bottcher,[2] 112 cm. with a polyp as the causative agent. The discharge of the gangrenous bowel may be the first sign of a rapid convalescence; if, however, the mortification has extended in the direction of the neck, perforation can be expected, with a resultant peritonitis which is most frequently diffuse.

This latter complication may arise without perforation, by extension from the inflamed and strangulated bowel, acute inflammation or sloughing of the mucous membrane so affecting the

[1] Med. Trans., vol. iv.

[2] Lobstein, Anat. Path., t. 1, p. 146.

remaining coats of the bowel that they are readily permeable to septic matter.

Again, cases of intussusception are recorded in which the condition has lasted for weeks and months without either producing obstructive symptoms during life or showing adhesions or marked congestion and inflammatory lesions after death.

Frequency of occurrence.—In a total of 1652 cases of intestinal obstruction, hernia excluded, collected by Leichtenstern and Bryant, 657, or approximately 40 per cent., were due to intussusception.

In regard to the age at which it develops all authors are agreed that it is most frequent in the first year of life. Of Leichtenstern's 593 cases, 131 occurred before the age of twelve months and the great majority of these in the fourth, fifth, and sixth months. The statistics of Smith,[1] Hansen,[2] and Pitts[3] absolutely confirm this. After the fifth year intussusception becomes comparatively rare till the fortieth or fiftieth year, when it again increases in frequency of occurrence.

The ileocæcal region is the favorite seat of invagination at all ages. This is especially marked in the first year of life, when this form of invagination is more common than the combined sum of all the others; the ileum invagination being exceedingly rare. If the invagination is in the ileum, the lower segment of this portion of the bowel is its common position; if in the colon, it will generally be found at the sigmoid flexure.

Symptoms.—Depending mainly upon the amount of constriction at the neck of the intussusceptum, consequently upon the amount of congestive swelling and bowel obstruction, the intussusception is classed as either *acute* or *chronic*, and the symptoms of each form are to a certain extent different. Also the symptomatology of intussusception in the infant is not identical with that of the adult or old man. In general it may be stated that the first symptom of acute intussusception is—

Pain.—Sudden, violent, diffuse; or, if localized, usually placed in the ileocæcal or umbilical region. After a few hours, in children, a much longer interval in the adult, the pain ceases, often as

[1] Amer. Journ. Med. Sci., 1862.

[2] Dissertat. In-aug. Dorpat., 1864.

[3] Jahrbuch für Kinderheil, 1870, Bd. 3.

suddenly as it commenced, and there is an interval in which there is little to suggest that the pathological condition still continues. This is followed by a return of the pain, the paroxysms becoming more violent and prolonged, the intervals less marked as the disease progresses, or in the adult if it passes into the chronic form, intervals of even days may elapse between the paroxysms. The pain is frequently accompanied by tenderness, but this is an exceedingly variable symptom, and at times pressure seems to relieve the pain.

Vomiting.—This is practically a constant symptom, occurring with the sudden pain, or, at times, even preceding it. In children it continues till shortly before death and is rarely feculent.

In the adult and in the chronic form, there may be complete absence of vomiting, though this is certainly exceedingly rare. Leichtenstern takes exception to the statement that the seat of obstruction is indicated by the period at which vomiting is developed.

The ileum-invagination is most frequently accompanied by early vomiting, not because of its seat, which is usually but little removed from the ileocæcal valve, but because it is commonly obstructive. The vomiting, both in time of development and in nature, will depend, not upon the seat of trouble, but upon the presence or absence of obstruction, and may be early, if the obstruction is absolute in the sigmoid flexure, and feculent if the bowel is occluded in the upper part of the ileum.

Blood-stained mucous evacuations.—This symptom is, in children, rarely wanting. Of 108 cases of invagination in the first year of life this symptom was absent in but four. It occurs within a few hours of the first attack. At first the discharge is of blood-stained feces; later, if obstruction is developed, of blood and mucus, and is usually exceedingly offensive. In children, diarrhœa is common throughout the whole course of the case. At times, following complete constipation and feculent vomiting, there will suddenly appear copious evacuations from the bowel, mingled with blood, and in which may be found evidences of the necrosed intussusceptum. Where this slough is extensive it may be lodged in a lower portion of the bowel and cause fatal obstruction.

Tenesmus.—In connection with the muco-sanguinolent evacuations the *tenesmus* or straining is a symptom so common that it is of some diagnostic import. That it is not dependent upon the character of the evacuation is shown by the fact that it is present

in cases of complete obstruction. Brinton has shown that this symptom is seldom developed except in the ileocæcal and colon invaginations.

A much rarer condition, and one which Leichtenstern ascribes to the secondary effect of intense tenesmus, is a *patulous condition of the anus* due to paralysis, and dependent upon invagination of the descending colon and rectum. This is never produced by invagination of the ileum.

Tumor.—Leichtenstern's statistics show that a tumor can be felt, either through the parietes or by rectal examination in 52 per cent. of all cases. In the first year of life this most important diagnostic sign was present in 63 per cent. The tumor is usually felt in the left iliac region, or by the finger passed into the anus. The ileocæcal invagination is most frequently accompanied by demonstrable tumor; the ileum invagination exhibits this symptom with less frequency.

Many authors have noted that the tumor varies in size and consistency from time to time, now, during an acute paroxysm of pain, being hard, knotty, and plainly perceptible shortly afterward eluding the most careful search. Duchaussoy has described two distinct movements which can often be perceived in the tumor, namely, the *erectile* and the *vermicular motion.*

Distention of the abdomen is not of great significance, because so often absent. In children especially it may appear not at all, or just before death. In adults, where obstruction is more common, it may become as well marked as in obstruction from any other cause.

Dance[1] calls attention to an inequality in the shape of the abdomen dependent upon the meteorism, and in view of which he states that the seat of obstruction can often be inferred. But few authors, however, have been able to profit by his observation.

In the chronic form of invagination the symptoms are less violent in onset; there may be nothing more characteristic of the attack than recurring paroxysms of pain, meteorism, and obstruction; with symptoms of intestinal stricture constantly manifesting themselves. These cases terminate either in cure by reduction or by extrusion of a slough, or perish from exhaustion, inanition, or

[1] Rept. gen. d'anat. et de phy. Path. bd. i. 1826, p. 206.

in the course of an acute attack. In over one-half the recorded cases a correct diagnosis was not made.

Prognosis.—Leichtenstern places the general mortality of intussusception as treated by the expectant method at 73 per cent. Pilz, Hansen, and Duchaussoy arrive at a similar conclusion. Our own statistics show even a higher rate of mortality (90 per cent.). In the first year of life this mortality is much higher, mounting to 88 per cent., and death commonly occurs between the fourth and seventh day. Between the eleventh and fiftieth years the fatality is less (63 per cent.), and the duration of the disease is, when fatal, between eleven and fourteen days. In late life the mortality rate rises again.

The sloughing and discharge of the intussusceptum must be regarded as a decidedly favorable circumstance, since of 408 children in whom the sloughing did not take place 345 (*i. e.* 85 per cent.) died, while of 149 children who passed the sphacelated portion of gut, 61 (41 per cent.) recovered. This discharge of bowel occurs very rarely in early infancy; it is most common when the ileum is involved in the intussusception, and is most favorable when it is observed in middle life. It usually occurs between the eleventh and twenty-first day of the attack.

It must not be considered that after discharge of a sphacelated bowel the danger is passed, since 41 per cent. of these cases perish at any time between a few hours and two years following the acute attack.

In case there is no sloughing of bowel, the colic and ileocæcal invaginations give a better probability of life than do those of the ileum.

The cause of death is usually, in children, exhaustion and inanition. General or perforative peritonitis is exceedingly uncommon. In the adult, perforation and resultant peritonitis are of frequent occurrence.

Diagnosis.—The diagnosis of intussusception is made upon the *acute onset* of colicky pain, and its intermittent character; passages from the bowels containing blood and mucus; the presence of a tumor, commonly in the left iliac region, or felt through the anus; varying in size and consistency from time to time, with an erectile

or vermiform motion and the ordinary obstruction symptoms. The diagnosis is further confirmed if there are violent peristalsis and tenesmus, and if these symptoms occur in an infant.

TREATMENT.—The diagnosis having been assured, the treatment will be either medical or surgical. And even in those hyper-acute cases, where death takes place in a few hours, apparently from shock, the first resort should be to those non-operative means to be shortly described, and which have many times proved successful.

The pathology of the disease teaches us that disinvagination becomes more difficult in direct proportion to the length of time which has elapsed since the onset of symptoms; hence every hour diminishes the chances of success. Whatever the age of the patient or the seat of the trouble, provided the case is not of such long standing that tight adhesions have probably made reduction impossible, or strangulation has produced a partial necrosis, ether should be administered to its full surgical extent, producing complete relaxation of the muscular system; by means of a fountain syringe *hot* (105° to 108°) .7 per cent. saline solution should be *slowly* (4 ounces to the minute) forced into the rectum under a pressure of not over two pounds to the inch (elevation of the irrigating bag 4 ft.), the liquid being retained by a shoulder upon the injection pipe, readily made by wrapping it with a narrow bandage; the abdomen should be thoroughly kneaded, the manipulations being so planned as to encourage disinvagination. This treatment should continue for thirty to forty minutes, the pressure being gradually increased by raising the bag till a pressure of not over eight pounds is produced, and may, if the tumor does not disappear, be combined with inversion and shaking.

This trial at forced reduction must be *thorough* and *final;* there should be no idea that it is to be repeated with more care and attention to detail. If it fails, the surgeon must proceed to an abdominal section for the purpose of accomplishing disinvagination. If there is a distinct tumor, the probable success of the method above detailed will be denoted by its disappearance, the positive failure by the tumor occupying the same position as before treatment and retaining its full size; in this latter case the surgeon may proceed to operate at once without letting the patient recover from the anæsthetic. Where there is any doubt as to the effect of the

treatment, however, and this will be in the majority of cases, the patient must be allowed to come out of his condition of anæsthesia, when the progress of symptoms will quickly decide as to whether a cure has or has not been effected.

It is true that the statistics of abdominal section for invagination appear to be exceedingly bad, Ashhurst[1] giving the mortality percentage in 65 cases at 75.4 per cent. There can be but little doubt that the percentage is in reality even higher than this, since the natural tendency is to report favorable cases. Individual experience will corroborate this, since every surgeon can recall unsuccessful and unreported cases of which he has personal knowledge while the few successful cases have all been put on record.

Heretofore abdominal section has been considered as a last resort to be attempted after days spent in repeated and ineffectual efforts at reduction by small enemata, by air or gas insufflation, by inversion and shaking, by, at times, full doses of purgatives, or pounds of metallic mercury; when the patient's strength was far spent, and inevitable and *immediate* death was staring him in the face.

Under these circumstances it is obviously unfair to compare the statistics of operative cases with those treated expectantly, yet the mortality against the surgeon is but little higher (less than 2 per cent.). Given an equal number of cases treated on the one hand expectantly, on the other hand by immediate operation, it would be hard to find an abdominal surgeon who doubts but that his percentage of success would justify his methods. Considering the class of cases in which section has been employed, any percentage of success would be encouraging; if resorted to when all conditions are favorable, that is, immediately after one thorough effort to accomplish reduction without operation, we believe that the percentage of recovery will be so high that even the most conservative will be disposed to recommend it.

While it is granted that there are certain cases in which disinvagination cannot be effected, and in which nature frequently accomplishes a spontaneous cure by sloughing, it must be remembered that this form of cure is very rare in young children, and that over 40 per cent. of cases thus terminating subsequently perish from

[1] Internat. Encyc. of Surg., vol. vi., p. 69.

the direct effects of the invagination and following necrosis. In those cases where the severity of the symptoms and the amount of obstruction denote much strangulation, and which have not been seen for several days from the onset of the attack, we believe that section should be the *first* resort.

Abdominal section then should follow immediately upon the failure to reduce. The incision should be over the tumor if one is demonstrable, or, in the absence of this sign, in the middle line of the body, below the umbilicus. The regions of preference should be searched, and the invagination being found, an effort at reduction should be made; not by pulling upon the intussusceptum, but by grasping the tumor at its lowest part, and by gentle, continued pressure, reducing the venous congestion; then by traction from above and pressure applied from below, the reduction will be much facilitated. If adhesions have formed about the neck, a probe passed between the entering and returning layer, and carried around the circumference of the bowel, may enable the surgeon to break them up, and thus accomplish reduction which would otherwise be impossible. If the adhesions are so tight that restoration of the gut to its normal condition is impossible, we believe that, unless the patient's strength is exceptionally well preserved, an enterostomy and formation of an artificial anus will afford the best hope of recovery, since it has been shown[1] that even where the cause of obstruction is not removed, the relief afforded by this operation frequently enables spontaneous resolution to take place subsequently, with complete restoration of the continuity of the alimentary canal. If gangrene has set in and is involving the intussuscipiens, resection with the formation of an artificial anus to be subsequently closed by plastic operation; or, in exceptional cases, lateral approximation will be indicated.

Of drugs, but two should be used in invagination, namely, opium and belladonna.

In another part of this paper (see Peritonitis) is discussed not only this subject, but the relative merits of the various therapeutic agencies, mechanical and otherwise (see Treatment of Obstruction), commonly employed in this affection. As a result of experimental work, of practical experience in this class of

[1] Curtis, Med. Rec., Sept. 1, 1888.

cases, of careful examination of elaborate statistics, we are convinced that the method of treatment above indicated is the one which will give the most satisfactory results.

INTUSSUSCEPTION.

Total number of cases		73
Operative cases	Recovered	11
	Died	8
Non-operative cases	Recovered	17
	Died	32

Five cases results not given.

CHAPTER III.

INTERNAL STRANGULATION.

As a cause of obstruction, internal strangulation by bands, etc., ranks in order of frequency next to intussusception, contributing more than 25 per cent. to these cases, or according to our own statistics 36 per cent. of classified cases. It occurs most frequently in males between the twentieth and fortieth year, and is, in the great majority of cases, due to the remains of a former peritonitis, though strangulation through the foramen of Winslow, through the diaphragm, and into congenital or acquired peritoneal diverticula, particularly in the region of the iliac fossa and the pelvis, have been many times observed. In regard to the seat of internal strangulation the combined statistics of Duchaussoy, Besnier, and Haven give, in a total of 151 cases, the small intestines as involved in 133, and our own figures are in accord with this.

Treves classes under the heading "Hernia-like Strangulation of the Bowel:"—

1. *Isolated peritoneal adhesions*, due to former peritonitis, and the subsequent drawing out of the organized lymph by means of the vermicular motion of the bowel into a cord, these bands being generally single and attached by their two extremities to practically any portion of the parietal peritoneum or the abdominal viscera.

When a short band stretches tightly over a firm surface the gut may slip beneath it and be strangulated.

When there is a long band not very tense, and attached only by its extremities, looping or knotting may occur. Le Bedois[1] notes a case of strangulation by a band passing twice around a loop of the ileum, and Leichtenstern describes a mechanism by which the false ligament being sufficiently loose a true slip-knot was formed, in the loop of which the bowel was caught. He states that all these knots are characterized by the circumstance that the moment

[1] Arch. Gén. de Méd., Par. 1827, xiii. 230.

the gut is released from their bight they can immediately be drawn out by pulling each end.

2. *Strangulation by cords formed from the omentum.*—Inflammatory adhesions, due either to traumatism or to involvement in peritonitis, are the beginning points of the thick strong omental cords. These are commonly found attached about the region of the internal inguinal ring of the left side. They are somewhat larger and looser than the isolated peritoneal bands, and hence more frequently form knots.

3. *Strangulation by Meckel's diverticulum.*—The vitelline pedicle attached in the embryo to the lower fourth of the ileum sometimes persists, and may, exceptionally, exhibit all the features of normal intestine. Thus Cruveilhier's[1] operation was unsuccessful because from the size and appearance of the constricting diverticulum it was taken for the intestine. More commonly it is represented by a blind tube or fibrous cord, two or three inches in length. The extremity of the diverticulum may be attached or remain free; if attached primarily, it will be found at or just below the position of the umbilicus. This attachment may be ruptured and secondary adhesions take place in nearly any part of the abdomen. The diverticulum is found to be much more common in the male than in the female.

In addition to the true Meckel diverticulum there are certain pouch-like extensions from the bowel, sometimes occurring in great numbers, and which may, by contracting adhesions with surrounding parts, or with each other, cause strangulation of the bowel. It is well recognized that these pouch-like extensions of the gut are particularly prone to take place into the substance of the epiploic appendages of the colon. This probably was the condition of affairs in a case reported by Holmes.[2] The bowel was strangulated by a ring formed by two adherent appendices epiploicæ. These false diverticula are usually rounded or saccular in shape, and are subject to inflammation from lodgment of undigested food, fruit-stones, etc.

4. *Strangulation by normal structures abnormally attached; and through slits and apertures.*

In the first caption of this form of internal strangulation the vermiform appendix is chiefly at fault. It sometimes attains the

[1] Gaz. des Hôp., 1872, p. 102.

[2] Tr. Path. Soc., Lond. 1860–61, xii., iii.

length of six or eight inches, and may contract adhesions at some distance from its normal seat, thus producing strangulation of a large portion of the bowel. It is usually adherent to structures lying near its proper position, particularly to the mesentery of the lower portion of the ileum.

The Fallopian tube is at times the constricting agent. Sedgewick[1] repeats a case of this nature.

Strangulation through slits and rents in the mesentery, omentum, or peritoneal ligaments has been often noted. Bailey[2] reports a case where three feet of the jejunum were strangulated through a rent in the mesentery. Diller[3] describes a case of internal hernia where the ileum passed through a rent in the sigmoid meso-colon. Deficiencies in the broad ligament have been found to cause strangulation.

The cause of rents in the mesentery and omentum is mainly traumatic, though a congenital origin for this condition cannot be disproven. Apertures may be formed by the loosening of the central portion of broad adhesions, and through these spaces a portion of the gut may pass and may be strangulated.

Pathology.—Intestinal strangulation may be of sudden or of gradual development. The gut may be violently drawn through a small aperture, and venous congestion and complete obstruction may develop at once, or the constriction may not be sufficient in itself to produce marked retardation of circulation till gaseous distention or undigested food effects an increase in the size of the imprisoned loop which causes venous congestion, after which the condition rapidly progresses to one of strangulation.

As in the case of hernia the vitality of the bowel is sooner or later destroyed by the blood stasis, mortification takes place, first in the parts most remote from the seat of constriction, and if the patient has survived the first onset he perishes later on of peritonitis, exhaustion, or septic absorption. The average duration of these cases is from four to six days.

Symptoms of Internal Strangulation.—The acute onset may be preceded by symptoms of colic and intestinal indigestion.

[1] London Lancet, Feb. 11, 1888.

[2] Prov. Med. and Surg. Journ., Lond. 1852, 188.

[3] Mich. Med. News, Detroit, 1881, iv. 138.

Usually without cause, and where the patient is in full health, there is—

1. *Sudden agonizing pain*, constant, and located about the umbilicus, with paroxysmal increments.

2. *A rapid, weak pulse and subnormal temperature.*—This is nearly constant in the early stages of the attack; later on, when local or general peritonitis develops, the temperature and pulse may assume the features characteristic of inflammation.

3. *Vomiting.*—First of the contents of the stomach, then of bile, and finally, in a large percentage of cases, of feculent matter. The *fecal* vomiting rarely appears before the third day, and in cases running a very acute course death may ensue before this symptom has time to develop. The vomiting is constant and gives no relief to the patient.

4. *Constipation.*—Exceptionally there may be one or two passages representing the contents of the bowel below the seat of obstruction; after that the constipation is absolute, not even flatus passing by the anus. Treves has suggested that the evacuations sometimes observed toward the termination of the case and not due to the relief of obstruction, may be dependent upon the beginning of peritonitis.

5. *Tympanitic distention.*—Where there is a large segment of gut involved in the strangulation, its early distention may give rise to a localized abdominal enlargement which is exceedingly suggestive as to the cause of the attack. In general the meteorism is not marked except when peritonitis supervenes.

Since in the large majority of cases the obstruction is localized in the lower portion of the small intestines, the primary distention will be observed in the mid-abdominal region, *i. e.*, the epigastric, umbilical, and hypogastric areas. Laugier[1] claims by this symptom to locate the obstruction with some certainty.

The violent peristalsis and repeated vomiting prevent the extreme meteorism characteristic of intestinal paralysis.

6. *Localized tenderness and percussion-dulness.*—When present these signs are of exceeding great importance, since they denote the position of the strangulated bowel.

[1] Bulletin de Chirurgie, t. i. 245.

Exceptionally a tumor may be felt formed by the congested gut or the matting together of the intestinal coils.

The urine is diminished in quantity and may be suppressed. In acute strangulation it commonly contains albumen and it is stated that this is of diagnostic value.

Diagnosis.—In this connection the history is of great importance.

Other congenital deformities would suggest the possibility of Meckel's diverticulum as a cause.

A preceding typhlitis, pelvic peritonitis, or severe abdominal traumatism would respectively assign an adherent vermiform appendix, peritoneal bands, or rents in the omentum or mesentery as the causative agents in the production of the symptoms.

The age of the patient should also be considered, since this form of obstruction usually occurs between the twentieth and fortieth year.

The sudden onset of violent persistent pain, subnormal temperature and frequent pulse, the obstinate, absolute constipation, the persistent, repeated vomiting, becoming fecal, and the rapid course of the disease, all point to internal strangulation.

Auscultation of the abdomen is at times of value, a sound compared to the click of the water-hammer being heard most distinctly at the point of obstruction.

Palpation and percussion should not be omitted, as thereby the seat of obstruction has been distinctly located.

Treatment.—Although a spontaneous cure of internal strangulation is possible, either by the rupture or absorption of the constricting band, or by an intestinal anastomosis by ulceration, this result must be exceedingly rare when the condition of strangulation is fully established. Nor can it readily be conceived in what way injections, massage, electricity, or any or all of the therapeutic means usually resorted to in cases of obstruction can, save under exceptional circumstances and then by the merest accident, be of the slightest avail. Given a diagnosis, and in any case of obstruction characterized by such fulminant symptoms as are common in strangulation, abdominal section, with the idea of mechanically removing the cause of obstruction, should be the first resort.

The contra-indication to immediate operation will be the shock which frequently signals the onset of the malady, and which may result fatally in a few hours. This, if profound, requires treatment even more imperatively than the strangulation. External heat, full doses of morphia, atropia and ether hypodermically, and whiskey by the bowel, four ounces diluted with eight times that quantity of hot water, will often succeed in bringing about reaction.

Even should the condition of shock not be benefited by these means, if the symptoms are steadily progressive, the surgeon should not hesitate to administer the minimum amount of ether necessary for anæsthesia, to open the abdomen, make a hurried search for the seat of constriction in the region where it is most commonly found, *i. e.*, lower part of the ileum, perform any operation for its relief, which can be quickly and easily executed, and flush out the peritoneal cavity with hot saline solution (108° Fahr.).

If, under these circumstances, that is, operation during profound shock, the seat of obstruction cannot immediately be found, or if found, the constriction is of such a nature that a tedious operation would be required for its relief, an enterostomy is clearly indicated, since following this procedure a spontaneous resolution and restoration of the normal course of the alimentary canal have many times taken place.

Where the patient is in good condition, a free parietal incision should be made, followed by a careful systematic search for the seat of the obstruction; the congestion and discoloration of the strangulated bowel, the inflation of the gut above the point of occlusion, and the empty flaccid condition of the intestine below will each in turn guide the surgeon to the seat of trouble. Diverticula, if large and patulous, should be ligated close to the bowel, divided, and the proximal end turned into the lumen of the latter by a Lembert suture applied to the peritoneal coat; the remaining portion of the diverticulum should be completely removed lest it give rise to future trouble. Bands from either parietal peritoneum, mesentery, or omentum should be ligated as near their points of origin as possible and removed.

Where the appendix is the seat of trouble its ligation and complete removal are indicated, followed by invagination of the proximal end and final closure by a peritoneal Lembert suture. When the strangulation is caused by rents or apertures in either the mesen-

tery, omentum, or peritoneum the general principles governing the treatment of external hernia should prevail. The aperture should be enlarged sufficiently to allow of easy reduction, and, as a means of preventing recurrence of the accident, should subsequently be completely closed by suture.

As a matter of prime importance the distended and paralyzed bowel should be evacuated of its contents by means of one or more incisions which can be closed at the conclusion of the operation.

When the obstruction is due to the matting together of a large mass of intestines, unless the adhesions are readily broken down, the safety of the patient will be consulted best by performing either an intestinal anastomosis between the healthy bowel leading to the adherent coils and that leading from it, or by forming an artificial anus. The effect of time and of the constant peristaltic and respiratory intra-abdominal motions is often marked by the complete disappearance of most extensive intestinal or omental adhesions.

Beyond the treatment of shock and vital depression, the administration of alimentation by the rectum, the free use of stimulants, either by the rectum or subcutaneously, lavage of the stomach, and absolute withholding of everything by the mouth, the treatment of these cases should be purely surgical.

After the cause of constriction has been removed a saline purge frequently acts most happily in restoring tone to the paretic bowel.

INTERNAL STRANGULATION.

Total number of cases				83
" " of deaths				78
" " of recoveries				4

One case not stated.

Bands	64	Operative	Recovered	4
			Died	16
		Non-operative	Recovered	0
			Died	44
Apertures	10			

CHAPTER IV.

VOLVULUS.

VOLVULUS, or twisting of the bowel, occurs, according to Brinton's statistics, in about 8 per cent. of the fatal cases of intestinal obstruction. Treves states that volvulus forms 2.5 per cent. of these cases; our own statistics give a result of 4 per cent. The twist is usually about the mesentery as an axis; two or even three complete turns are found at times; exceptionally the gut may be twisted about its own axis. Under the heading of volvulus is also included the knotting together of different portions of the gut.

This form of intestinal obstruction occurs usually after middle age, and is much more commonly observed in men than in women. Of 18 cases collected by Haven,[1] 16 were men.[2] The portion of the bowel most frequently affected is the sigmoid flexure. Even in the form characterized by the intertwining of several loops, it is with the sigmoid flexure that the small bowel usually becomes entangled.

The ascending colon and cæcum and the small intestines may be involved, at times, in this condition.

The twisting of the bowel about its mesenteric attachment is, under normal conditions, scarcely possible. Experimentally we have made repeated trials to produce in dogs a volvulus, but have always failed, the bowel quickly returning to its normal position.

A long mesentery with a comparatively narrow attachment is necessary for the development of the twist. This may be congenital, more commonly it is acquired; years of constipation so dragging upon the sigmoid flexure that it is enlarged, the two extremities being constantly more approximated, until the condition suitable to the development of the trouble obtains. It is on account of this slow development that the disease is commonly observed in men past middle life.

When volvulus appears in the ascending colon and cæcum it is

[1] Amer. Journ. Med. Sc., Oct. 1855.

[2] In our own table of 10 cases 64 were for men.

commonly dependent upon the same condition as in the case of the sigmoid flexure, *i. e.*, an abnormally elongated mesentery. There is also in this position a peculiar form of volvulus, consisting in a twist of the colon about its longitudinal axis, which, though rare, has been clearly described.

When the small intestine is affected by volvulus it takes the form of a twist upon an elongated mesentery, or an entanglement between two or more intestinal coils.

PATHOLOGY.—Venous congestion, as in all forms of intestinal obstruction, plays an important part in the changes dependent upon volvulus. The involved loop becomes shortly engorged with blood, and immensely distended from decomposition of its contents, so that even when mechanical reduction is effected, unless the gas be evacuated, the bowel on being released has a tendency to at once assume its twisted position. Peritonitis is developed very constantly, and if the congestion is not relieved the constricted portion of the bowel becomes gangrenous. At times perforations are formed above the point of constriction, but this is rare. All the intestines become quickly distended, but not to the same degree as the volvulus; the latter, in fact, frequently becoming so immensely inflated as to practically fill the abdominal cavity.

PROGNOSIS.—Treves states that volvulus in the sigmoid flexure is invariably fatal unless relieved by surgical interference, and the general concensus of medical opinion is to the hopelessness of medical treatment when this part of the bowel is involved. Even upon the autopsy table Smith found that he could not undo a twist of the cæcum although the external incision extended from the sternum to the pubes.

There is, however, clinical evidence as to the possibility of reduction when the small intestine is involved in the twist. Thus Kohle,[1] who had treated a patient by oil injection for obstruction, found, upon post-mortem examination, death having taken place from intestinal paralysis, clear evidence of a reduced volvulus at the lower part of the ileum.

In the chronic form of volvulus life may be prolonged for months,

[1] Correspondez Blatt für Schu. Aert., July 15, 1889.

or even years, but in the acute forms the prognosis must be, for cases not treated surgically, almost absolutely bad. Haven states that the average expectation of life is about five days.

Symptoms.—Absolute constipation, vomiting, which gradually becomes feculent, and abdominal distention are present in volvulus as in other forms of intestinal obstruction. According to the seat and nature of the twist symptoms will vary somewhat, being characterized by violence of onset and rapidity of course in proportion to the tightness of the twist. The sigmoid flexure being the commonest seat of trouble, the symptoms of its involvement are usually taken as a type of this displacement in general.

A history of constipation.—As the pathological condition necessary for the formation of the twist requires a long period for its development, there is commonly a history of previous constipation. This was observed in 70 per cent. of Treves's cases.

Pain.—The acute onset may be determined by a long-continued constipation. The attack is usually inaugurated by sudden, severe, but not absolutely agonizing pain, felt about the umbilicus, or exceptionally at the seat of trouble. This is constant with exacerbations, but gradually diminishes. It is accompanied by a moderate degree of shock or nervous prostration. Shortly following the pain, tenderness is manifest, as a result of the early lighting up of local peritonitis. Treves states that peritonitis is nearly always quickly developed, in connection with volvulus. Haven's tables, however, show that this complication is not more common than in internal strangulation.

Constipation.—This is one of the most constant symptoms, and in all of Haven's cases it was present. It is usually absolute. In a small percentage of cases it has been preceded by diarrhœa.

Very frequently *tenesmus* is a prominent feature.

Vomiting.—This is much less constant than in internal strangulation and is usually not fecal. It is frequently slight and rarely repeated, and in some cases is altogether absent.

Meteorism.—This symptom is usually very well marked. Indeed, it is in this form of intestinal obstruction that the abdominal distention reaches its extreme limit. At first the swelling is confined to the region of the colon, if the twist is in its usual position. Later the small intestine is involved, as peritonitis destroys its

muscular contractility, and stills the violent peristalsis provoked by any obstruction to the onward passage of the intestinal contents. This tympanitic distention at times seriously interferes with the respiratory functions and may be the immediate cause of death.

Following the condition of shock, which denotes the onset of volvulus, the symptoms of a sthenic peritonitis may develop, with the wiry pulse, high temperature, and excessive tenderness characteristic of the disorder; or intestinal paralysis, great distention, and rapid absorption may produce a condition of intestino-peritoneal septicæmia from which the patient may perish with no other symptoms than extensive meteorism and rapid pulse. (See Peritonitis.)

Diagnosis.—Old age is generally believed to predispose to volvulus, yet Haven gives the average age of patients suffering from this form of obstruction as 35; our own tables place the age at 32.

Sex is a distinct predisposing factor, the large majority of reported cases having been men. A previous history of constipation is always suggestive.

If then, in a man at, or past middle age, of constipated habit, severe, but not agonizing pain attended with symptoms of moderate shock should inaugurate an illness characterized by moderate bilious vomiting, absolute constipation, and great abdominal distention, with tenderness on pressure appearing shortly, the probability of volvulus would be strong and would be still further confirmed were tenesmus present, and were a history of distention first appearing in the region of the colon given.

Further, by means of water injection followed by abdominal palpation and percussion, an obstruction of the bowel between the rectum and transverse colon can be readily demonstrated.

Treatment.—The natural tendency of these cases is towards death. Purgatives are as evil in their effects as in other forms of obstruction, and their administration has frequently been the starting point for the acute outbreak.

It is difficult to understand how enemata could be of service, since the bowel is very early fixed by distention, by congestion, and by peritonitis, in its abnormal position. A gradual forced injection of water, with the patient in the knee elbow, or inverted position, might possibly be productive of some good.

We think there is but one treatment for these cases, and that is, immediate operation with untwisting of the bowel segment and evacuation of its contents. If this is undertaken before distention has paralyzed the gut, or peritonitis has fixed it in an abnormal position, the prognosis is favorable.

Lavage of the stomach, the avoidance of food by the mouth, and in general, the treatment applicable to other forms of obstruction are valuable here.

CHAPTER V.

OBSTRUCTION FROM FOREIGN BODIES.

UNDER this heading are conveniently considered, not only those cases of obstruction due to foreign bodies, which, when swallowed, either from their size, or from a peculiarity in conformation, are capable of lodging in some portion of the alimentary canal and mechanically blocking the onward passage of its contents, but also those cases in which acute symptoms are produced by intestinal concretions, enteroliths, gall-stones, hydatids, or any mass sufficiently large to block the bowel.

A foreign body which has safely passed into the stomach, if of considerable size, is liable to be arrested in this viscus.

Should it pass the pylorus, unless there be congenital or acquired abnormality in the lumen of the bowel, the cæcum will probably be the next point of lodgement. The majority of foreign bodies which have entered the bowel and not been discharged by the anus are, according to Caron, found in the cæcum.

If the cæcum is passed, discharge is not yet assured, since the rectum is also a favorite lodging place for these bodies.

Substances may be swallowed which, in themselves, are not dangerous, but which being taken in large numbers or great quantity, may form a conglomeration which can effectually occlude the bowel. Cherry-stones very frequently produce obstruction in this way. Landais[1] narrates the history of a patient who passed 400 of these stones 15 months after they had been taken, several of them showing signs of beginning vegetation.

Cruveilhier[2] reports a case of obstruction due to a mass made up of 617 cherry-stones. Instances are noted where concentric masses of hair filling the stomach and small intestines caused death.[3]

In the majority of cases the œsophagus is an accurate gauge of

[1] Ancien. Jour. de Méd., xxxvii., p. 137.

[2] Anat. Path., livr. 26, pl. 6.

[3] Ancien. Jour. de Méd., 1779, t. lii.

the possibility of a body passing the entire length of the alimentary canal, the chances being largely in favor of a spontaneous discharge of whatever has passed into the stomach through the cardiac valve. Charles II. of England (Bonet) placed a razor and two knives in the mouth of a professional sword swallower; they were swallowed, and discharged per anum on the third day. On the authority of Longius it is stated that a sharp pair of scissors swallowed by an epileptic were evacuated on the 9th day. Bouchet[1] quotes Gosselin's observation of a sailor, who having swallowed a pipe suffered for ten days with colic, nausea, and vomiting, when a natural discharge of the offending body produced instant relief. The pipe could be felt through the abdominal walls and its progress from day to day distinctly outlined.

In contrast with these cases Denovilliers notes an autopsy which showed that death had resulted from the obstruction caused by a single cherry-stone occluding a strictured part of the gut.

The foreign bodies may be:—

1. Large, but regular or rounded in outline. Here there is every prospect of spontaneous discharge without damage to the intestine; coins, marbles, pebbles, etc., would be classed under this category.

2. Large, irregular and angular in outline; edged or pointed. Although the probability is, even in these cases, that spontaneous discharge will take place, serious complications are likely to arise. Injury to the mucous membrane of the bowel, perforation of all its coats, lodgement and blocking of its lumen may occur. False teeth, knives, spoons, scissors, nails, etc., are classed under this heading.

3. Small in size, of regular shape, single or numerous. A single body of this nature can only by the rarest exception, as in the case cited above, produce obstructive symptoms. Masses of such bodies are the commonest cause of the form of obstruction under consideration. Cherry-stones, date-stones, prune-stones, grape-seeds are the representatives of this class of foreign bodies.

4. Small in size, sharp or pointed, single or numerous. Here the danger to life is slight. Perforation and migration of the foreign bodies frequently takes place but rarely causes serious symp-

[1] Bull. de la Soc. Anat., 30, 1855.

toms. When large numbers of such bodies are taken, masses are formed which may produce obstruction or perforative peritonitis. Pins and needles, which have been swallowed by the pound without causing death,[1] represent this class.

GALL-STONES.—Under the heading of large bodies of rounded outline would fall gall-stones. Obstructive symptoms from this cause are rare, since an enormous size must be reached before the bowel becomes unable to expel the obstructing mass. When lodgement is once effected, the stone may remain for months in one position, giving rise to no characteristic symptoms and steadily enlarging by a surface deposit of earthy matter. Leichtenstern states that one such stone was upwards of five inches in circumference. The common lodging places were in order of frequency, in Leichtenstern's thirty-two cases, the lower part of the ileum, the duodenum and jejunum, and the middle of the ileum. This form of occlusion occurs most frequently in females and after middle age has been passed.

ENTEROLITHS are practically foreign bodies in the bowel, and act simply by their large size. Leichtenstern describes one which was nine inches in circumference. They are usually formed about a foreign body, as a cherry-stone, or piece of vegetable fibre. They may be mainly phosphatic, in that case being arranged in concentric layers and being distinctly calculous in weight and consistency. They may be made up of mineral matter swallowed in the form of medicine, particularly of magnesia, or they may be formed of vegetable or animal matter densely packed together and intermingled and encrusted with a certain amount of lime salts. They are usually found lodged in the cæcum.

They are most frequent in men before, or about the period of middle age, and very exceptionally cause obstructive symptoms. (.2 per cent.)

PATHOLOGY.—The lesions produced by foreign bodies are :—

1. *Ulceration*, with or without subsequent cicatrization and stricture of the bowel.

2. *Perforation*, with or without either general peritonitis or parietal abscess formation.

[1] Bull. de la Soc. Anat., 17 an. p. 274.

3. *Acute or chronic obstruction* with the resultant pathological changes in the gut.

LeDentu[1] reports a case in which a wooden kitchen spoon perforated the stomach within fifteen hours of its entrance into that organ, and passing between the two anterior layers of the omentum entered the general peritoneal cavity without producing symptoms of peritonitis.

Prognosis.—This is usually favorable; considering the immense number of foreign bodies swallowed it is certainly the rare exception in which obstructive symptoms are subsequently developed.

Symptoms.—In addition to the history of a foreign body having been swallowed, of attacks of hepatic colic, or, where a gall-stone ulcerates through into the bowel, of some local peritonitis about the region of the liver, there can commonly be elicited a record of sharp colicky pains, of partial obstruction, and of vomiting. The distention is slight, the amount of systemic shock far less than in other forms of obstruction, and the duration of the attack somewhat longer than usually obtains in this class of affections. The symptoms of obstruction are freqently only partial, the vomiting being moderate in amount and not stercoraceous, the constipation not being absolute.

Except in the case of enteroliths and very large foreign bodies a tumor can rarely be felt.

Diagnosis.—It is often impossible to diagnose this form of obstruction from that depending upon a narrowing of the lumen of the bowel, such as cancer or stricture produces. The previous history is always of great importance. The presence of indican rather than albumin in the urine, the comparative mildness of the attack, the moderate meteorism, and the slower course of the disease, all help to exclude internal strangulation or volvulus. It is, however, mainly upon the history that the diagnosis will be founded.

Treatment.—Where obstruction is fully developed and the diagnosis of foreign body in the causative role clearly established,

[1] La Semaine méd., Jan. 9th, 1889.

an abdominal section, enterotomy and removal, with subsequent enterorraphy with Lembert sutures is indicated. If the lodgement is in the rectum the body should, of course, be removed through the bowel. Radestock[1] performed enterotomy twice and gastrotomy once upon the same patient to remove many foreign bodies swallowed with suicidal intent. If operation be absolutely refused, the controlling of pain and violent peristalsis by morphia hypodermically, deep forced enemata, gentle massage, and feeding by the rectum may be tried. After acute obstructive symptoms have passed off, a continued gentle action upon the bowels by means of a pill composed of aloin, strychnia, and belladonna has been exceedingly satisfactory in its results.

[1] New Orleans Med. and Surg. Jour., Sept. 1889.

CHAPTER VI.

INTESTINAL PARALYSIS.

CERTAIN cases of intestinal obstruction occur and frequently run on to a fatal issue, yet, at the autopsy no sufficient cause can be found for the symptoms observed during life. These cases are classed by Henrot under the name Pseudo-strangulation, and are classified as follows :—

1. Cases dependent upon paralysis of the muscular coat of the bowel, due to pathological changes.
2. Cases in which the muscular coat is intact, the symptoms depending upon reflex action.
3. Cases in which there is paresis or paralysis dependent upon a general condition of the nervous system.

The symptoms dependent upon conditions under Henrot's second and third heading are usually evanescent in character and threaten danger to life or cause difficulty in diagnosis only for a very brief period. Inflammation of the abdominal parietes, severe injury to the testicle, operations about the rectum, or general hysteria have all been accompanied by symptoms of acute intestinal obstruction which were promptly relieved by attention to the condition which had excited the reflex.

After abdominal wounds, however, tedious laparotomies, or severe contusions in the abdominal region, there may be developed a condition of intestinal paralysis which quickly leads to obstruction, to great distention, and to death from either septic absorption, exhaustion, or peritonitis; it is to this condition far more than to well-developed inflammation that the ovariotomist of the past can trace many of the deaths following operation. We have frequently examined post mortem the abdominal cavities of these cases, perishing a few days after operation and presenting the characteristic symptoms of obstruction, and have found nothing beyond enormous distention of the gut with kinking, moderate injection, and a slight sero-sanguinolent effusion.

It is probable that in all of these cases, or at least the great majority, the symptoms are dependent upon extension of irritation or inflammation from the mucous or peritoneal coat of the bowel rather than upon pure reflexes.

A certain number originate from an attack of acute indigestion, and as a typical example of this can be cited Henrot's XXI. observation, which that author takes as an example of pure paralysis. A man of 66 years was seized with colic, cramps, and bilious vomiting, great distention and absolute constipation followed with a fatal termination on the fifth day. Absolutely no obstacle to the passage of the intestinal contents was found at the autopsy.

Inflammation or ulceration of the mucous membrane not rarely causes cessation of peristalsis and resultant obstruction symptoms. Thus Denarié recounts the history of a man of 66 who died after nearly two weeks of absolute constipation, there was great meteorism and consequent systemic depression, but no pain or fever. At the autopsy a recent ulcer of the descending colon was found, beyond this, nothing pathological in connection with the intestinal canal except great distention.

Long-continued venous congestion may be followed by absolute paralysis of the muscular coat of the bowel. The literature of hernia is full of records where, after reduction, symptoms have not abated and death has ensued as inevitably as though the gut were still strangulated.

Severe abdominal traumatism is frequently followed by immediate meteorism with obstructive symptoms. Three cases of this nature have fallen under our personal observation, one progressing to a fatal issue. In the last the absence of internal gross lesion could not be confirmed, as an autopsy was refused.

Jordan[1] believes that fatty degeneration of the muscular coat of the bowel may act as a direct and indirect cause of intestinal obstruction and death. In one case the microscope confirmed the fatty change which the muscular fibres were supposed to have undergone. The patients who exhibit this degeneration are those who suffer from fatty changes in other parts of the body. The ultimate paralysis is commonly produced by flatulent distention, but any injury or operation about the peritoneal cavity or pelvis

[1] Brit. Med. Jour., April 26, 1879.

may determine the incompetency of the already weakened muscular fibres, the patient perishing with obstructive symptoms, tympany being well developed. The anxiety which all laparotomists feel in operations upon excessively fat patients is not because of the mechanical difficulties which the thick abdominal walls and loaded omentum offer, but because it is universally recognized that in these patients symptoms of obstruction are peculiarly prone to occur.

Jurgens[1] describes a pathological change affecting not only the muscles of the bowel but also the terminal nerve filaments. Henrot[2] notes the invasion of the muscularis by certain sclerosed areas. Nepva detected, in a case of fecal obstruction, atrophy of the muscular coat of the bowel. Thibierge[3] found in the bowel of the aged suffering from obstinate constipation glandular atrophy, wasting of the muscular coat and probably of the intra-parietal nerves, and arterial atheroma. Intestinal paralysis may result then—

1. From a general neurotic or hysterical condition.
2. From local reflex action.
3. From abdominal traumatism, or exposure of the abdominal viscera.
4. From enteritis or peritonitis.
5. From atrophy or fatty degeneration of the muscular coat of the bowel.

The form of paralysis associated with distention and septic absorption will be considered later.

Prognosis.—This, if the case is recognized early and the general condition is not too profoundly depressed, is, except in post-operative cases, less serious than is the case with any other form of acute obstruction. Since, without the corroborative testimony of an autopsy, it is impossible to say whether or not obstruction has depended upon paralysis, statistics upon this subject cannot be given. There is good reason for believing, however, that many if not the majority of cases of internal strangulation, volvulus, etc., cured by such remedial means as puncture, salines, enemeta, and massage have in reality been cases of paretic obstruction, since it is difficult to conceive how these measures could be of the slightest use were the conditions diagnosed actually present.

[1] Berlin. Klin. Woch., 1881.
[2] Union. méd., 1878.
[3] Thès. de Par., 1884, No. 231.

Symptoms.—A purely neurotic paralytic obstruction would probably be marked by irregularity in course, and the characteristic manifestations of disordered nerve action. When observed it has been in the person of young hysterical females.

The reflex paralysis has also been characterized by a comparatively short duration and sudden disappearance of symptoms on attacking the source of the nervous disturbance.

The paralysis dependent upon abdominal injury or visceral exposure is that most commonly met, since it is this form which occurs after operations. Any degeneration of the intestinal walls strongly predisposes to the development of this form of obstruction, though it may appear when the gut is perfectly healthy. Many authors have lately called attention to this condition, until recently confounded with peritonitis. Thus Malcolm[1] shows that intestinal paralysis is an important factor to be considered in the after-treatment of abdominal section. Olhausen[2] describes paralysis of the intestines, or pseudo-ileus, as a hitherto unrecognized cause of death after laparotomy, and Verchère, under the heading "Intestino-peritoneal-septicæmia" (see section on Peritonitis), justly describes death in these cases to the intestinal palsy.

The characteristics of this condition, as usually observed, are as follows: After a prolonged operation with possibly partial eventration, or much exposure of the intestines, the course of the patient may seem satisfactory for one to three days, when a condition of partial collapse is developed. This is usually gradual in onset, but may, unless the patient is carefully watched, seem sudden in development. The pulse is rapid and running, the belly quickly becomes greatly distended, there is vomiting either of ingested food or bilious matter, and finally there is absolute constipation. Pain may at first be exceedingly severe but does not reach the agonizing intensity characteristic of strangulation.

There is no marked tenderness and no characteristic alteration in the temperature. Death seems to occur from heart failure.

Olhausen states that a venous hyperæmia, consequent upon mechanical disturbance, is the cause of the trouble, and that it does not immediately develop is probably due to the fact that a certain amount of time is required for fermentation of the contents of the

[1] Med.-Chirur. Trans., vol. xxi.

[2] Centralbl. für Gyn., 1888, p. 10.

gut, when gaseous distention completes the paralysis of the partially crippled bowel, and adds to the impermeability of the canal by the kinking which great inflation generally produces.

The symptoms of paralytic obstruction, depending upon degenerative changes of the muscular layer of the bowel, are fairly characteristic. The patients are usually advanced in years, and not rarely show atheromatous or fatty change in other parts of the body. There is a preceding history of long-contined constipation, and possibly of occasional attacks of temporary obstruction. The acute onset is usually preceded by an unusually long and obstinate constipation, symptoms of obstruction developing after the taking of an active purge.

Pain at times denotes the beginning of acute symptoms; this may be so intense as to suggest internal strangulation. Thibierge states that this pain is due to the mechanical effect of stretching upon the intra-parietal bowel nerves. Often pain is not a conspicuous feature of the attack.

Distention is well marked and involves the whole abdomen. At times in the cæcum and sigmoid flexure the presence of fecal accumulations may be perceived by palpation and percussion.

Vomiting is usually well marked; it may become bilious, but not fecal. At times it is entirely absent.

Constipation is from the beginning of acute symptoms absolute.

Tenderness is usually absent—the temperature remains about normal, the *pulse steadily increases in rapidity* and the patient perishes of exhaustion or septic absorption.

TREATMENT.—In this condition death seems to be produced by—

1. The mechanical interference to respiration occasioned by the enormous distention.

2. The exhaustion, consequent upon the cessation of assimilation, the pain, and the constant vomiting.

3. Septic absorption.

It is particularly in this class of cases that salines have won their reputation. Administered in the first stage before paralysis is fairly developed they seem to have the power of re-establishing peristalsis, of restoring tone to the muscular coat of the bowel and of sweeping from the intestine the partially digested matter ripe for fermentation and putrefaction. That the paralysis dependent

upon a beginning typhilitis, salpingitis or any form of local peritonitis has been many times avoided by the prompt administration of saline cathartics, cannot, for a moment, be doubted. Salines, then, should be administered freely in the beginning of this form of obstruction.

If distention has reached any great development, and vomiting has set in, salines are no longer indicated. Absolutely nothing should be given by the mouth, lavage of the stomach should be practised, the rectal tube should be inserted to excite peristalsis of the colon and draw off the wind in the rectum, the patient should be freely stimulated by whiskey, per rectum or hypodermically, and the faradic current should be applied with one metal pole within the anus, the other swept over the motor points of the abdominal muscles.

If the distention still increases, repeated punctures into the inflated intestinal loops may be made with an aspirator or hypodermic needle. Finally, if death threatens from septic absorption, the abdomen should be opened, the bowel incised in as many places as evacuation of its gaseous and liquid contents requires, and an artificial anus should be formed in the full confidence that should the patient recover from the acute attack, spontaneous closure will probably take place.

The over-distention being relieved, there is a chance that the tonus of the muscles may be restored. For spontaneous resolution when the meteorism reaches an extreme limit there is not the slightest hope.

Where there is acute pain morphia, administered hypodermically, is of great service; except for belladonna and strychnine, pushed to their extreme physiological limit, there is little indication for the use of other drugs.

CHAPTER VII.

CHRONIC OBSTRUCTION.

SPASMODIC OBSTRUCTION.—In the writings of thirty years ago frequent references were made to spasmodic ileus, and the belief in this form of obstruction was commonly accepted. With the growth of pathological knowledge, however, a certain amount of skepticism has developed, till in the present day the majority of text-books dealing with intestinal troubles make no mention of the possibility of spasm causing occlusion of the bowel. There can be little doubt that in cases of stricture or other forms of narrowing of the intestinal lumen, there is frequently a spasmodic element which determines the onset of an acute attack of obstruction. Though it is hard to disprove that muscular contraction, pure and simple, is able to produce the symptoms characteristic of ileus, there is certainly no pathological evidence to prove that this has occurred. Both Jacoud[1] and Cherchewski,[2] however, state that they have observed this form of obstruction, particularly in hysterical and neurotic patients.

Certain rare forms of obstruction, the diagnosis of which is not possible during life, are occasionally observed. Thus in the South African Medical Journal (November 30, '89), is reported a case which, on post-morten examination, was found to present an appearance as though six inches of the jejunum were gangrenous. On careful examination this was found to be a thrombus, lying between the peritoneal and muscular coats of the bowel, and so large that the lumen of the latter was completely occluded.

Several instances of embolism of the superior mesenteric artery, with resultant mortification of a portion of the intestine, are on record.

CHRONIC OBSTRUCTION.—This form of obstruction is produced by any cause which gradually engenders a narrowing of the bowel

[1] Path. int. t. II.

[2] Rev. de Méd., 1883.

lumen. Thus the shrinking of plastic lymph deposited upon the bowel surface during an acute inflammation; the cicatricial contraction following ulceration, whether simple, tubercular, typhoid, or syphilitic; the narrowing following the extrusion by sloughing of an intussusceptum; the gradual blocking caused by matting together of coils of the bowel by extensive adhesions, by the dragging upon an appendix of by kinking in connection with adhesions; and finally the encroachment upon the lumen of the bowel by new growths, all produce the symptoms of chronic obstruction. In addition, any of the conditions considered under the head of acute obstruction may, if there is not immediate and complete occlusion of the bowel, pass into the chronic form of the disorder.

In the case of stricture the bowel above the point of narrowing is commonly dilated and ulcerated. The amount of narrowing is not necessarily indicated by the severity of symptoms, since frequently death occurs with an opening so large that it is hard to imagine why the obstruction could not be relieved.

The most characteristic symptoms of chronic obstruction are as follows: irregular attacks of colicky pain, increasing in frequency and appearing a few hours after eating. There is frequently vomiting, which may become fecal on the supervention of an acute attack, it is rarely copious. There is not often much meteorism, and peristalsis can frequently be seen plainly through the abdominal wall; this is at times exceedingly well marked. If a new growth causes the narrowing, in addition to the above signs a tumor may be detected.

Prognosis.—This must be very guarded. Many cases with stricture of the bowel, under careful dietetics, run for years without serious developments. The general tendency is, however, toward progressive narrowing.

Treatment.—By careful dietetics and attention to producing regular alvine evacuation, preferably by enemata, operative treatment may often be indefinitely postponed. When symptoms are progressive, however, operative interference must be counselled, *particularly before the onset of an acute attack.*

Here the patient is in fairly good condition, the surgeon is fully

prepared, and a formal and complete operation can be performed with a prospect of success.

If the narrowing is caused by a cancer, the procedure will depend upon whether or not this tumor can be removed. If it can be removed, total extirpation of the growth together with the involved gut is indicated with restoration of the continuity of the intestinal canal by Senn's invagination circular enterorraphy, or by lateral anastomosis. In case this cannot be performed both bowel ends may be secured in the parietal wound, with the idea of closing the openings by a subsequent plastic operation.

If the malignant growth cannot be removed it should either be switched out of the direct alimentary path by performing a lateral anastomosis between the bowel above and the bowel below the seat of obstruction, or, as the last and least desirable resort, but safest in so far as immediate danger to life is concerned, an artificial anus may be formed.

If the narrowing is non-malignant, excluding it by a lateral anastomosis will be found easy of performance and effectual.

The mortality of resection does not yet justify this operation when there is an alternative, even though the latter is not so mechanically perfect as complete removal of the diseased portion and immediate restoration of the continuity of the gut.

As a form of lateral anastomosis the coil of intestine above and the one below the constriction may be secured in the external wound in close apposition. By opening these two coils an artificial anus will be made, and the first step towards restoring the continuity of the canal will be taken. Subsequently, by the use of the enterotome, and the performance of one or more plastic operations, this artificial anus may be closed.

This is far more tedious, less sure, and, we think, less safe than lateral anastomosis by approximation plates.

CHAPTER VIII.

PERITONITIS.

PERITONITIS is such a frequent and grave complication of intestinal obstruction that, in discussing the latter affection, a consideration of the former cannot be omitted.

The inflammation involving the serous membrane may be local or general, it may be plastic or suppurative, it may be acute or chronic. Mikulicz[1] considers acute peritonitis under the following headings :—

1. *General diffuse peritonitis*, causing death in a few hours, with at first slight injection, then an abundant fibrinous exudate and fulminant sepsis.

2. *Progressive suppurative peritonitis.*—The course of the disease is slow, but it steadily advances. New areas are constantly involved in the suppurative process.

To these may be added a third caption, which, though not pathologically or clinically identical with peritonitis, has been so constantly regarded as a form of this affection, and is such an important complication of intestinal wounds and obstruction that it is conveniently considered with inflammation of the peritoneum. This condition is termed by Verchère,[2] *Intestino-peritoneal septicæmia.*

Excluding certain cases of plastic peritonitis, as, for instance, that which occurs in peri-hepatitis, or at the seat of interference in aseptic abdominal work, it may be safely assumed that the disease is dependent upon micro-organisms and their products; that it is consecutive to infection from either the abdominal parietes, the intra-abdominal organs, or, in some cases, parts still more remote, and that traumatism, or irritation of any kind, is a strong predisposing factor in the development of this condition.

Thus Rinné[3] has experimentally demonstrated that the perito-

[1] Berlin. Klin. Woch., June 10, 1889.

[2] Cong. Franc. de Chirur., 1888, p. 291.

[3] Archiv. für Klin. Chirur. v., p. 39.

neum can absorb from its cavity large quantities of septic matter, which may subsequently be eliminated without harm to the patient, provided it has not been subject to insult or traumatism. Pawloski[1] has shown that non-pathogenic microbes and filtered and sterilized digestive secretions do not, when introduced into the abdominal cavity, produce peritonitis. On the other hand, the unfiltered partly digested food, and very small quantities of the pathogenic micro-organisms produce a septic hemorrhagic inflammation of the peritoneum.

Habershon,[2] in 501 autopsies, found positive evidence in over 50 per cent. to the effect that the peritonitis was due to direct extension; in no instance did he find the disease existing solely in the serous membrane. Hernia represented the most common starting-point of the inflammation, after which perforation of the intestinal canal was next in order.

Leaving out of the question those cases of plastic peritonitis which are conservative in their nature, and the symptoms of which are, at most, local pain and tenderness, with possibly slight fever and tympany, we have to consider the symptomatology of—

Diffuse septic peritonitis.—The usual cause of this is a perforation, pathological or traumatic, of one of the hollow viscera contained in the abdominal cavity. The gall-bladder, urinary bladder, stomach, or intestines, if extensively opened, will discharge their contents upon a large surface of the peritoneum, and unless death occurs in a few hours from shock or virulent septic absorption, will produce a diffuse inflammation of the peritoneum, characterized by an exudation of blood-stained serum or thin fetid pus. There are no extensive fibrinous deposits.

Progressive fibro-purulent peritonitis.—This is typefied by those cases of perforation in which, the aperture being small and extravasation being slow or wanting, there is time for a reactive inflammation to cut off the infected area from the general peritoneal cavity by an abundant deposit of plastic lymph and tight peritoneal adhesions. There is a progressive extension of the process with frequently many foci of septic matter incapsulated between the adherent viscera.

[1] Internat. Klin. Rundsch., March 17, 1889.

[2] Diseases of the Abdomen. Second ed. London, 1862, p. 555

It is well known that nearly all cases of obstruction terminating fatally are complicated by peritonitis, even though no perforation can be demonstrated; the distended and congested bowel wall allowing free passage of septic irritating matter. This peritonitis, not due to perforation, is at first a progressive fibro-purulent form, though it may be suddenly converted to a diffuse form.

Intestino-peritoneal Septicæmia. — Under this heading Verchère describes an abdominal affection characterized by constitutional symptoms, with locally *marked meteorism*. Death occurs, usually, between the eighth and twelfth day; rarely before the sixth day. At the autopsy a small quantity of sero-sanguinolent fluid is found in the peritoneal cavity; this is at times fetid, but no adhesions, no signs of peritonitis are observed.

It was for this condition that Marion Sims, who described it accurately and assigned the causative role to septic absorption, advised abdominal section. Barnard and St. Laurent have also clearly described the condition, as has Jobert under the heading "A Latent Form of Peritonitis, of which Meteorism is the most Characteristic Symptom."

The cause for the constitutional symptoms of this form of abdominal trouble, which is commonly termed peritonitis, is probably filtration and absorption of the septic products of decomposition within the bowel.

Symptoms of acute peritonitis.—Where inflammation is due to perforation the onset is usually sudden, and is characterized by intense pain with symptoms of collapse; this latter condition may rapidly become more marked, and the patient may perish in the course of a few hours. Commonly, the pain is shortly followed by abdominal distention and tenderness.

The respirations are entirely thoracic, the diaphragm being either paralyzed by extensive inflammation or not acting on account of pain.

The pulse is commonly rapid and wanting in power; during the height of the inflammation it may be hard and small, the so-called wiry pulse.

There is obstinate vomiting of thin, bile-stained matter, and the bowels are confined.

The muscles of the intestinal walls are quickly paralyzed from involvement in the inflammatory action, peristalsis ceases absolutely, nor can it, when the disease is well developed, be re-established by salines or any other form of medication.

On deep pressure friction sensation may be felt, and on the authority of Batty and Chaumel friction sounds are readily detected on auscultation.

The position of the patient is upon the back with the thighs flexed upon the pelvis. The face is characteristic in expression; always very pale, thus differing from nearly all acute inflammations, and with a peculiar pinched anxious expression.

There is frequently retention of urine, nearly always a very scanty secretion of this fluid.

The temperature varies greatly, generally ranging high throughout the course of the disease and becoming subnormal before death.

Hiccough, subnormal temperature, and a pulse increasing in frequency and decreasing in volume and strength are certain signs of rapidly approaching dissolution. The mind is commonly clear.

To these symptoms are frequently added those of acute intestinal obstruction, since paralysis and distention of the bowel commonly prevent the natural passage of its contents. These cases usually terminate in death in from twenty-four to forty-eight hours.

The symptoms of the *progressive suppurative peritonitis* are similar in nature to those of the general diffuse inflammation, but produce less marked effect upon the system at large. The inflammation of the serous membrane accompanying suppurative typhlitis is typical of this form of inflammation.

The pain may be as great, but is more localized. The tenderness is especially marked at the focus of inflammation, and in the direction towards which it is extending. In addition palpation will often reveal a distinct tumor in which fluctuation may be perceived.

Though distention and tympany are usually pronounced, they do not reach the extent common in the diffuse inflammation.

The pulse is usually quick and full. The breathing is not so markedly thoracic, the vomiting is often absent, constipation is stubborn, but can be overcome.

The temperature is akin to that of inflammation in any other

part of the body, ranging between 100° and 104°. The pinched pallid sunken face is not observed.

This form of inflammation may at any time cause obstruction, or may, by the bursting of an encapsulated purulent deposit into the general peritoneal cavity, become diffuse, in which case the symptoms characteristic of these conditions will quickly develop.

Intestino-peritoneal Septicæmia.—In place of the violent outbreak so common in peritonitis the disease begins insidiously. There may be at first shock, but no complaint of marked abdominal pain or tenderness.

The abdominal facies is usually the first symptom, characterized by the hollow dark-ringed eyes, the sunken cheeks, the pinched nose, and the preternatural calmness of expression. At times there is absolutely no other sign of grave trouble on inspection till immediately before death.

The pulse is always frequent, the temperature normal or subnormal till just before death, when it suddenly rises. The ratio between pulse and temperature is particularly suggestive, the one running above 140 and often the other not rising above 98.2.

The most characteristic sign in connection with the abdomen is the marked tympanitic distention. This is not accompanied by either pain or tenderness at any time in the course of the case.

There is vomiting, first of the contents of the stomach, then of bile, finally of fecal matter. Death usually takes place between the eighth and twelfth day.

The autopsy shows that there is no pus and no adhesions, that the bowel is greatly distended, and that there is in the dependent parts of the abdominal cavity a little sero-sanguinolent fluid, sometimes ill-smelling and containing micro-organisms. Extravasation of fecal matter is not found in these cases.

After traumatism, wounds of the intestines, intestinal strangulation, sudden obstruction from any cause or insult to the abdominal contents in the course of prolonged operations involving their exposure, this train of symptoms not unfrequently develops, and is ascribed by Verchère to the retention and filtration of intestinal gas, micro-organisms, or ptomaines. Examinations of the blood have not shown the presence of micro-organisms, hence it is

probable that it is their products, and not themselves, which are responsible for the train of symptoms described.

It will be recognized at once that a great number of individual cases present a combination of the symptoms of the different conditions described, rather than the typical course of either diffuse, or spreading peritonitis, or abdominal septicæmia. This is because these conditions may complicate each other. Thus given, a case of acute purulent peritonitis, or the spreading form of this inflammation, complicated, as it frequently is, with obstruction, if the bowel contains large quantities of putrescent matter, fermentation and gas formation are exceedingly rapid, the ptomaines are absorbed in large quantities, and in place of pain and fever the toxic symptoms may prevail. The characteristic features of abdominal septicæmia may mark the case, the normal or subnormal temperature and the absence of pain and tenderness often conveying a belief in amelioration in the condition of the patient which the weak, running pulse should at once dispel.

At times there is not only absence of pain and tenderness, but there may be no sign of tympanitic distention, though the abdominal cavity may be full of pus. These cases are marked by the character of the pulse and by a peculiar board-like hardness of the abdominal muscles. This latter sign is, however, not always present. To account for this want of tympany, no other explanation is needed than absence in the alimentary canal of fermentable substances, or presence of certain chemical agencies which prevent this fermentation. It is probable that the same paralysis of the intestinal walls exists as in other cases, but that there is not present the, at times, enormous pneumatic pressure developed by the decomposition of organic bodies. The septic absorption in these cases would come from the pus in the peritoneal cavity rather than from the bowel contents.

The violence of the symptoms is by no means commensurate with the septic matter inclosed within the peritoneum. Sims, Baudens, and many others have observed that death resulted when only an ounce or two of non-offensive, blood-stained serum was found in the abdominal cavity. Musser[1] records the successful issue of a case from which three gallons of bloody, purulent fluid were withdrawn by means of a canula.

[1] University Med. Mag., vol. 1, p. 273.

It would seem that, where the inflammation is from the first sufficiently violent to block the lymphatics, there is comparatively a moderate amount of septic absorption; where these vessels still preserve their physiological capabilities, and the amount of septic matter is so great that it overwhelms the emunctories, the typical symptoms of intestinal septicæmia are developed.

Diagnosis.—In typical cases the diagnosis is easy. Fever, vomiting of bile, constipation, pain, tenderness, tympanitic distention, absence of abdominal breathing, and rapid pulse, if present, so clearly characterize the nature of the complaint that a mistake is scarcely possible. Cramps from muscular spasm or possibly temporary invagination, pain from gall-stones or renal calculi, pressure, effects of abdominal tumors, pus formation in the abdominal walls, although presenting individually certain of the characteristic symptoms of peritonitis, never present the complete picture of inflammation of the serous membrane, and, moreover, present features, peculiar to themselves, which will usually render a diagnosis practicable. While the diagnosis cannot immediately be made in some cases, by waiting a few hours the presence or absence of peritonitis usually becomes clear.

From obstruction, peritonitis is distinguished with some difficulty, since one condition usually complicates the other. Peritonitis, with its rapid onset, absence of peristalsis, and excessive tenderness, is to be contrasted with the violent peristalsis, the steady advance of symptoms, and the moderate tenderness of intestinal obstruction in its early stages. In many cases the dividing line cannot be drawn, and Le Fort, Kronlein, and Mikulicz have all operated for the relief of obstruction and found the patient suffering from a perforative peritonitis.

Rheumatism of the abdominal walls can be a cause of doubt only for a short time, and the rheumatic peritonitis usually shows its nature by sudden transference of symptoms to other parts of the body, and by prompt yielding to the effects of anti-rheumatic treatment.

The scanty, high-colored urine is not in any way diagnostic, since all intra-abdominal affections accompanied by persistent vomiting are characterized by similar alterations of this fluid.

TREATMENT.—This must depend upon the origin and upon the particular form of the inflammation. In general terms it may be stated to be either *surgical* or *medical*. Each method has its indications, and each, if properly used, will give a large percentage of success. Thus Bouilly,[1] in 12 desperate cases, saved 6 by abdominal section. Wagner,[2] by operation, cured a case of perforative peritonitis due to relapsing typhoid ulcer. Mikulicz[3] states that of 74 cases reported by two authors 28 recovered. Koenig, Rosenberger, Stelzner, Tait, and others have recorded many successful cases.

From the medical side of the question Musser gives the histories of 19 cases of septic peritonitis, all of whom recovered without operation. In addition he records 7 puerperal cases, with 3 deaths. In all he has treated 29 cases, with 3 deaths; 22 cures by medical means and 4 cures by operation. Obalinski[4] strongly favors the expectant treatment even when the inflammation is complicated by obstruction. Of 12 cases thus treated 9 recovered.

OPERATIVE TREATMENT.—Mikulicz states that many patients are directly injured by operation, and that recovery after operation seems to depend less upon the procedure adopted than upon accident. Thus Demons,[5] with a rough sponge and knife-blade, scraped the entire surface of the intestine in a case of purulent peritonitis following suppuration of an ovarian cyst, and the patient made a rapid recovery.

In regard to general diffuse peritonitis, whether dependent upon perforation and extravasation or not, there is a growing belief that prompt abdominal section, abundant washing of the peritoneal cavity with hot solutions, closing of the visceral opening, if one exists, and drainage, offer by large odds the best hope of recovery. In addition to this the tympany should be relieved by one or more quarter-inch incisions into the convex surface of the gut, the intestinal tube should be washed with a weak solution of naphthol or other mild antiseptic, to prevent continuance of fermentation

[1] Le Bulletin Méd., Oct. 13, 1889.

[2] Cong. der Deutsch. Gesel. f. Chirur. Berlin. Klin. Woch., June 10, 1889.

[3] Berlin. Klin. Woch., June 10, 1889.

[4] XVI. Versamm. Deutsch. Chirurg., 1887.

[5] French Surg. Cong. Le Bull. Méd., Oct. 13, 1889.

and renewal of distention, and provision should be made for repeated irrigation with hot (106–110° F.) sterilized salt solution (seven-tenths of one per cent.), several tubes being carried to the various parts of the abdominal cavity, and the latter being flushed out every hour until the formation of adhesions prevents this.

Nothing should be given by the mouth except intestinal antiseptics such as naphthol, salol, or salicylic acid.

As stimulants are most important they should be given freely, either by the rectum or, better, by means of hypodermic medication, thus saving this portion of the bowel for the absorption of peptonoids and other nutrient enemata. For this purpose an ounce of brandy may be dissolved in eight ounces of sterile water and slowly injected by means of gravity into the subcutaneous or muscular tissues of the buttocks, abdominal walls, or other thick, fleshy region. For sudden prostration, hypodermics of ether, twenty minims pure, forced directly into the muscles, and repeated six or eight times at short intervals, will be found most efficacious.

Progressive Suppurative Peritonitis. — The advice of Treves in the treatment of this condition, as developed by inflammation about the cæcum, that is to open and evacuate the purulent collections without breaking through the wall which separates them from the rest of the abdominal cavity, should dominate the surgeon in the treatment of this form of peritonitis, no matter what its origin or seat may be; and it is to the neglect of this practice that many deaths must be ascribed. Mikulicz operated upon five cases of this character. On two of these cases he operated several times, opening each new accumulation of pus as it was discovered. The cavities were washed out with salt solution; even if the gut was perforated, no attempt was made to suture it unless the wound was accessible; drainage was provided for by iodoform gauze tamponade; a few sutures were placed in the parietal wound. The two cases thus treated recovered, while three treated in the usual manner perished.

In these cases there is often no great urgency; the course is one of weeks or even months. Suppuration is denoted by hectic or simply by night-sweats and by loss of flesh and strength. Sooner or later dulness on percussion, local pain or tenderness, and the

signs of tumor, point to the seat of trouble. These cases, if generally treated on the lines laid down by Mikulicz, are destined to present a far smaller mortality than heretofore.

Intestino-peritoneal Septicæmia.—Although it is generally stated that these cases are beyond hope and that, barring the medical treatment, nothing should be attempted, we are profoundly convinced that prompt abdominal section and washing out of the peritoneum, together with many incisions into the gut, and cleansing of it with mild antiseptic agents, will be of service. Thus will be removed the source of septic absorption, and even though a new supply be forthcoming the system will have had a respite in which to gather strength for the struggle against toxæmia. Stimulants forced to their extreme limits are indicated in these cases and are best given subcutaneously. Lavage of both stomach and colon should be employed.

There remain many cases of peritonitis in which the knife can be productive of no good, cases without suppuration, and presenting no evidences of bowel obstruction; or possibly with symptoms of both these conditions, dependent upon intestinal paralysis. In all cases of peritonitis, except those which break out with virulent intensity, we believe that the first thought of the attendant should be a resort to medical treatment.

Considering the disease from the standpoint of the therapeutist, an inflammation of the peritoneum, as in the case of any serous membrane, may be either sthenic or asthenic. The same rules hold, therefore, in this case as in all forms of inflammation, namely, that circulatory depressants are only to be used in the first type and followed, if needed, by stimulants; whereas in the asthenic class the use of stimulants is called for at once and depressants are contra-indicated. For many years the profession has recognized opium and belladonna, particularly the former, as the most universally applicable remedies and best curative drugs for cases of peritoneal inflammation, and while a new school of treatment in this disease has arisen, it has only proved itself of value in certain cases.

In so far as the treatment of the inflammation is concerned the course to be pursued is fairly plain.

While the use of veratrum viride may be resorted to where the patient is strong and the pulse hard and tense, aconite may perhaps, in such cases, be better, for the double reason that vomiting is apt to occur of itself and may be induced by the veratrum viride, while aconite decidedly prevents any such tendencies. This is important in view of the fact that vomiting always is to be avoided, lest the retching increase the peritoneal inflammation.

If vomiting and pain are present, they should be controlled by the use of full doses of opium and belladonna, say one-quarter of a grain of the extract of each to an adult, and the application of leeches to the abdominal wall in large number (from 10 to 30) or the use of counter-irritants. If the vomiting is too severe to take the drugs by the mouth, they must be given by the rectum in a half pint of starch-water, laudanum and the tincture of belladonna being employed in the proportion of half a drachm each, or the alkaloids may be given hypodermically.

Opium is always well borne in full doses by those suffering severe pain, and it seems to be particularly well borne in peritonitis. The use of the drug here, as everywhere else in medicine, is not governed by the amount which has been used, but by the effects which it produces. Opium and belladonna, unlike the depressants and stimulants, may be used in all stages of peritonitis, if called for, but the leeches and counter-irritants are limited in their use to early periods of the attack.

The use of calomel in peritonitis is highly praised by some and decried by others, largely because its proper sphere is not recognized. Mercury does good only in the severe acute forms of peritonitis where the disease arises from traumatism or other cause, and is not to be used except for the changing of a fibrinous exudate into one incapable of undergoing organization.

Absolute rest and the administration of stimulants and food by the rectum till stomach becomes retentive must be enforced.

Commonly in peritonitis the inflammation involves the muscular layer of the bowels. As a result of this obstinate constipation ensues, which is not always to be overcome by purges, which, if they are mild, will not act, and if severe are dangerous, but by the use of belladonna and opium already spoken of. The *rationale* of this treatment, in the light of our present physiological knowledge, is not far to seek. Belladonna acts as an antispas-

modic upon all unstriped muscular fibre, and in the large doses here given depresses the peripheral ends of the splanchnic or inhibitory intestinal nerves. In this way the muscular fibres, which are in spasm, are relaxed and the peristaltic waves set free. The value of the opium also is apparent, for it allays and prevents the reflex muscular spasm and hence the pain and inflammation. Obstinate constipation after the ingestion of irritant foods, such as putrid meat, will often be relieved by opium and belladonna as effectively as if the patient was purged by an ordinary purgative.

Very frequently in acute peritonitis tympanitis becomes not only a very painful, but even a dangerous symptom, the distention of the belly being very great. This may be greatly relieved by the employment of turpentine stupes, and in some cases by the rectal injection of the milk of asafœtida, or better still: turpentine, 1 drachm; milk of asafœtida, 3 ounces; and warm water, 4 ounces.

Not content with having made a vast stride forward during the past few years, abdominal surgery brings with it not only new methods of treating disease in this region by the knife, but also has given us a method of healing peritonitis by the use of saline purgatives, which is certainly of greatest value in those sudden inflammatory conditions which occasionally spring into life after operations upon the abdominal contents. It will be remembered that Mr. Lawson Tait has been the chief advocate of this treatment for several years, and that the wonderful results which he obtained, the reputation of the reporter, and the complete reversal of all our ideas concerning the treatment of the disease, have called forth not only an enormous number of trials of the method in this country, but have also brought forth two opposing factions in the profession. The first of these is chiefly of surgeons; the second of persons who, in a long experience, have reached good results by older methods, and who are generally physicians. The first class dogmatically assert that the physician should turn over every case of peritonitis to the surgeon to be opened, searched, and purged; the second class do not deny that saline purgatives do good in the hands of the surgeon, but are more conservative in their opinions concerning the general use of such, measured in all cases of peritonitis.

Again, it would seem to be impossible at the present time to assert that peritonitis may be either idiopathic or traumatic without bringing upon one's head a storm of criticism, for on the one

side we have a number of physicians who believe that peritonitis may arise without any direct exciting cause, and on the other hand an equally large body of observers who assert that it is essentially a secondary inflammation brought about by direct contiguity with an already inflamed tissue; or else that the inflammation is set up by the escape of foreign bodies into the peritoneal cavity, or by pathological changes in organs normally situated in these regions, as, for example, fibroid enlargements of the uterus with impaction in the pelvis, or pyosalpynx.

As it is absolutely impossible for either side, at present, to prove that their opponents are wrong, and as both sides are not to be doubted in the integrity of their observations, the unbiased judge can but come to the conclusion that, as yet, we have a right to believe that idiopathic peritonitis may exist.

If those observers are correct who believe that no peritonitis arises save as the result of some one of these conditions, then the attempt on the part of the physician to treat such a case is criminal negligence, and, as such, cannot be too severely condemned; but too many cases of peritonitis are to-day walking examples of the value of the use of opium to permit of any one asserting that this treatment is useless, or that the knife of the surgeon is to be used in every case; yet some of the more positive members of the profession would have us believe the abdomen should be opened solely for the purpose of making a diagnosis, and that this having been done and no intestinal complications found, salines should be given.

Whether the inflammation be idiopathic or not has little to do, however, with the methods which we are to resort to in the medical treatment of this condition. It cannot be gainsaid that the results obtained by surgeons in the use of saline purgatives have been startlingly brilliant, neither can any one deny that their methods may sometimes be employed in medicine as well as in surgery; but there are several points to be recalled by both parties which, we think, so seriously modify the views of each as, after all, to somewhat harmonize their views. No one denies that the surgeon does rightly when he uses salines to prevent peritonitis, after an operation, but the knowledge of the condition of the patient after he has been operated upon by the surgeon, and that possessed by the physician when called to see a case of peritonitis, are radically different, for the surgeon has a right to believe that the

intestinal canal is patulous and devoid of impactions and intussusceptions, while the latter knows not whether he has before him an inflammation of the peritoneum without intestinal involvement, or inflammation dependent upon some abnormality in the primæ viæ. As a consequence, it is perfectly proper for surgeons to administer salines which, to use their own words, not only deplete the abdominal bloodvessels, but also, by the increased peristaltic movements produced, prevent adhesions; while the physician in the case of peritonitis from perforation, impaction, or intussusception, may do the patient an immense amount of harm by such a procedure long before it is possible to decide what the cause of the trouble may be.

It is evident, therefore, that the opium treatment must be adhered to, at least until the diagnosis is formed, unless at the first sign of pain an exploratory incision is made instead of using those remedies generally employed in ordinary attacks of abdominal discomfort; and it should not be forgotten that pain and tenderness with inflammation are not only the symptoms of peritonitis after section, but also of many other states in the ordinary individual.

It is also evident that other conditions may exist which render the administration of purges unjustifiable, and in which the use of the knife by the surgeon is not to be thought of. It is undeniable that the surgeon should be summoned the moment a suspicion of perforation arises, but in the case of a person in whom an enteritis has arisen, locally, by an old adhesion, increased peristaltic movement is equivalent to strapping the normal side of the chest in pleurisy, with the object of giving the diseased side more exercise.

Again, it is of the gravest importance that both the physician and surgeon should distinguish very clearly between an inflammation of the peritoneum in a strong healthy person, and in one who is in a condition of vital depression, or exhausted from prolonged disease elsewhere. Depletion by means of purges is of course, in the first class, as much indicated as the application of leeches or bleeding, but in the second class, quite as strongly contraindicated. In the dynamic form of inflammation, there is danger of adhesions being formed by reason of the fibrinous exudate thrown out; in the adynamic condition of inflammation there is already an enormous exudation of serum into the abdominal cavity, which purges cannot remove till they have drained off a large amount of liquid from the blood.

Again, there are some cases of peritonitis which are ushered in by an acute paroxysm of pain, but which do not continue during their whole course as dynamic cases, and in which depletion at first results in exhaustion later on.

Until the profession have employed these two methods side by side, with an absolutely unbiased opinion for a long period of time, the only proper conclusion to be reached seems to us to be this, namely, that in acute peritonitis suddenly lighted up in a surgical case, and which is recognized almost at the moment of its inception by the surgeon, who is ever watchful for it, salines should be given ; in the case which the physician rarely sees till hours have elapsed, and in which grave doubt must exist as to the cause of the trouble opium and external methods of depletion must be resorted to.

CHAPTER IX.

ON DIAGNOSING THE VARIOUS FORMS OF INTESTINAL OBSTRUCTION.

EACH of the common forms of intestinal obstruction has been considered individually, with the general appropriate treatment. It is now in order to discuss the differential diagnosis between the various forms of obstruction, and to treat in more minute detail the various therapeutic means which have been proposed in the treatment of this class of affections.

In general, the symptoms caused by occlusion of the intestinal canal are the same: pain, distention, obstinate constipation and vomiting, and systemic depression. Each form of obstruction presents certain peculiarities, but these are unfortunately not constant. Hutchinson[1] states that an accurate diagnosis of the cause of obstruction is not in four out of five cases possible. Obalinski[2] says that a diagnosis cannot be made in more than half the cases. Déprès,[3] however, holds that the diagnosis of the cause can be made when the symptoms are well developed in 99 per cent. of all cases. With this statement there are few practical surgeons who will agree.

At the very beginning of the question comes the difficult question of distinguishing between cases of obstruction due to mechanical occlusion of the bowel and those due to paralysis. Where the paralysis is the result of a frank peritonitis, the pain, tenderness, decubitus, characteristic vomiting, tympany, and absence of peristalsis, with high temperature and rapid, wiry pulse, will at once suggest the diagnosis. Where it is attended with the minimum amount of inflammation, however, or where the septic symptoms predominate, it may be impossible to decide as to the nature of the case. Heusner[4] reports two cases in which laparotomy for obstruc-

[1] Archives of Surg., Vol. 1, No. 1, p. 10.

[2] VI. Langenbeck Arch. f. Chirur., xxxviii., 2.

[3] Rev. de Chir., 1887.

[4] Deut. Med. Woch., 1887.

tion was performed, the operation showing that the symptoms were dependent upon a perforative paralysis. We have an unreported case where the abdomen was opened for internal strangulation when a paretic condition of the bowel dependent upon enteritis was present. Many instances of failure to determine between these two conditions can be cited, and it is well known that the men of greatest experience express least confidence in making a differential diagnosis.

The history of the case is always important. A previous attack of inflammation would suggest bands or adhesions. A record of typhoid, or other ulceration of the bowel, would suggest stricture; a history of anomalies in the family would suggest a Meckle's diverticulum. An account of abdominal traumatism would suggest hernia through rents in the mesentery or omentum; a history of stubborn constipation would suggest volvulus, impaction of feces, adhesion, or stricture.

Age and *sex* must be considered—infants are prone to intussusception, young adults to internal strangulation, adult females[1] to fecal impactions. Males at about middle age or somewhat past it, to volvulus, this condition being exceedingly rare before the twenty-fifth year.

Onset.—This will serve to distinguish the acute from the chronic forms of obstruction. If it occurs suddenly in a person of good health, not presenting previous bowel symptoms, and especially if dependent upon some sudden or violent muscular exertion, the chances are greatly in favor of internal strangulation being the causative condition. Frequently, however, a violent outbreak with fulminant symptoms is found to depend upon a chronic form of obstruction.

Pain and shock.—These symptoms are usually best marked in cases of internal strangulation. They both, however, depend in the beginning upon the amount of constriction to which the bowel is subject, and they may be, exceptionally, well marked from the first in volvulus or invagination. The seat of pain should be carefully considered, since, if it is correctly referred to the position of the obstruction, and this is occasionally the case, it may be a valuable diagnostic guide.

[1] Treves, London Lancet, 1887.

Temperature.—This makes no great departure from normal till peritonitis sets in, when it may be moderately elevated. In distention with septic absorption a subnormal temperature is frequently noted.

Pulse.—In acute obstruction the pulse is quickly and profoundly affected. It becomes exceedingly rapid and weak, thus markedly contrasting with the normal or subnormal temperature. Of all single symptoms this is the one which is most constant and most significant as to the vital condition of the patient. As a means of differential diagnosis it is of no value.

Meteorism and abdominal configuration.—If the patient is seen early, the meteorism may suggest the seat, if not the nature, of the obstruction. With a stoppage at the sigmoid flexure, first the colon, then ultimately the small intestines become distended, giving the belly a quadrilateral shape. When the small intestines are involved there is primarily a bullet-shaped enlargement of the central part of the belly, with flatness in the region of the colon. The amount of distention is dependent upon the absoluteness of the obstruction, the presence or absence of vigorous peristalsis, and the amount of fermentable matter in the bowel. So long as the muscular walls of the gut retain vigorous contracting power, there is constant regurgitation of liquids and gases into the stomach, whence they are quickly vomited. When paralysis allows wide dilatation and consequent kinking, the contents of the gut cannot escape, and meteorism reaches its extreme limit.

An irregularity in the abdominal distention is of diagnostic value; in both volvulus and strangulation the constricted loop is the first to become inflated; this loop, if of any length, will produce a local tumefaction preceding the general swelling. Invagination usually gives but little meteorism. In general, the distention is proportionate to the suddenness and acuteness of the process.

Peristalsis.—This, in peritonitis and paralysis of the bowel from other causes, is absent. In mechanical obstruction it is violent and long continued, and can be perceived by palpation and auscultation.

Urine.—Though much has been written upon this subject, there is little here to guide us. In amount, it probably depends upon the frequency of vomiting. In strangulation it has often been observed to contain albumin, while in pure obstruction indican in large quantities is always found. We have made a number of personal

observations upon this test, but find indican so frequently present in other pathological conditions, or even when the urine is in all respects normal, that the finding of it in any given case is without value.

Vomiting.—In strangulation, vomiting comes on early and becomes fecal rapidly. In other forms of obstruction the vomiting may be slight, or even wanting altogether. In peritonitis it is bilious and at times takes the form of an outpouring from the stomach with scarcely any effort on the part of the patient, and with all the symptoms of a cholera-collapse. In both volvulus and invagination the vomiting is rarely fecal.

Constipation.—Excepting invagination, there is constipation in all of the forms of obstruction. Volvulus sometimes gives one or two passages, and at times the onset of peritonitis is denoted by watery alvine evacuations.

Tenesmus.—This is peculiarly characteristic of intussusception involving the descending colon and sigmoid flexure, though it has been noted in volvulus of this part of the gut. When combined with the discharge of blood and mucus it practically makes certain the diagnosis of intussusception.

Palpation and percussion will detect the tenderness of peritonitis, the sausage-shaped erectile tumor of intussusception, the doughy masses of fecal impaction, the central tympany with peripheral dulness of exudative peritonitis, the hard induration of cancerous stricture, the localized tenderness and resistance of circumscribed peritonitis, and more rarely, the tender tympanitic swelling of strangulation or volvulus. An examination of the rectum should never be omitted, since invagination, occlusion by malignant growth, and impaction of feces or foreign body have many times been diagnosed by this means.

Auscultation.—The loud borborygmi dependent upon the increased peristalsis of mechanical obstruction are readily heard; at times they can be traced to the point of obstruction, where they are replaced, according to Auffret, by a peculiar click resembling that of the water-hammer. By using gentle palpation the friction sounds of a beginning peritonitis may occasionally be perceived.

Injection.—Gas or water can be used and either will be of diagnostic value in the early stages of obstruction. The colon, if pervious, can by this means be clearly outlined and percussed; if not,

the impossibility of forcing over a quart of water into the bowel would at once suggest an occlusion about the sigmoid flexure. It must be borne in mind that the amount of water which the rectum can hold varies greatly, depending upon the condition of its muscular coat, and that at times its capacity for distention is very great.

In a case reported by Miller[1] the test of the capacity of the rectum, and its perviousness to water injection seems to have failed, since, although the strangulation was in the small intestine, only a very small amount of liquid could be forced into the bowel by the injection pipe. The report of this case is so meagre, however, that it is impossible to discover how thorough a trial was made of the method.

Prognosis.—It is almost impossible to justly decide as to the average chance of life in a case of acute intestinal obstruction. On the one hand the statement is made that "nearly all cases of acute mechanical intestinal obstruction die unless relieved by surgical interference,"[2] on the other it is within the experience of every practising physician that cases of this nature do get well under careful medical treatment. As to the probability of relief to internal strangulation, or confirmed volvulus by palliative means this is open to doubt, since an autopsy is necessary to confirm the diagnosis, but that paretic distention and invagination frequently yield to the physician's manipulations cannot be questioned. Curschmann[3] places the mortality of obstruction from all causes at about 65 per cent. Our own tables give a considerably higher death rate.

[1] Edinburg Med. Jour., 1890.

[2] Fitz., Boston Med. & Surg. Jour., Nov. 15, 1888.

[3] Therapeut. Monatsh., May, 1889.

CHAPTER X.

ON THE GENERAL TREATMENT OF INTESTINAL OBSTRUCTION.

On this question the surgeon and physician are arrayed against each other. The extremist of one party rejects all the ordinary therapeutical agencies and advises immediate recourse to the knife, while his opponent cites the appalling mortality of operative cases, and trusts to measures which, if not successful, at least do not hasten death.

In so far as statistics can be relied on, the surgeon certainly has the best of the discussion. In another place we have alluded to some of the reasons which make conclusions founded upon reported cases of doubtful value. Under intussusception it has been shown that the mortality of the operative cases was practically the same as that of cases treated expectantly, although as a rule only the desperate cases were subjected to the knife. It may be safely assumed that the mortality of cases of acute intestinal obstruction treated medically lies somewhere between 65 and 75 per cent., our own statistics give 73.2 per cent. Obalinski,[1] of 38 cases treated by laparotomy lost 60.5 per cent. In his last series of nineteen the mortality was 52.6 per cent. Schramm gives a mortality, since the aseptic wound treatment, of 58 per cent. Curtis[2] reports 328 cases of acute intestinal obstruction treated by section with a mortality of 68.9 per cent., 62 cases treated by enterostomy[3] gave a mortality of 43.3 per cent.

Far more conclusive than statistics, which are decidedly favorable to operation, are the records of the autopsy room, which show that so many of the fatal cases could have been relieved by operation.

It is now very generally conceded that, provided a patient is in good general condition, an exploration of the abdominal cavity, if quickly performed, is attended with very little danger to life. When tympany is enormously developed such exploration becomes

[1] V. Langenbeck, Arch. f. Chirur., xxxviii. 2.

[2] Annals of Surg., May, 1888.

[3] Med. Rec., Sept. 1, 1888.

both difficult and dangerous; where the case is complicated by peritonitis and adhesions the surgeon may find it impossible to discover the seat of obstruction. These cases then present in their early stages no grave difficulties to the surgeon, either from the mechanical obstacles to be overcome or from the unfavorable condition of the patient; in the latter stages complications and difficulties are developed which may well deter the boldest from operating. It is then in the early stages that operation should be advised. All surgeons are agreed upon this point, and many physicians are realizing its importance.

The question at once arises, what is meant by the early stages? A certain amount of time is often necessary to confirm the diagnosis. Vomiting, constipation, pain, and meteorism may be symptomatic of conditions other than those of intestinal obstruction. It is upon the persistence of these symptoms and the development of others that the surgeon must rely, and this may be a matter of hours, or even days. Richardson[1] considers stercoraceous vomiting as the index of obstruction requiring operation. Since this symptom is frequently absent even in acute strangulation, cases running a fatal course before fecal vomiting has time to appear, this sign is not for a moment to be relied on.

Schramm advises immediate operation upon the diagnosis of obstruction being confirmed. In the discussion of the British Medical Association upon the subject (1887) the general consensus of opinion seemed to be that in doubtful cases no time should be lost but an exploratory section should at once be performed.

Obalinski advises in acute cases that an exploratory incision should be made in the first twenty-four hours. The paralytic impermeability following typhlitis, oöphoritis, or other forms of local peritonitis, should, however, be treated expectantly. Of twelve such cases subjected by Obalinski to morphia and belladonna treatment, nine recovered.

Goltdamer[2] would limit laparotomy to cases of intussusception; cases in which symptoms of obstruction are steadily progressive in spite of the free use of opium; cases in which after opium has produced a remission of all symptoms, these seem suddenly to develop anew.

[1] Med. Press and Circ., Feb. 7, 1889.

[2] Brit. Med. Journ., March 11, 1889.

Krönlein and Czerny advise early operation; abdominal section when the strength of the patient is well preserved; when the abdomen is soft and not distended; and when by means of palpation the seat of obstruction can be partly determined. In all other cases they advise an ileostomy through a small incision.

Both surgeons and physicians are agreed upon the value of opium in cases of mechanical obstruction. It is best given in the form of morphia subcutaneously, and should be combined with full doses of belladonna or its alkaloid atropia. Of the effects of these drugs we have spoken under peritonitis.

We feel convinced that the time to operate cannot be expressed in hours or days, or by specific symptoms. It is first necessary to confirm the diagnosis of obstruction, and this in the majority of cases is quickly and surely done. Immediately, morphia and belladonna having been properly administered and the stomach having been washed out, *one thorough trial at reduction* should be made. In all cases the patient should be relaxed by the administration of an anæsthetic. If invagination is suspected, slow, persistent gravity injection with abdominal kneading or inversion and shaking. In supposed volvulus and internal strangulation the same treatment with the patient in the knee-elbow position can do little harm. In supposed intestinal paralysis the application of electricity.

If this trial is unsuccessful *immediate* abdominal section is indicated.

At this stage, when the patient's strength is well preserved, when tympany is but mildly developed, when there is reason to believe that no extensive pathological changes have taken place in the gut, we think an enterostomy as a primary procedure should not be considered. The abdomen should be opened by a *free* median incision, and the ordinary seats of obstruction should be explored by eye and hand.

Since the fatal result after abdominal section is commonly due to shock, the operation should be conducted with the greatest possible rapidity. If the seat of obstruction cannot be quickly found; or if found required a tedious procedure for the restoration of the continuity of the gut, we think an enterostomy would be indicated.

Circular enterorraphy has in these cases been nearly uniformly fatal. Lateral approximation by plates or implantation, or invagination by the rubber ring are quickly performed, and when the

operation has not already been unduly prolonged, may be indicated. A half hour should, in general, be the extreme limit of time during which the belly should be open. If this period has elapsed, and the seat of trouble is not yet found, or if found the obstruction not overcome, an enterostomy should be performed.

Under some circumstances the seat of obstruction, when not acutely congested or inflamed, may be switched out of the alimentary tract by an anastomosis between the afferent and efferent bowel segments. In general the operator should aim at rapidity of manipulation and the immediate safety of the patient, rather than at an ideal restoration of parts to their normal condition.

We think that the danger of secondary occlusion by displacement of bowel segments or by intestinal paralysis is lessened by an abundant irrigation of the peritoneal cavity with hot saline solution. Malcolm[1] has called attention to the value of this as a means of securing a natural disposition of the intestines after abdominal section.

The preservation of the body heat of the patient is most important. The operating table we describe, together with thin ribbed hot water bags placed over the chest and about the portion of the abdomen which is not subject to operation, are efficient means of accomplishing this. Since the amount of heat abstracted from the highly vascular peritoneum is, when the latter is exposed, enormous, it should be the duty of one assistant to keep all exposed bowel segments covered with rubber dam or with thin sponges wrung out in hot saline solution.

Nothing should be taken by the mouth for from twenty-four to forty-eight hours after operation.

[1] Lancet, Jan. 11, 1890.

CHAPTER XI.

SPECIAL TREATMENT OF OBSTRUCTION.

In a detailed consideration of the various methods of treatment advocated for intestinal obstruction, including the surgical operations which are indicated, the first subjects which present themselves are—

Diet and medication.—The profession is now practically unanimous in advising that neither food nor drink should be given by the mouth during the continuance of acute obstructive symptoms. The objection to gastric alimentation is not merely that there can be no digestion and no absorption, but that fresh matter is supplied for decomposition, and that fresh impetus is given to the exhausting vomiting. In one unreported case of acute obstruction we withheld food for six days ; the patient recovered showing no marked emaciation as a result of her long fast. There can be no objection to the administration by the rectum of beef peptoids of peptonized milk and eggs, and of stimulants. The thirst is relieved by gently injecting one or two pints of warm water into the lower bowel.

If the heart shows signs of flagging, especially if there is a condition of collapse similar to that observed in cholera, three to six ounces of whiskey dissolved in one to two pints of warm saline solution can be thrown by gravity into the cellular tissues. Hypodermics of ether, frequently repeated, are peculiarly applicable to this condition. Personally we have not obtained satisfactory results from the use of digitalis. Against heart failure, whiskey is the main stay, and must be pushed to its physiological effect. The rectum may also be used for the absorption of whiskey, but in this case it should be diluted at least six or eight times since acute inflammation of the mucous membrane has been produced by concentrated solutions.

Of opium and belladonna, the two drugs mainly indicated, we have spoken at length under peritonitis. We think that both should be given hypodermically.

Strychnia is at times of great service, especially in conditions of profound nervous shock, and in paretic states of the bowel. To be of service it must be pushed till its physiological effect is produced.

Purgatives are to be avoided, Stoker[1] being the only surgeon of prominence advocating their use in recent times.

Lavage of the stomach.—This treatment, originally advocated by Küssmaul, has received the highest clinical endorsement. Its effect is direct and readily understood. It mechanically removes a large quantity of putrid septic matter which otherwise would be slowly and laboriously regurgitated by violent muscular efforts, thus still further weakening an already debilitated patient. It assists nature in her eliminative efforts, and almost without exception produces an immediate improvement in the patient's condition. Indeed, there is so great an amelioration of symptoms that this procedure is utterly condemned by some surgeons as producing, like opium, a seeming improvement not warranted by the condition of the bowel at the seat of obstruction, and thus leading to a postponement of operation.

In some cases it produces not only relief, but is absolutely curative. Mahnert[2] reports several cases of cure. Even where death is inevitable it is productive of such relief that it may be employed if nausea and vomiting are well marked. Curschmann[3] ranks washing of the stomach next to opium as a palliative and curative agent. Nothnagel[4] and Gerster[5] commend this procedure, as do indeed all surgeons who have fairly tried it.

Either plain water may be used, or normal saline solution, or mild antiseptic lotions, such as solutions of boric or salicylic acid. Since there is a patulous condition of the pylorus the weak antiseptic solutions are particularly indicated, as by becoming mingled with the intestinal contents, further fermentation is retarded or entirely prevented. We believe that these injections should always be made with hot solutions (106° F.) for reasons given under the section on enemata.

Enemata.—In the use of enemata there is more confidence than

[1] Dublin Journ. Med. Sc., Nov. 1889.
[2] Memorabil. Heil., March 16, 1889.
[3] Therapeut. Monatsh., May, 1889.
[4] Allgemein. Wien. Med. Zeit., May 7, 1889.
[5] N. Y. Med. Journ., May, 1889.

in all the combined palliative means of treatment. Though peculiarly applicable to cases of intussusception, paralysis is benefited by the stimulus thus given to peristalsis. It is asserted that volvulus may be untwisted provided the injection is accompanied by inversion or massage, and even internal strangulation may be made to yield to the gradual distention of the lower bowel segment, though clinical proof in regard to the justice of these claims is wanting.

In the chronic obstructions dependent upon impacted feces and upon narrowing in some portion of the colon the use of enemata is practically the only palliative measure left to the physician.

The method of giving enemata has been described under invagination.

Even though the invagination were seated at the small bowel we would not hesitate to employ injection as described. Senn states, on the basis of experiments resulting fatally upon animals, "That the injection of the water beyond the cæcal valve, in the treatment of intestinal obstruction, must be looked upon in the light of a dangerous expedient, and must never be resorted to." We have repeatedly passed water from the anus to the mouth of dogs without producing the slightest unfavorable symptoms, except in one instance, our first experiment, where water was taken directly from the tap (52° F.); the dog perished after twelve hours, having suffered with tenesmus, and having passed some blood-stained mucous evacuations. The post-mortem examination showed intense congestion of the colon.

Battey[1] reports a case in which water injected into the anus with an ordinary syringe entered the stomach and was vomited.

Though the necessity for injections so copious as this rarely arises, yet there are scattered through medical literature a sufficient number of reports to confirm the results of our experiments upon dogs as to the harmlessness of forcing water past the ileocæcal valve.

There are certain points of cardinal importance to be considered in making these injections:—

1. The liquid must enter the bowel by a gradual, steady flow.

2. The temperature should not differ greatly from that of the body.

[1] Atlanta Med. and Surg. Journ., June, 1874. Medical Record, July 1, 1874.

3. The pressure should be uniform and long-continued, starting at two pounds (an elevation of 4 feet), and, if necessary, gradually increasing to not over eight pounds (elevation of 16 feet), this is effected by slowly raising the reservoir.

4. Not over three-quarters of an hour should be spent in attempting to force the liquid past the seat of constriction.

The danger of rupturing the bowel must not be forgotten. In any case where beginning mortification is feared, as, for instance, in intussusception where shreds of necrotic tissue have been discharged, or in cases characterized by acute symptoms which have lasted for three days or upwards, we think that the danger of forced injection is so great, and its probable efficacy so limited, that it should give place to operative procedure.

We have knowledge of three unreported cases in which forced injections resulted in rupture of the bowel and speedy death. In each case these injections were made with the Davidson syringe, and the amount of force used was undeterminable. There are many recorded cases where this accident has occurred.[1] Under any circumstances there is a risk in the employment of eight pounds of pressure, though experiment has shown us that this is far within the bursting strain of normal gut. In view of the hundreds of successful results following this method, or rather very imperfect attempts at it, we think the physician is justified in taking this risk in suitable cases, provided preparation is made for an immediate abdominal section, should symptoms characteristic of rupture of the bowel appear (*i. e.*, sudden uniform swelling of the belly, loss of outline of distended colon, and collapse).

We would particularly protest against frequently repeated small injections with the Davidson or other pumping syringe.

Each hour diminishes the chances of success. That second and third efforts have accomplished their objects has been simply because they were more efficiently made. At the first effort the circumstances are most favorable for reduction, and the physician is justified in using more force and perseverance than at any other time in the course of the disease. This first attempt should, then, be so thorough that he can feel assured the method, and not its mode of application, is at fault.

[1] Medico-Chirurgical Transactions, 59th volume.

Electricity.—As a means of encouraging peristalsis, electricity has been warmly commended from the time of its general introduction into the treatment of disease. How it can effect the mechanical forms of obstruction is difficult to understand, yet many cases of cure are placed to its credit. It is in paralytic distention, however, that this treatment has obtained most brilliant results.

As a type of the results sometimes obtained we quote one case, given together with several others by Auffret.[1] The patient had a history of previous slight attacks of a similar nature; after several days of constipation he entered the hospital with great abdominal pain exaggerated by pressure, with meteorism and bilious vomiting.

Abdominal facies was marked, the thighs were flexed upon the body, the pain was located about the umbilicus, there was general meteorism, with dilated intestinal loops clearly outlined through the parietes. Pulse scarcely perceptible; temperature subnormal.

The following day all symptoms were exaggerated, and death seemed immediate and inevitable.

The two poles of a faradic battery were placed one over the abdominal parietes, the other within the rectum. The application was continued twenty minutes, and was carried to its maximum intensity, when suddenly the patient experienced a sudden jar accompanied by a feeling of intestinal displacement. Immediately free evacuation of gas and fecal masses took place through the bowel, and the patient rapidly convalesced.

In one of our cases the application of faradism was equally successful. A patient suffering from chronic Bright's disease remained obstinately constipated for three days, when the abdomen became, rather suddenly, enormously distended; the patient complained of intense pain about the umbilicus, and frequently repeated bilious vomiting set in. In eight hours the distention had reached such a degree that death from respiratory failure was threatened. The rectal tube, stimulating enemata, large forced enemata had all been tried in vain.

Before resorting to puncture of the bowel the poles of a powerful faradic battery were applied, one to the small of the back, the other to the abdominal muscles. In fifteen minutes there was an enor-

[1] Mem. sur les Occlus. Intest., Par., 1885.

mous discharge of gas followed by several passages of thin yellow feces.

Both these cases were probably examples of paralytic obstruction. Where it is uncertain whether this condition or mechanical blocking is causing obstructive symptoms we think the application of the faradic battery should be given a thorough trial, preferably by a metal electrode carried into the rectum the other pole being applied to the belly walls. As a means of applying the current still more directly, Heard[1] advocates filling the rectum with saline solution and introducing the rectal electrode into this.

Perhaps the majority of physicians utterly distrust electricity as a curative agent in intestinal obstruction. This is doubtless owing to its want of success in cases dependent upon mechanical causes. Even that the majority of paralytic obstruction cases will yield to its influence cannot be claimed. That some do, is indisputable, and we think that an agent which may do good, which consumes little time in its application, and which, if unsuccessful, can do no harm, should be given a fair trial.

Gaseous injection.—The injection of air or gas as a means of locating intestinal obstruction has lately been warmly and nearly universally commended. Belief in its greater permeability is universal, the experiments of Senn, and the statements of Curschmann[2] and the majority of surgeons being to the effect that the ileocæcal valve is practically closed to the upward passage of water. Mahnert,[3] Damsch,[4] Head,[5] Crisp,[6] Bryant,[7] and many others have employed air injections in the treatment of intussusception. Schuetter advocates CO_2, and Damsch states that a litre of this will fill the colon to the ileocæcal valve without producing peristalsis, but that it will not pass this valve as readily as will air.

That air or gas injections have frequently been efficient in removing the cause of obstruction cannot be denied, but as the pressure is less directly under control, and as in certain cases, the mechanical benefit of the weight of water seems to be an important

[1] Weekly Med. Rev., Aug. 17, 1889.
[2] Loc. cit.
[3] Loc. cit.
[4] Berlin. Klin. Woch., April 15, 1889.
[5] St. Barthol. Hosp. Rept., 1867, III. 85.
[6] London Lancet, 1847, I. 557.
[7] Brit. Med. Journ., 1884, II. 1801.

factor in the accomplishment of a cure we do not consider insufflation so valuable a method of treatment as injection of liquids.

We performed numerous experiments upon dogs, injecting air from end to end,[1] and in one instance ligating the cardiac end of the stomach and injecting, with the idea of discovering how readily intestinal paralysis from over-distention, and consequent crippling of the diaphragm could be accomplished. A pressure of four pounds was as much as we could obtain with the means at hand, and this continued for three-quarters of an hour, produced but little more distention than that present when the gas was freely eructated.

This proved that the effect upon respiration and circulation was absolutely negative in gaseous injections even when an obstruction in the upper part of the alimentary canal was present.

The cause of frequent failure of this method is, as in the employment of enemata, because of an imperfect method of applying it. Any injection into the bowel causes a spasmodic resistance and effort at extrusion—this is increased if the pressure is constantly varying. Spasm ultimately yields to steady continued pressure, even though this be very slight. Time and again we have seen operators fail to pass gas from anus to mouth simply because they did not recognize the importance of the element of time in overcoming muscular resistance. The spasmodically contracted muscles of a fractured thigh, which even the mighty power of windlass and pulley may fail to overcome, yield in a night to the continued traction of a few pounds. So the resistant muscular coat of the bowel may, if the struggle be short and violent, rupture before yielding, but inevitably relaxes under persistent gentle pressure.

[1] As a type of this series of experiments the following is given :—

Pup, 30 lbs. purged by buck-thorn the night before. Two grains of morphia administered hypodermically.

2. P.M. Insufflation begun by means of gas bag. Pressure one and a half pounds, circumference of belly 13½ inches.

2.10. Circumference of belly 14 inches. Colon full as denoted by palpation and percussion.

2.15. Loud rumbling and rapid inward passage of gas denoting opening of ileocæcal valve ; circumference of belly 16 inches.

2.20. Loud rumbling repeated, denoting entrance of gas into stomach, circumference of belly 17 inches.

2.23. Gas belched up at intervals of a few seconds, loud rumbling accompanying each eruction.

Thus with a pressure of a half pound we have, in forty minutes, passed gas along the entire intestinal tract of a dog. If obstruction is to be overcome, the gas must reach the seat of obstruction, and it is far safer to accomplish this by moderate continued pressure, continued for thirty or forty minutes, than by rapidly increasing the pressure, if in five or ten minutes no results seem to follow. The physician should always have an accurate idea of just how much pressure is being employed, and for this purpose should attach a mercury manometer to the injection pipe. That this is a necessary precaution is shown by repeated cases of rupture during insufflation.[1]

Our conclusions in regard to insufflation are :—

1. It is a valuable means of overcoming acute obstruction in any part of the alimentary tract, but must rank in order of efficiency after water injections.

2. The injection should be slow and long continued, the pressure should be evenly maintained and should be indicated by a manometer.

3. The danger of rupture must be considered in gaseous injections.

It seems proper in this connection to discuss two subjects intimately connected with rectal injection, namely :—

Heat preservation, and

The effect of intra-abdominal pressure produced by forced enemata.

At the very first glance it will be clearly seen that the maintenance of bodily heat at the normal point or at least at a temperature approximating the normal is necessary for the welfare of the patient. This is very well illustrated by the experiments of Brunton, and many others including our own, for it was found that lethal doses of chloral do not produce death if the bodily heat of the drugged animal be carefully watched after. The maintenance of the normal temperature in man is far more important than its maintenance in animals. In the human body every atom of protoplasm is a sensitive tropical plant, only exposed, except in disease, to the variation of a very small fraction of a degree in the heat supplied

[1] Medico-Chirurgical Trans., 1876, p. 97.

to it, simply because man's temperature is constant, whereas in the dog or other brute the normal temperature is ever varying, now high, now low. Thus in the dog, the temperature of 12 noon may be 102.1°; at 12.15, 102.5°; at 12.30 or 12.45, 102°, and by 2 o'clock up to 103°, only to return at 3 to the original number of degrees, and yet perfect health be present. To express the difference in a homely simile, man is a fine chronometer, never varying, while the dog or rabbit is a Waterbury watch made of cheap and coarse protoplasm which can only approximate.

We learn therefore, as one of the first and most important points in the use of injections in obstruction, that the water used must be warm, and that cold water is distinctly harmful. If we remember that the heat functions of the body are chiefly centred in the abdominal viscera, and that these viscera are particularly arranged by nature in such a way as to be protected from exposure to cold, we can readily see the importance of this subject. For the purpose of avoiding chilling, the skin, soft tissues, and bones, are arranged as one impenetrable, non-conducting covering which neither transmits cold nor heat. Yet some have resorted to cold injections without so much as a thought that the patient, already weakened and exhausted by disease and vomiting, should be carefully protected from cold, particularly in his vital parts.

For the purpose of determining the exact importance of these precautions, we have made a series of experiments with results which are well shown in the record given below and which is taken as a typical example of a number of trials. It will be seen that the introduction of water as it comes from the tap lowers the normal bodily heat with great rapidity, and even causes marked coldness of the belly walls.[1]

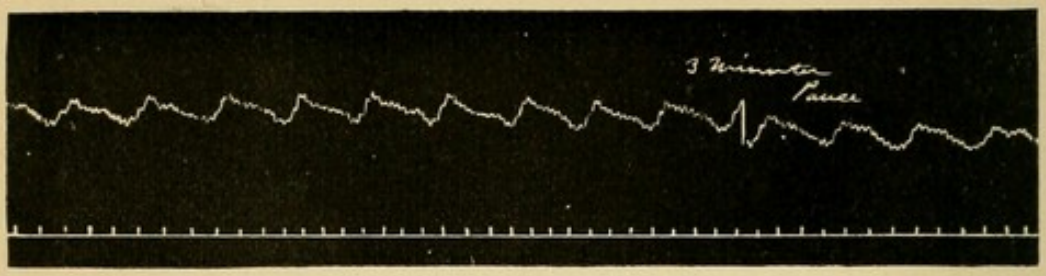
Experiment.—Dog, weight 27 pounds. No morphine or ether used.

11 A. M. Began injecting by hydrostatic syringe four quarts of water at 65° Fahr., the pressure being equal to 35 millimeters of mercury. Temperature in the axilla 102°.

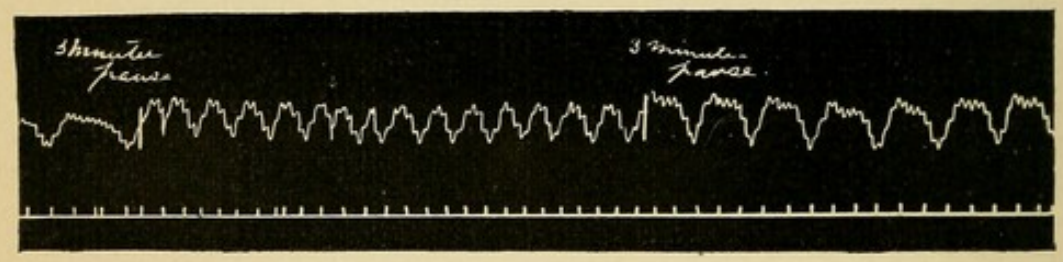
[1] The method of experimentation consisted in the connection of an ordinary fountain syringe with a Y-shaped tube, one arm of which was attached to a mercurial manometer, the other to the tube entering the rectum of the animal. By raising and lowering the bag holding the water the pressure could be varied at will and the manometer afforded a ready gauge as to the amount of this pressure.

Tracings to determine the effect of passing water at 65° F. from anus to mouth upon the pulse and respiration.

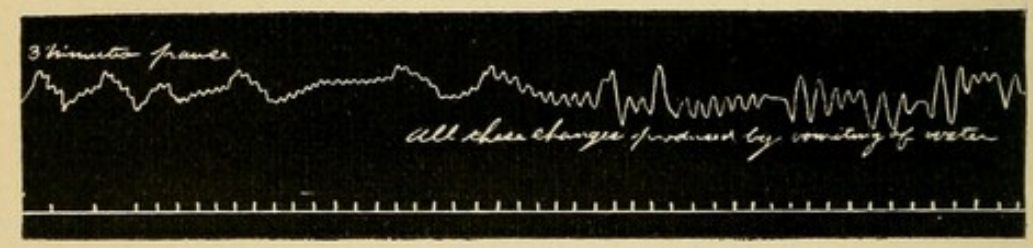
I. [To face page 99.



II.



III.



The last tracings before the change induced by vomiting movements shows 18 mm. fall in blood pressure.

11.10 A. M. Belly walls are exceedingly cold, frequent rigors pass over the body.

11.30 A. M. Vomited contents of stomach and the water which had been passed through. Axillary temperature now found to be 99° Fahr., or in other words a fall of 3° in bodily temperature had taken place in about thirty minutes. Temperature of the internal viscera must have been even less than this owing to the direct contact of the water, for the dog was in a state of collapse and shock, and seemed almost dead from the cold. The time occupied in passing the water from anus to mouth was thirty minutes, the pressure being 35 millimetres. [See tracings.]

Very few persons, even among surgeons, who constantly operate, have any conception of the decidedly depressant effects which anæsthetics exert upon bodily temperature; and again, very few know that the mere stretching out of the patient upon an operating table also produces a great loss of heat. The following experiments performed by us in regard to this point show in a somewhat startling but nevertheless accurate manner the truth of our assertions, and we have found them to hold good, not only in the lower animals, but also in man. Thus we have experimentally determined that it is possible to lower the normal rectal temperature of the dog as much as from 8° to 10° Fahr. by continuous etherization for an hour, giving two drachms of ether every five minutes after the animal has been put thoroughly under the anæsthetic influence.

These two series of studies on man which follow are particularly interesting. In the first series the temperature was taken in the axilla, and in the second in the rectum.

Series I.

No.	Operation.	Temperature before.	Temperature after.
1	Anal fistula	99°	96.2°
2	Carcinoma	98.6	95
3	Arthritis of knee	99.1	96 4
4	Arthritis of knee	98.8	95.8
5	Sarcoma of both testicles	98.6	94.2
6	Vesical stone	99	97.1
7	Arthritis of knee	99	96.8
8	Vesical stone	98.6	96.4
9	Traumatic epilepsy	98.1	95.4
10	Necrosis of tibia	98.5	97.2
11	Necrosis of phalanx	98.2	96.8
12	Renal calculus	99.4	96.8
13	Nasal sarcoma	98.4	97.2

The average fall of temperature is seen to be over $2\frac{1}{2}°$ Fahr., the greatest fall being 4.4° Fahr., the least 1.2°.

Series II.

No.	Sex.	Operation.	Temperature before.	Temperature after.	Duration of etherization.
1	Adult, M.	Necrosis of femur	99.5°	98°	$1\frac{3}{4}$ hours.
2	Adult, F.	Carcinoma of axillary glands	100.15	98.5	1 hour.
3	Adult, M.	Excision of the knee	Mouth, 99.4	Mouth, 97.2	Short.
4	Adult, F.	Abscess of abdominal wall	99.4	98.4	1 hour.
5	Adult, F.	Caries of vertebræ	Axillary, 98.4	Axillary, 97	$\frac{3}{4}$ "
6	Adult, F.	Carcinoma of breast	" 99.45	" 96.3	1 "
7	Adult, F.	Carcinoma of breast	98	95.4	$\frac{3}{4}$ "
8	Adult, M.	Hypospadias	99.2	96.3	$\frac{3}{4}$ "
9	M., æt. 6 months.	McEwen's, for deformity of tibia	99.2	97.4	$\frac{1}{2}$ "
10	Adult, M.	Necrosis of femur	Mouth, 98.4	Mouth, 98.4	$\frac{1}{2}$ "
11	Adult, M.	Epithelium of nose (plastic operation)	Axillary, 100.2	Axillary, 99	$\frac{3}{4}$ "
12	M.	Excision of hip	102	100.2	1 "
13	M.	Empyema, drainage-tube	Axillary, 98.4	Axillary, 97.6	$\frac{1}{2}$ "

Average fall of temperature 2.32° F. Greatest fall 3.15° Fahr. Smallest fall 0.8° F.

We find therefore that the present custom of applying heat to the patient is closely allied to locking the door after the horse is stolen, and the results given in these two tables seem at least to

afford sufficient evidence of the propriety of using external heat not after, but *during* anæsthesia.

Since the placing of hot cans about the patient during operation is not practicable, the heating apparatus must be in direct connection with the operating table. This may be accomplished by means of a galvanized iron water bath made in the form of a shallow tray, and of dimensions sufficient to receive the patient.

When this water bath is placed upon an operating table and filled with water at a temperature of 110° there is no danger of burning the operator, his assistants, or the patient, but the loss of bodily heat is prevented.

Having called attention to the importance of the employment of heat it remains for us to utter a word of warning against the use of water at too high a temperature. This, at first sight, seems absurd, as the merest tyro would not inject very *hot* water into the rectum or use it over the surface of the body, yet it is necessary to have a moderate degree of heat and no more, for it is as possible to cause heat stroke by the use of too hot water as it is to chill the patient to death by cold injections. The following experiment shows this very clearly :—

Experiment.—Dog, weight 50 pounds. Full grown.

Temperature of water injected into bowel 115° F. Pressure of water 65 millimeters of mercury.

12.27 Axillary temperature 101.1°.

12.35 Began injection.

12.40 Axillary temperature 102°.

12.55 Axillary temperature 105°.

1 Axillary temperature 106°. Marked signs of heat dyspnœa. Belly walls very hot. Vomited water. Time of passing water through from anus to mouth twenty-five minutes at a pressure of 65 millimeters.

Having found that water at the temperature of 115° Fahr. produces symptoms of heat stroke, other experiments were made to determine the safest temperature in every case, and it was found that the water should be at about 105° to 108°, owing to the fact that so much of the heat is lost by the slow progress of the water from the bag to the anus, through the connecting rubber tube. If the tube be very short the temperature need not be above 103°.

The following experiment shows very well the advantages of a moderate temperature :—

Dog, weight 40 pounds. Full grown. Axillary temperature $99\frac{2}{5}°$.

Injected hot water at 110° F. from anus to mouth.

12.16 Began injection ; pressure 15 to 20 mm. Hg.

12.20 Colon full.

12.24 Belly very distended. Axillary temperature $99\frac{3}{5}°$.

12.30 Vomited the water. Axillary temperature 101 1°.

12.50 Seems quite well.

It will be seen on glancing at the three typical experiments which we have given, in which cold, hot, and warm water were used, that several valuable points appear. Where cold water was used the animal was severely chilled, shocked, and in collapse, and although he was only 27 pounds in weight it took thirty minutes to pass the liquid through the gut from end to end at a pressure of 35 millimeters of mercury. In the instance where the heat was great the dog was nearly twice as large (50 pounds), and it required only twenty-five minutes to pass the water through the gut at a pressure of 65 mm. of mercury. In other words, the increased size of the dog necessarily called for nearly double the pressure, and twice the bulk of water, but the heat enabled the liquid to overcome the muscular resistance which was met with. The heat was, however, too great, and heat stroke came on.

In the third experiment, the temperature of the water in the bag was at 110° F., the dog weighed forty pounds, and only had a pressure of from 15 to 20 mm. of mercury on the water. Yet in this case the water passed through, from end to end, in fourteen minutes without any untoward effects, and the animal enjoyed perfect health afterwards. It is evident, therefore, that four things are worthy of note : 1st, that the use of cold injections is harmful ; 2d, that they cause resistance on the part of the bowel ; 3d, that very hot water goes through somewhat faster, but causes heat stroke ; 4th, that moderately warm water passes through very rapidly and produces no ill effects.

From the results of our studies we would also recommend the addition of about 1 drachm of common salt to each 8 ounces of water used, for it was found, when fresh water was employed, and a post-mortem examination made, that the intestines were

whitened or bleached, and often spasmodically contracted and stiffened. The explanation of this is not far to seek. The circulation of a salt solution containing less than the normal quantity of saline (7 per 1000) causes an absorption of salts from the surrounding tissues, as is well known to all physiologists, whereas a solution of greater strength than 7 to 1000 causes an abstraction of water.

In the consideration of the use of injections in intestinal obstructions, we at once find ourselves face to face with the question as to whether the pressure exerted upon the intestinal contents by the distention of the bowel can influence the heart and respiration to any appreciable extent, and we have carried out a series of studies to cover these points, with the result of finding that the distention of the primæ viæ by an injection as it passes through the abdominal cavity, has no more effect upon the system in general than the passage of an inflated tube through the centre of a room or box. This is clearly shown by the following tracing obtained by attaching the carotid artery of a dog to the mercurial manometer and taking a tracing as the injection was made. The slight changes occurring in the tracing are such as constantly take place in all experiments, and are due to arhythmic respiratory movements.

In cases of obstruction, therefore, there is no danger in using injections, for distention of the intestinal wall of brief duration cannot produce ill effects, at least when due to such a cause. On the other hand it is true that if the abdominal contents be compressed by liquids outside of the intestines, that is free in the abdominal cavity, death will take place. This will be seen in the following experiments and tracings, the lethal result being due to respiratory failure, produced through pressure exerted on the diaphragm whereby exhaustion of the supplementary respiratory muscles ensued as a result of diaphragmatic paralysis.[1]

[1] Since making these studies Heinricus has published a series of experiments made by him of identically the same character as our own, which reach results of a similar nature, although performed in the pursuance of a different line of study.

See Zeitschrift für Biologie, 1889.

Delbert (Annales de Gynecologie, 1889) has also reached the same results, so that it may be said that three different researches, performed independently of one another, are in accord.

Experiment.—Dog, weight 70 pounds.

Passed into the belly, through a small trocar pushed through the belly wall, a sufficient quantity of warm water to produce complete distention and finally death. The abdominal muscles first ceased to act, then the thoracic muscles failed, and, finally, the cervical muscles, after a few contractions, gave out.

Post mortem.—The liver and spleen were dirty brown in color and contracted. The intestines were shrivelled, contracted, and empty, except the duodenum and the jejunum. There was moderate venous congestion of the omentum and mesentery.

Thinking that the fatal result might be due to the use of a non-saline fluid, we performed the following test, but found that death was still the result.

Dog, weight 70 pounds. Newfoundland pup.

Passed into the abdomen warm normal saline fluid in the same manner as in the last experiment, but death occurred in the same way. On section the liver and spleen were normal in color, and there was no shrinking to be seen. The intestines were somewhat rigid from contraction of their muscular walls. The trocar had wounded a bloodvessel in the mesentery of the lower part of the ileum, and an extravasation the size of a bean was found at this point between two mesenteric layers (see tracings).

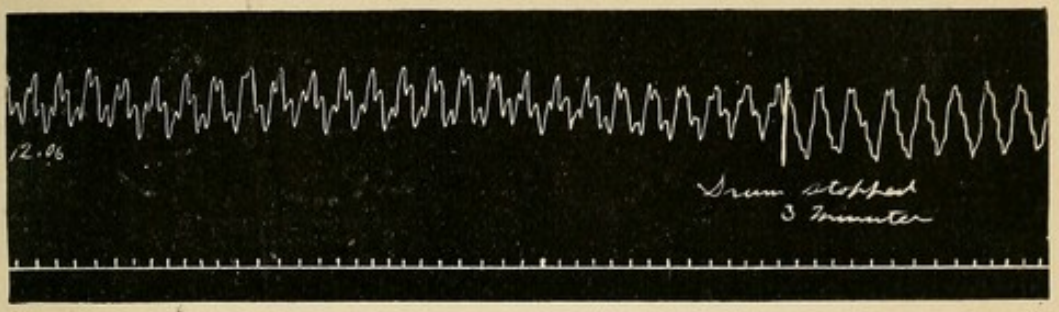
Abdominal massage.—Hutchinson[1] has given kneading of the abdomen under an anæsthetic, and in combination with injections, high praise as a treatment for intestinal obstruction. He states that the only cases in which the surgeon is the least likely to regret having employed it are those in which peritonitis simulates obstruction.

It must not be forgotten that massage is a treatment which is purely empirical, that its skilful and judicious application is a matter of chance in the obscurity which always surrounds these cases of obstruction, and that not only may it be absolutely hurtful in peritonitis, but may immediately determine a rupture in a greatly distended and congested loop of gut. It is easy to see how it *may* be beneficial in every form of acute obstruction; but to so apply it that it necessarily will produce the result desired is an impossibility.

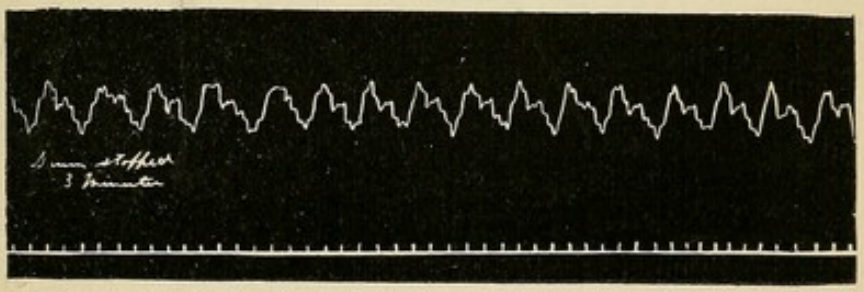
[1] Loc. cit.

Tracings showing the primary slight effect of great intra-abdominal pressure, with ultimate death from respiratory failure. Water injected into abdominal cavity.

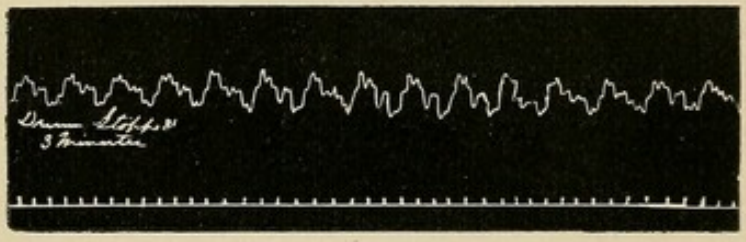
1. [To face page 104.



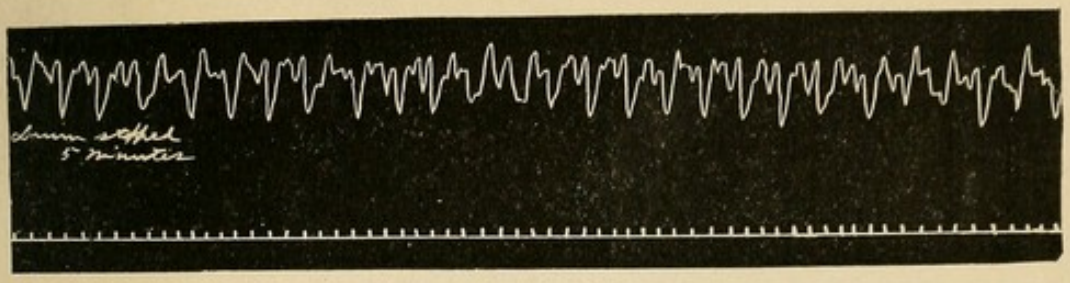
II.



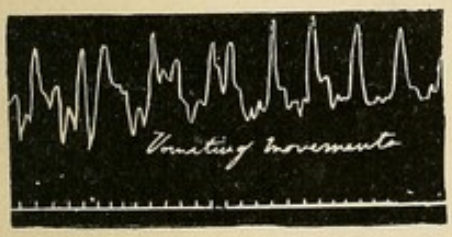
III.



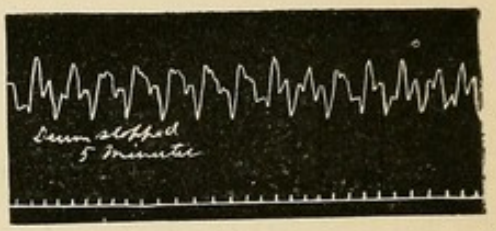
IV.


Drum stopped
5 Minutes

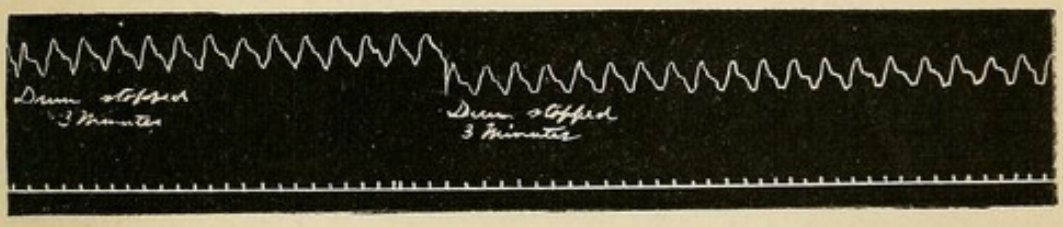
V.


Vomiting movements

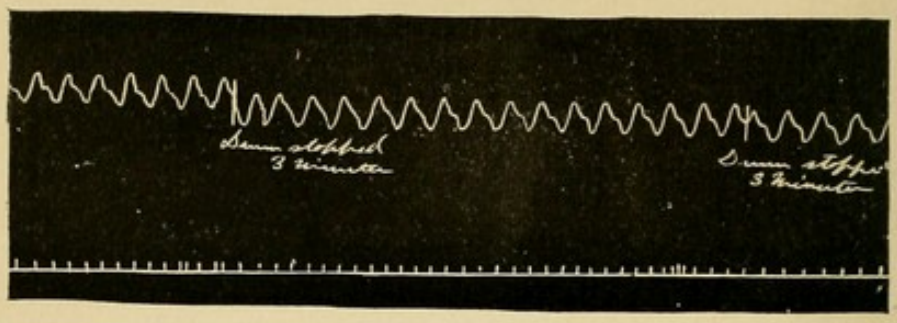
VI.


Drum stopped
5 Minutes

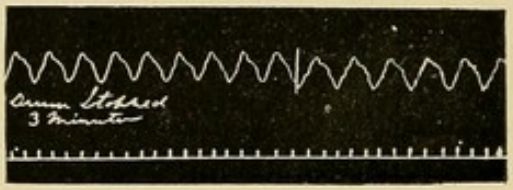
VII.


Drum stopped
3 Minutes
Drum stopped
3 Minutes

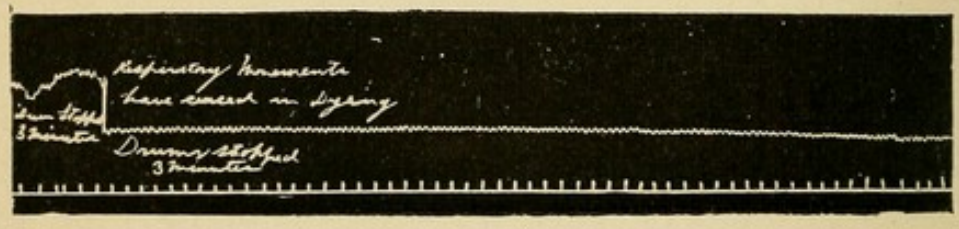
VIII.


Drum stopped
3 minutes

IX.

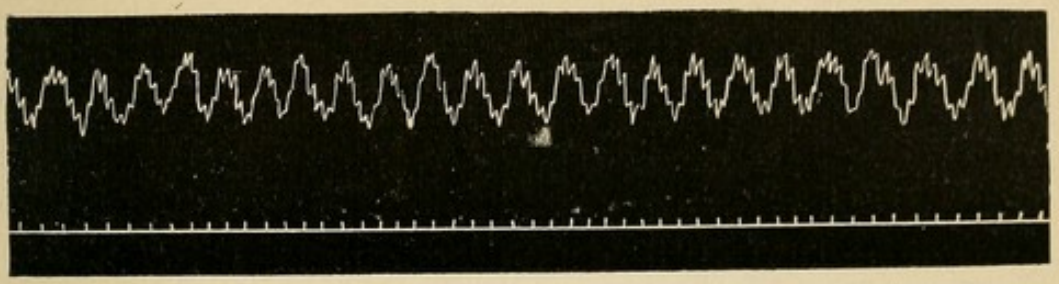

Drum stopped
3 minutes

X.

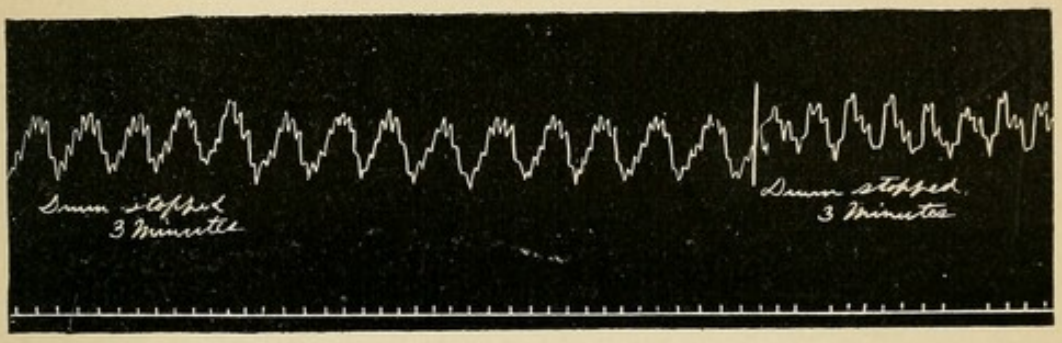

Respiratory movements
have ceased in dying
Drum stopped
3 minutes

Tracings showing effects of passing into the abdominal cavity two gallons .7 per cent. saline solution at a temperature of 108° F.

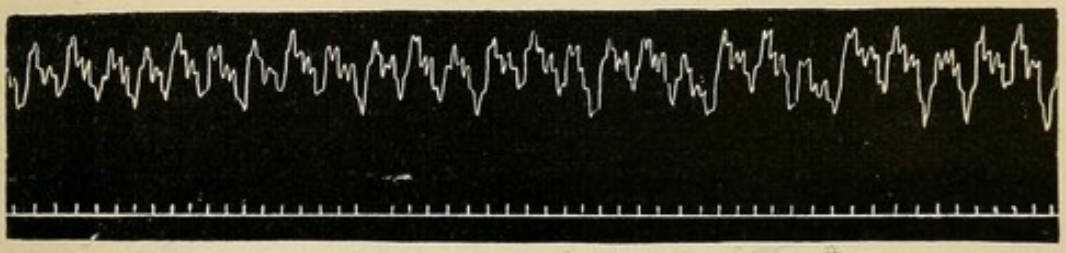
I. [To face page 104.



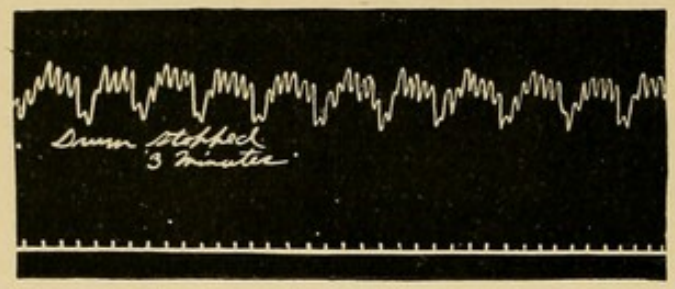
II.



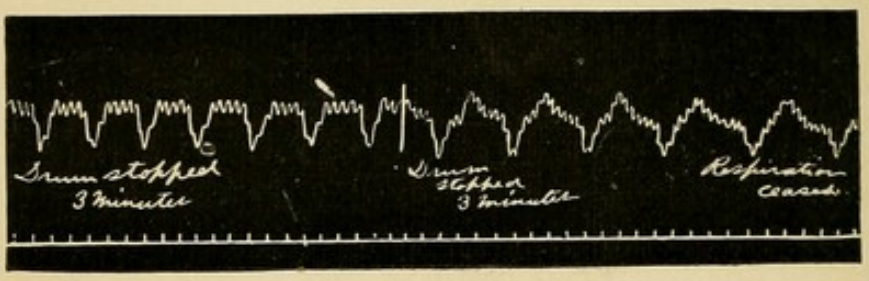
III.



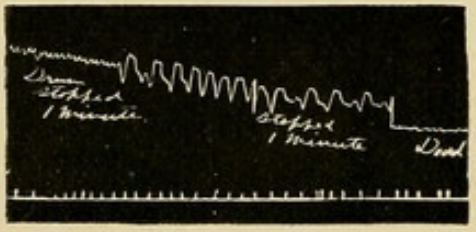
IV.


Drum stopped
3 Minutes

V.


Drum stopped
3 Minutes
Drum
Stopped
3 Minutes
Respiration
ceased.

VI.


Drum
Stopped
1 Minute
Stopped
1 Minute
Dead

The use of metallic mercury.—The use of metallic mercury in obstruction is certainly rare at the present day. Treves, quoting Matignon, states that it may be of service in cases of ileus following fecal accumulation, the metal becoming finely divided and so coating and penetrating the obstructing mass, that the latter is loosened and its discharge facilitated. Matignon states that in no instance is mercurial poisoning produced, that pain and vomiting are quickly relieved, and that frequently there is a prompt evacuation of the bowel contents following this treatment, and this after all other means have been absolutely fruitless. Brown[1] reports a case of obstruction relieved by the administration of seven pounds of metallic mercury. Head[2] injected one pound into the rectum of an infant aged five months suffering from invagination, and by inversion of the patient attempted to effect reduction. The child recovered, but this was not attributed to the mercury.

In spite of Matignon's assurance as to the innocuousness of this agent there is reason to believe that its result may be disastrous. Crisp[3] assigns death in one instance to the administration of half an ounce of mercury. Oke[4] reports a case in which six ounces caused pouching and resultant gangrene on the proximal side of a chronic obstruction.

The special application of metallic mercury would seem to be in cases of fecal impaction where other means have not been successful.

Other Means of Treatment.—*The rectal tube* is of distinct value in the beginning of paralytic distention. By its action peristalsis is excited, and the resistance of the sphincter is overcome. Though many cases are reported in which it is alleged that the point of the tube has reached the cæcum, the sharp angularities of the sigmoid and its free mesenteric attachment are probably insuperable obstacles to this. The attempt to reduce an invagination or volvulus by means of a stiff tube is not to be commended.

Ice to the abdomen.—The arguments against cold injections also apply to external application of ice. In the obstruction of suppurative peritonitis, however, when the temperature is high, ice

[1] Soc. Med. Journ., London, 1853, p. 117.
[2] St. Barth. Repts., 1867, III. 85.
[3] London Lancet, 1847, L. 557.
[4] Prov. Med. & Surg. Journ., 1852, p. 293.

may be applied, as a treatment to the inflammation rather than the obstruction.

Leaden bullets.—These have been swallowed, literally by the hundred, with the idea of sweeping by their weight impacted feces from the bowel. Such treatment is, of course, to be condemned.

Injections of ether.—This agent has been used by rectal injection as a means not only of encouraging peristalsis, but also of causing rapid dilatation by vaporization. Clause[1] reports two successful cases in which relief was immediate on the injection of a pint of a 3 per cent. solution of ether.

Position.—Cases are occasionally reported where relief followed upon inversion of a patient. The knee elbow position is said to have instantly cured a case of marked obstruction.

[1] II Morgagni, Sept. 1889.

CHAPTER XII.

SURGICAL TREATMENT OF INTESTINAL OBSTRUCTION.

PUNCTURE OF THE ABDOMEN.—This, as a means of giving relief in excessive tympany, has its most able advocate in the person of Ogle,[1] who has gleaned from medical literature positive proofs of its extensive employment and the great improvements, at times positive cures, attributable to it. In cases of meteorism sufficiently developed to seriously embarrass the respiratory functions, he advocates one or more punctures into the distended gut by means of an aspirator or hypodermic needle, and the withdrawal of as much gas as possible. This is followed by immediate relief. Rosenbach,[2] on a basis of four cases, two of which were cured, the remainder greatly benefited by this procedure, directs that the punctures should be made in the most distended part of the abdomen, that the needle should be entered gently, and that after the evacuation a few drops of carbolic solution or iodoform oil should be injected to disinfect the puncture track. He states that this procedure has never been followed by an infectious peritonitis. Stuckey,[3] in a case of laparotomy and enterorraphy for gunshot wound, reduced tympany by a number of minute punctures made with the point of a lancet; the patient recovered.

Demons reported six cases of puncture with successful results in each instance. Unfavorable comments upon this method are, however, not far to seek. Morris, Bryant, Bristowe, and Curtis all point out the great danger of fecal extravasation following even a minute puncture in a dilated bowel, and cite cases in support of their objection. Curschmann, while warmly advocating punctures, advises against them in peritonitis.

We believe that punctures are of distinct service in excessive and dangerous tympany. They should be made by means of the hypodermic or fine aspirating needle, and under rigid antiseptic precau-

[1] On the Relief of Tympanites by Puncture of the Abdomen, London, 1888.
[2] Berlin. Klin. Woch., 1889, No. 21. [3] Med. Record, Nov. 21, 1885.

tions. The needle should be driven in with a sudden violent thrust, the thumb guarding against too deep penetration; by this means there is less danger of the bowel being pushed before the point of the instrument rather than being penetrated by it. A fine rod or wire should be provided for clearing the canal of the needle in case it becomes blocked. As many punctures should be made as are necessary for the entire relief of pressure symptoms. There can be no objection to causing collapse of all the visible bowel coils. The lumen of the needle should be flushed out with an antiseptic solution before withdrawal. If the muscular coat of the bowel retains the slightest amount of tonicity the puncture will be immediately closed, since, as the gut contracts, the relative change in the opening through the various coats at once occludes the minute canal.

If the gut is in a condition of absolute and hopeless paralysis, then feces may leak through even the minute opening made by an aspirator needle. The condition of these cases is, however, usually so desperate that it is a question as to whether any means offers the slightest prospect of hope. As to the penetration of the gut with a large sized trocar and canula, the latter being allowed to remain in place for the evacuation of the intestinal contents, such a procedure is to be absolutely condemned.

Enterostomy.—This name has been proposed by Curtis for the operation of securing any portion of the small or large intestines to the abdominal parietes and making an artificial anus. By Nélaton, who particularly favored it, this procedure when the small intestine was involved was termed enterotomy, the term colotomy being applied to the formation of a more or less permanent opening in the colon.

The operation, when it concerns the small intestine, consists, briefly, in an incision commonly placed in the right iliac region, into which is secured the first distended intestinal coil which presents by a line of sutures apposing its surface to the entire circumference of the peritoneum about the parietal wound, the skin and peritoneum lining the two surfaces of which have been previously united by a continuous suture.

The gut is then incised and its contents evacuated, thus establishing an artificial anus.

The mortality of non-malignant cases is, according to Peyrot and Treves's tables, 67 per cent.

Curtis[1] statistics are far more favorable, indeed he is the most able advocate of this procedure in recent years, and his results go far to confirm Banks's prophecy that this is the operation of the future. In a total of 62 cases, relief to the obstruction was obtained in 42 (76 per cent.). The mortality was 48.3 per cent., 32 cases recovering. In 19 of these recovered cases normal passages were resumed, the recovery thus being complete and definite. This gives us then complete recovery, *i. e.*, with closure of the artificial anus, in 30⅔ per cent., of all cases, and partial recovery, the bowel opening remaining patulous in a further 21 per cent. Comparing these results with abdominal section we find that the latter operation gives a mortality, from Ashhurst's 346 cases, of 69 per cent. Enterostomy gives then a recovery as complete as the best that can be afforded by laparotomy in practically the same percentage of cases (31 per cent. in laparotomy, 30⅔ per cent. in enterostomy). Moreover, it gives a further percentage of 21 per cent. of partial cures, the artificial anus persisting. Of course if the surgeon takes the view that death is not more to be dreaded than an artificial anus, so far as the statistical study goes, he will find little choice between the operations. If, however, the life of his patient is the prime object, enterostomy will be an operation to which he will at times resort. It has been clearly shown that by relief of pressure obtained by enterostomy, intussusception, volvulus, and even internal strangulation may undergo spontaneous cure. It is not from the study of individual and peculiar cases that the general rules of surgical procedures are drawn, but rather from conditions and results observed in the majority of such cases. Hence because exceptionally a patient perishes after enterostomy from gangrene dependent upon the constriction of a band which laparotomy might have exposed and enabled the surgeon to divide it must not be concluded that the simpler operation is so imperfect that it should be utterly rejected. On the contrary, we must recollect that abdominal section is, in the majority of cases, followed by death; that enterostomy relieves many cases, which if subjected to section would

[1] Med. Record, Sept. 1, 1888.

surely die, and that exceptional instances are valuable in drawing conclusions in proportion to their frequency.

We believe that in all cases where the probable cause and seat of intestinal obstruction cannot be diagnosed, and where meteorism is well marked, the surgeon having decided to operate should perform enterostomy; and this is indicated as the preferable operation still more decidedly if the patient's circulation has begun to show the effect of his malady.

Colotomy, which we consider under the heading Enterostomy, is, of course, an operation applicable only when either the colon, sigmoid flexure, or rectum is subject to obstruction. It is a procedure rarely resorted to except for chronic obstruction or for an acute attack occurring in the course of the chronic disorder. Yet both volvulus and invagination may produce sudden obstruction at the termination of the large intestine, and may demand for immediate relief an incision into the gut. In this case the indications for enterostomy being plain, the right inguinal incision may be made with the idea of opening the first prominent loop of small intestine. If the cæcum is dilated, however, the incision should be made here, as it is found that there is not, as has been claimed, a regurgitation of feces through the ileo-cæcal valve.

Of colotomy, when the obstruction is in or about the rectum, both the iliac and lumbar operation have their enthusiastic advocates.

Bryant still warmly recommends the lumbar operation in all cases complicated by distention, and acute in nature, claiming that in this condition the procedure he commends is both easier and safer, and gives, from a statistical study, a greater percentage of successes. Batts's 244 cases of lumbar colotomy give a mortality of 32 per cent. The inguinal operation, however, gives a mortality of over 50 per cent. Cripps still urges the latter operation, claiming that it is more easily performed, is more likely to successfully open the colon, and makes a more convenient opening. The inguinal operation in addition to its other advantages enables the surgeon to explore the peritoneal cavity.

The bowel should be drawn down to its full extent to prevent prolapse, should be sutured to the united skin and peritoneum, and subsequently should be opened. Or Madyl's operation may be

performed, the gut being held in the wound by means of a hard rubber tube passed transversely across it and through its mesentery; the periphery of the gut is then sutured to the parietal peritoneum, which has previously been sutured to the skin.

If there is an idea of subsequently closing this opening a longitudinal incision is made in the gut. Then when the permeability of the rectum is re-established the supporting tube is withdrawn and the bowel spontaneously retracts and closes. If a permanent artificial anus is necessary the bowel is cut transversely across, and sutured in place.

Abdominal Section.—By abdominal section, as applied in intestinal obstruction, is meant the formal opening of the abdominal cavity with the idea of searching for the seat of obstruction and removing the exciting cause. It is the ideal operation, since, if successful, the parts are immediately restored to their normal condition. From a statistical standpoint, though the proof thus offered is of little value, section offers practically as favorable results as expectant treatment. In one table we have the records of 197 cases of obstruction not operated upon, and of which 148 died, giving a mortality of 73.2 per cent., while of the 38 operative cases 27 died, giving a mortality of 71 per cent. This death rate corresponds closely with that given by Ashhurst in his elaborate tables.

Even though the statistical study of this subject is of no value in making a comparison between the results of the operative and non-operative treatment, the fact remains that many cases have recovered from operation who inevitably would have perished had expectant treatment been continued. Is there to be contrasted with this a series of cases which might have undergone spontaneous resolution, but for the operative interference? We think the answer to this must be, with some reservation, in the negative. With reservation because undoubtedly cases have been lost because of the surgeon's desire to do too much, to find and remedy the obstruction regardless of the patient's condition. Such patients might have survived, not by being treated medically, but by being subjected to a more conservative surgical operation. We think, in acute cases, the indications for abdominal section are as yet limited.

They may be formulated by stating that this operation should be performed—

In unreduced invagination in impacted foreign body, in internal strangulation and in volvulus, if the seat of trouble can be diagnosed before operation.

In cases of intestinal obstruction the nature and seat of which are unknown, if seen early, when the meteorism is not yet developed and when strength is well preserved.

In peritonitis of all varieties, where there is pus or septic effusion in the abdominal cavity.

Paralytic distention is, we think, better relieved by multiple punctures, since the shock of a formal section is liable to increase the intestinal paralysis even though the distention is relieved by incision. To be sure punctures, exceptionally, result disastrously, but as death is the rule after section for this condition, we think the surgeon is justified in first resorting to the least dangerous expedient.

Where in spite of puncture death is steadily approaching with the symptoms of intestino-peritoneal-septicæmia there should be no hesitation in opening the abdomen, irrigating its cavity and evacuating the intestinal contents by small transverse incisions, these latter to be immediately closed by Lembert sutures.

Where the seat and nature of the obstruction are unknown, a free median sub-umbilical incision should be made, and the hand should at once be carried to the cæcum. If this part of the bowel is inflated the obstruction will necessarily be in the large intestine; if flaccid and empty, or containing only feces, the small intestine will have to be searched for the seat of blocking. It is a good general rule to search for the empty intestinal loops, and trace them along till the distended part is reached, not only because there is a probability of thus reaching the seat of obstruction much more quickly, but because handling of the inflated gut is thus avoided.

We think it is important, in all these manipulations, to keep the gut constantly covered with sheets of rubber dam, and to avoid, except in case of absolute necessity, withdrawing any large part of the intestines from the abdominal cavity. Where this is required hot sponge cloths and rubber sheeting should protect and keep warm the exposed intestine. If the seat of obstruction cannot be readily found, and the operator is hampered for want of room, there should be no hesitation in enlarging the incision, even carry-

ing it to the entiform process if necessity requires, or making a transverse cut toward one or the other lumbar region. We think that thirty minutes is the extreme limit of time allowable for search if the seat of trouble is difficult to find. Failing in that time the loop of intestine nearest the occlusion should be secured in the external wound, and an artificial anus should be formed.

Even though the obstruction is found, it may be discovered that it cannot be relieved without prolonged and extensive operative procedure.

The difficulty may depend upon a great mass of small intestines bound together by tight adhesions. It may be due to an invagination so tightly adherent that disinvagination is impossible, or a volvulus which in spite of puncture and reduction immediately springs back to its twisted condition, or extensive adhesions of an old or recent peritonitis—or even if the obstruction is of such a nature as to be readily overcome, the bowel may be already gangrenous.

Under these circumstances an artificial anus should be formed. It may happen, however, that a mass of adherent intestinal coils, say in the upper part of the ileum, are causing obstruction. Adhesions are so tight and extensive that freeing them is obviously hopeless. An artificial anus formed on the proximal side of this obstruction will certainly result fatally from inanition. Here, we think, a lateral anastomosis by bone plates, catgut rings, or by ordinary rubber drainage tube rings is indicated.

Where the bowel is gangrenous and requires resection, the continuity of the canal may be restored by invaginating each end and closing it by Lembert sutures, then performing a lateral anastomosis, or end to end approximation, either by Senn's method or by making use of the rubber drainage tube where the catgut or rubber band is not to be obtained.

It may not be amiss to mention here the method of apposition by rubber drainage tube rings. It is practically identical with that described by Senn, except that in place of bone plates we use an ordinary small drainage tube.

As a result of numerous experiments we are convinced that it has nearly all the advantages of the decalcified bone, and moreover it is always at hand when the surgeon needs it and can be immediately adjusted to any required size. One year ago we began our

experiments with these rings, since on account of the time required in the preparation of both Senn's and Abbe's plates we believed they would not be widely used by surgeons. As far as experimental work goes, we have demonstrated—

1. That approximation rings each made of a single rubber drainage tube produce tight apposition of two apposed bowel loops.

2. That the rings are subsequently discharged per anum without difficulty.

3. That they can be made and applied in a very few minutes.

4. That the elastic pressure they afford is of distinct advantage.

5. That for end to end invagination by Senn's modification of Jobert's method these rings are satisfactory, but are not so desirable as Senn's flat rubber ring.

6. That for end to end approximation these rings are well adapted.

In the construction of the rings a piece of drainage tube of appropriate length is cut obliquely across the two ends; these ends are then approximated, thus making an oval, and held in place by catgut suture. If a circular ring is desired the ends are cut off square.

Finally six sutures armed with needles are secured to the ring, and it is ready to be placed.[1]

We have confirmed Senn's experiments in regard to quicker and firmer union following scarification of the apposed peritoneal surfaces, and we believe that this procedure should always precede approximation. The suture material we have always used in our intestinal researches is catgut; we think this is least likely to be followed by perforation, since by its swelling, it entirely fills the aperture made by the needle, and by its rapid absorption the seton-like action of the silk thread is avoided. Although peritonitis from giving way of catgut suture has occurred, we do not recall any instance where, experimentally or in actual practice, this result has followed from ulceration along the track of the suture.

[1] As one typical of a series of experiments we give the following:—

June 14, '89. Pup. aet. 7 mo., wt. 20 pounds.

Etherized, belly opened, gut cut, lateral anastomosis by means of two rings made of ordinary drainage tube. Two rings passed, one on third and one on fifth day. Remained in perfect health for several months. Was then lost sight of.

If catgut is used it must be strong and aseptic. The surgeon should personally prepare his suture material in these cases—first, testing its strength, then subjecting it to the ordinary processes, with every attention to cleanliness and thoroughness. Corrosive sublimate or carbolic acid may be added to the absolute alcohol in which it is finally stored. Firm adhesion can be expected in eighteen to thirty-six hours, and the catgut never yields before that time. It is true that silk knots are less likely to slip than those of catgut, still, as this is a matter of nicety of manipulation on the part of the surgeon, it does not constitute an insuperable objection to the use of catgut.

Since the original unpublished experiments performed by us with the rubber ring as a means of producing implantation and anastomosis, Brokaw[1] has described practically the same means of accomplishing this object. He directs that the ring shall be made by passing a catgut strand through the lumina of several small sections of drainage tube. As the catgut is softened the ring breaks into its several small portions, and is discharged. He describes by this method, implantation and approximation, with successful experimental result. In place of six ligatures he uses but four. Senn and other experimenters state that this is a sufficient number. We have, however, so frequently been compelled to place reinforcing sutures to prevent eversion of a portion of the wound edge when four sutures were used that, as a routine, we have been in the habit of employing the two extra ones as described.

The technique of approximation and implantation methods has been so recently and fully described in current medical literature, that a minute detailed description seems superfluous.

Senn's modifications of much older methods are practically the operations of the day. The intestinal anastomosis of Maisonneuve, the end to end suture of Gély, Jobert, Lembert, Czerny, all brilliant operations and crowned with many successes, must yield to the quicker, safer, and equally efficient procedures of a later date.

The importance of the element of time has long been recognized in these abdominal operations. It was partly this which led Denans to propose his three suture rings, two placed each some little distance within an end of the divided bowel, the third arranged so that these

[1] Med. News, Nov. 30, 1889.

two were clamped together, approximating the serous coats. This method closely resembles the modern end to end approximation. Baudens, somewhat later (1840), devised a still more ingenious method. Into the lower extremity of the cut bowel, two lines deep, he placed a metal ring, concave and furrowed upon its outer surface, to receive and hold an elastic ring. This elastic ring was placed in the upper bowel segment, three lines deep, the edges of the bowel being folded in over it. The upper ring was then stretched over the lower, thus producing and holding in place a local invagination. He operated upon animals, using this method with successful results.

Whether the rubber rings and decalcified bone plates prepared by Senn, the segmented rubber tubes of Brokaw, the catgut rings of Abbe, the catgut plates and mats of Davis, or the rubber tube prepared by ourselves be used, the operative procedures are practically the same.

Lateral apposition.—In these operations two portions of the gut, or the gut and a hollow viscus, having been arranged side by side, so that they both pass in the same general direction, are opened, each upon its convex apposed surface. An approximating ring, with sutures attached, is passed into the bowel, and arranged so that it surrounds the opening ; the sutures are then passed through the gut wall from within outward. When both plates are in position by tying the corresponding sutures of the two plates together, the openings are fixed to each other, and a false passage is established.

This approximation may be strengthened by a few Lembert sutures placed peripherally.

End to end approximation.—This is performed by passing two rubber rings, each respectively within the lumen of the upper and lower bowel segment. The rings are placed a fourth of an inch from the cut extremities, then allowing the latter to be somewhat invaginated. The sutures are passed through the bowel walls and tied each with its fellow of the opposite ring. Around the whole is placed the continuous Lembert suture of fine catgut.

Senn's modification of Jobert's invagination.—In performing this operation it is necessary to know which is the upper and which the lower bowel segment since invagination made in the wrong direction might result disastrously. With the idea of determining this we made many experiments with Nothnagel' test, but in every case

were disappointed, the peristalsis produced by the saline either remaining local, or becoming diffused so slowly that it was impossible to distinguish it from the vermicular motion taking place in other parts of the bowel. As Nothnagel himself now denies the existence of reversed peristalsis, we are at a loss to account for the abundant corroborative testimony his first observations have received. Even by means of electric currents we were unable to inaugurate peristaltic waves so distinct by their direction as to be of practical service. The oblique attachment of the mesentery from above downward and from left to right will act as a guide if the bowels are normally placed, but this is so frequently not the case that a careful tracing of the intestine to seek the duodenum or the ileo-cæcal valve may be necessary.

If this is necessary we would recommend a procedure suggested by Bulteau,[1] namely, passing through the mesentery, first, a white suture, then an inch removed in the direction of the search, one of different color. We have seen much time lost from the operator being required, after having found the ileocæcal valve, to laboriously retrace his steps to discover in which direction he had been travelling.

The direction of the intestinal canal having been decided upon, the upper bowel or intussusceptum receives into its lumen a rubber band one-third inch wide, turned in the form of a ring, and secured with catgut sutures. To this band the cut border of the gut is secured by a continued suture, thus preventing eversion of mucous membrane. Two catgut sutures each threaded with two needles are then passed from within outward through the upper portion of the rubber ring and the gut wall, the one not far from the mesenteric attachment, the other on the opposite convex side of the bowel. These needles are then passed, at corresponding points of the lower gut end and about a third of an inch from the margin, through all the coats but the mucous; by gently drawing on these sutures, and turning in the edges of the lower segment invagination is accomplished so completely, that Senn states no reinforcing sutures are necessary.

In circular enterorraphy or end to end approximation or invagination, great attention must be paid to the mesenteric attachment

[1] De l'Occlus. Intest., Par. 1878.

of the gut, not only because this is the only part of the bowel circumference uncovered by peritoneum, but because the constant traction by the mesentery is exceedingly likely to destroy the close approximation at this point; therefore most operators are careful to place sutures in this region with great accuracy. The peritoneum should be neatly brought together by additional stitches in cases of enterorraphy, or strengthened by the placing of one or two extra threads where the other operations are performed.

Implantation.—Ileo-colostomy for obstructions about the ileo-cæcal valve is best performed by this method. The bowel having been divided, and the distal end washed out, invaginated and sutured so that it is tightly and permanently closed, the proximal end is lined with a rubber ring and transfixed with sutures, as in case of invagination. An incision of size appropriate to receive the ileum is then made in the colon. The sutures are passed through all but the mucous coat of the latter, and by traction upon them the ileum is invaginated into the large intestine. Brokaw has proposed to modify this operation by placing one ring in the colon, the other in the ileum, and bringing the bowel together by tying the corresponding sutures of the two rings together. We have not yet had an opportunity of trying this modification, but theoretically cannot see its value, the ordinary procedure being rapidly executed and giving perfect results. In case section of the bowel is not indicated, ileo-colostomy by lateral apposition by means of rubber rings or plates can, of course, be performed.

It must be borne in mind that all traumatism of the bowel operative or otherwise is followed by local paralysis, and that this is liable to occasion temporary obstruction. The paralysis is purely conservative in its action and allows of fixation of the bowel till exudation and plastic adhesion has to an extent guarded against the danger of extravasation. The practical deduction from this is that absolutely nothing should be given by the mouth till this paralysis and obstruction has yielded. Thirst can be relieved by the rectum, (see Treatment of Obstruction) and medication can be administered subcutaneously.

Senn's suggestions in regard to strengthening the line of suture by omental grafts were so striking that we at once proceeded to experiment upon the subject. There is certainly no doubt of the quick union which forms between transplanted flaps and the inme-

diate environment of a line of suture, especially after scarification of the latter. We have seen flaps so closely adherent in four days that their removal was difficult and was attended with bleeding. Our experiments show, however, that these flaps are more commonly followed by extensive adhesions than where no such reinforcement is employed. This seemed so constant in our ordinary suture experiments that we made one observation with the sole purpose of determining the point.

Experiment.—Dog, weight 27 lbs. Etherized; convexity of small intestine seared with red hot iron in three spots, each two inches apart. Each burn was half an inch long and one-sixth inch wide. Middle burn covered with omental flap overlapping it one-fourth inch, secured by four fine catgut sutures. Killed in one week. Omentum adherent to all points of burning. Readily stripped from areas not grafted. Impossible to strip omentum from graft area without injuring gut. This part of gut together with its adherent omentum glued tightly to parietal incision.

It would thus seem that omental grafts are of distinct value when there is fear of perforation through either lack of vitality in the bowel wall, or distrust in the method or manner of suture, but that as a disadvantage this method is followed by tight and extensive adhesions.

One more point must be considered in certain operations done to restore the continuity of the alimentary canal. Page[1] and other operators have lost their patients in gastro-enterostomy through physiologically excluding the greater part of the small intestine, the loop hooked up for attachment to the stomach belonging to the lower part of the ileum rather than the upper part of the jejunum. In these cases the direction to seize the first presenting loop is unsafe—there should be a careful search for the upper part of the jejunum, the fixed duodenum being a safe and sure guide to this part of the bowel.

We believe the greater majority of abdominal surgeons now use for irrigation simply hot distilled water. We have in another place given our reasons for believing that the normal saline solution is to be preferred. Against the use of antiseptic solutions strong objections can be urged. If used in efficient strengths they are

[1] London Lancet, Mar. 18, 1889.

distinctly irritating locally, and are liable to be followed by systemic poisoning. Even in weak solution, used as they are in large quantities, dangerous symptoms have resulted. Thus Gelli[1] reports three cases where $\frac{1}{10000}$ bichloride solution was followed by the appearance of toxic symptoms.

As a result of intra-abdominal injection it has been found that the usually dehydrated blood absorbs at first the injected liquid with the greatest rapidity; but that soon becoming fully hydrated absorption absolutely ceases and poisonous injections may be given freely in so far as the systemic effect is concerned. The practical bearing of this is obvious. If the surgeon wishes to use antiseptics in the peritoneal cavity this can be safely done provided the cavity has been previously flushed with water or saline solution. It would seem then that the following conclusions may be drawn:—

1. Where there is great tympany threatening life, and there is reason to believe that this is due to a paretic state of the bowel only, puncture and aspiration of gas under antiseptic precaution may be both palliative and curative. Certain cases of chronic obstruction are also benefited by this procedure. If the bowel contracts the puncture is immediately closed; where paralysis is absolute, however, leakage of feces may occur.

2. Enterorraphy is indicated in cases of acute obstruction where tympany is marked, the vital powers are greatly enfeebled, and both the seat and nature of obstruction are unknown. When the obstruction is in the colon the opening should be into the large gut. This method is both palliative and curative, relief of pressure being frequently followed by spontaneous restoration of the continuity of the intestinal tract.

3. Abdominal section is indicated where the abdomen is soft, the patient's condition fairly good, particularly if the seat and nature of obstruction are indicated. The incision should be free, and the operation should very exceptionally last over thirty minutes. Difficult and prolonged operations must give place to formation of an artificial anus, resection followed by end to end suture being totally unjustifiable. If the patient's condition permits apposition, implantation or invagination operations may be performed.

4. Transplantation of omental flaps is followed by more extensive

[1] Annal de Obstetricia e Genecol., Nos. 6–7.

adhesions than where this procedure is not adopted. If antiseptic irrigation is used the abdominal cavity should be previously flushed with sterile water or saline solution.

Complications.—We would finally call attention to two complications attendant upon abdominal surgery, and which should be considered in all cases by the operator.

The first is sudden syncope, which may run directly into death. This, though rare, has been frequently observed. It is no doubt the cause of a number of deaths placed to the credit of ether or chloroform. By private communication we have knowledge of two such cases. From a letter describing one we quote :—

"Spaniard, man æt. sixty-five, scrotal hernia of years' standing retained by truss. Truss being broken patient worked without it and hernia came down. Reduced, and man put to bed. Refused to stay there, feeling perfectly well. Gut again incarcerated. Examination revealed a large scrotal rupture not tightly incarcerated, and showing no signs of inflammation or serious trouble. Taxis was resorted to, and after a little manipulation the hernia was much smaller, when suddenly the patient moaned as if in pain, and apparently fainted. Examination showed that the faint was in reality the sleep of death. No autopsy was allowed." Of course in this case an injury to the gut was possible, though not probable. These deaths are commonly ascribed to cardiac inhibition. Had even a few whiffs of ether been given in this case the anæsthetic would undoubtedly have been considered as the cause of the fatal termination.

The second complication, common in all surgical operations, but particularly so in abdominal work, is pneumonia. This has frequently caused death where the operation was perfectly successful, and has followed the latter by weeks or even months. Both septic and aseptic intra-abdominal operations are thus complicated. The most obvious explanation would seem to be that it is an embolic process, yet this is far from proven.

The knowledge that this inflammation is liable to develop should lead the surgeon to avoid every possible exciting cause, and to be ever watchful for its earliest symptoms that the treatment may be inaugurated before the disease is fairly established.

CHAPTER XIII.

WOUNDS OF THE INTESTINES.

Gunshot Wounds of the Intestines.—As in the case of gunshot injuries of other parts, when a bullet traverses the abdominal cavity, it produces a lesion which partakes of the nature of a lacerated and contused wound. The peculiarity of shot wounds, when invading this portion of the body, lies in the enormous penetrating power of the modern bullet, and in the close crowding of the abdominal space with vital organs. The rifle bullet, if it penetrates the abdominal cavity, almost certainly produces extensive visceral laceration. This is in marked contrast with the musket balls of the early part of the century. Thus Larrey and Baudens describe abdominal wounds in which the bullet has carried a pouch of undershirt before it into the peritoneal cavity; by pulling upon this garment the bullet was withdrawn, not having passed through the fabric. The conical shape of the modern bullet also has a distinct bearing upon the extent of the injury, since a small ball twisted sideways may inflict a larger and more dangerous wound than a heavier ball passing point first. As a matter of fact, however, it is impossible to determine how extensively a penetrating gunshot wounds the viscera, since the latter are not fixed in position, and a small ball passing parallel to the long axis of a bowel loop may tear an opening into it two or three inches in length.

In the United States Army the standard rifle carries a ball $\frac{44}{100}$ inch in diameter, and weighing 500 grains. It is propelled by 70 grains of powder. Abdominal wounds inflicted by this weapon are now exceedingly rare, and would necessarily be attended with a very great mortality. In the Civil War the bullet used weighed 500 grains, and was half an inch in diameter. It seems scarcely possible that this large elongated mass of lead, driven through and through the peritoneal cavity, could escape inflicting mortal wounds, yet that this has happened is attested by the Surgeon-General's report. Such injuries are obviously not to be

classed with those occurring in civil practice, where the diameter of the ball is frequently but $\frac{22}{100}$ inch, and its weight 60 grains. Much larger balls are used, $\frac{32}{100}$ calibre perhaps being the common size. We have in our tables instances of No. 38 and No. 44 revolvers having been used at close range. These would, of course, inflict as much injury as the rifle ball.

The first thing to consider in dealing with gunshot wounds of the abdomen is as to whether or not the bullet has pierced the parietal peritoneum. This, which would seem an easy problem at first glance, is in reality one which is difficult to solve. We have seen two penetrating gunshot wounds, inflicted by a $\frac{32}{100}$ ball, and from which the patient shortly perished, thwart every effort of the operator to follow with the finger or probe the course of the vulnerating body. In experimental work upon dogs we have in the majority of instances not succeeded in passing a probe along the track of the ball into the peritoneal cavity.

In deciding as to penetration, certain facts will materially aid the surgeon. First must be considered the size and length of the cartridge. A Flobert cap or a 22 short, may not have sufficient force to penetrate the clothing and the abdominal wall ; the bullet of a larger cartridge will almost certainly penetrate if its course is straight.

The distance from which the ball was fired, the direction from which it came, the position of the wounded man when struck, are all important matters. The possibility of the ball being deflected by a button or by any foreign body in the pocket, or, after it has penetrated into the body, by bony prominences, must also be considered. McGraw claims that balls are not deflected by soft parts, but against this is the record of well authenticated cases. In our own experiments (20 in number), the ball was deflected in but one instance. It was fired from a distance of ten feet, in a direction downward, and at right angles to the long axis of the dog. It passed in (calibre 22) upon the left side, half an inch below the rib margin, and one and a half inches to the left of the nipple line. It perforated the colon, made four wounds in the ileum, two in the cæcum, and lodged in the pelvis of the right side, a deflection of fully four inches. It struck against no bony part, nor were there hardened feces which might have turned it from its course. This

positive evidence is, of course, far more conclusive than many negative experiments.

As a rule, and as general in application as the one which states that all penetrating wounds of this class are attended with visceral injury, it may be stated that the course of the bullet is a straight one. The application of this rule would be of very great practical value to surgeons, but for one circumstance. To determine the track of the ball the surgeon must know the direction from which it was fired, and the exact position of the wounded person when struck. This information, in the majority of cases, cannot be obtained. We can determine that the injury was inflicted from in front, or from the side, but rarely can eye-witnesses or the patient himself tell us whether or not he was rising from his chair, was stooping forward, was twisted sideways, was running, or was making any violent muscular effort. The shape of the wound sometimes suggests the direction from which the ball has come, the surface impact making either a clear cut hole or a grooved or contused track, depending upon whether the ball is received from the front or strikes obliquely.

It may generally be accepted for granted that a ball from any revolver, with greater penetrating power than that given from the 22 short cartridge, which has struck the abdomen squarely from the front, has penetrated into the peritoneal cavity. As positive knowledge upon this point is of cardinal importance, the value of the information thus gained constitutes a sufficient excuse for both probing and digital exploration under rigid antiseptic precautions. If, after this method of examination, the surgeon is still in the dark, we can see no objection to carefully following up the ball track by incisions. In case of non-penetration the original wound has not been seriously complicated. If the abdominal cavity is entered, the surgeon's finger arrives at the point where the signs of serious visceral wounds are most likely to be manifested.

The diagnosis of penetration having been made the question as to whether or not serious visceral lesions have resulted becomes one of prime importance. In every one of our experiments a penetrating gunshot wound was followed by wound of the abdominal contents. In our appended tables but four cases were, upon section, found to have no internal injury.

When we speak of the abdominal cavity it must be borne in mind

that this space is absolutely and entirely filled with important organs. There are no interstices or spaces in which nothing is placed. Each viscus is accurately packed, and is kept in close apposition under alterations in size, by the ever changing tension of the belly walls. Hence even the slightest penetration of the peritoneal cavity, by a missile travelling with the velocity of a bullet, will almost certainly result in injury to the contained organs. It can be assumed, then, as a working rule, that every penetrating wound of the abdomen has produced more or less serious visceral lesion. On the basis that certain cases which recover without serious symptoms after penetrating or perforating gunshot wounds of the belly recover, because there are no visceral lesions, the percentage of wounds entering the abdominal cavity without wounding the viscera is frequently stated to be ten in the hundred. We shall presently show that statistics founded upon this estimation are not reliable, since patients do frequently recover from these injuries even though there may have been multiple and extensive visceral lesions. Our own figures show that the percentage of penetration without visceral wound is about $3\frac{1}{2}$ per cent.

As a second proposition it may be stated that the lesion inflicted by a penetrating gunshot wound of the abdomen, especially if the ball has passed through and through, is multiple.

Since it is especially with intestinal wounds that we have to deal in this paper, it is next in order to study the pathological changes which occur in a portion of the gut lacerated by a pistol ball. The first effect is to produce a local spasm, so marked that Baudens[1] used it in his digital intra-abdominal search, as a diagnostic point. Immediately, consequent upon muscular contraction, there is an eversion of the loose mucous coat of the bowel, sufficient to entirely occlude even comparatively large wounds. Following the spasmodic contraction the involved portion of the gut becomes paretic, absolutely losing all peristaltic motion. Beck[2] observes that in his vivisection experiments, so long as the healing can be delayed by peristalsis the animal instinctively refuses all food. This paralysis is not so absolute but that purgatives, or even the irritation of the ordinary ingesta may overcome it. It is sufficient,

[1] Clinique des Plaies d'Armes à Feu.

[2] Schusswunden, Heidelberg, 1849.

however, to splint small wounds until they can be tightly closed in the further process of healing.

The next step in the process is the effusion and organization of plastic lymph. This may simply envelop the seat of trauma, or, and this is much more common, may serve as an organizable glue for the purpose of tightly apposing healthy omentum or peritoneal surface to the bowel wound temporarily closed by prolapsed mucous membrane. At times the omentum enters as a cork through the wound into the bowel lumen, and is secured in this position by rapid adhesive inflammation. The opening is frequently closed by neighboring intestinal loops which act as temporary occluders. Subsequent cicatrization of the effused plastic lymph accomplishes the permanent healing of bowel wounds. By the constant peristalsis adhesions may subsequently be drawn out into bands; more frequently they entirely disappear. Jobert claimed that, although the muscular contraction and mucous membrane prolapse prevented the escape of feces, gas nearly always passed out through a bowel wound, and by the immediate resultant tympany gave rise to a pathogenic symptom of this form of injury. It is recognized now that the closing which nature spontaneously effects is sufficient to retain both gas and feces. Even though the latter escape in small quantity there is still a method of cure. By plastic inflammation the extravasation can be shut off from the general peritoneal cavity, and the resultant abscess may gradually work its way to the surface, generally through the track of the wounding body.

Although it is true that even very small wounds may be followed by fecal extravasation, it should be well recognized that this complication is an exception rather than a rule. Even though the intestinal walls be torn, since there is in reality no cavity into which the bowel contents can be poured there is no natural tendency for extravasation to take place. If the bowels are inflated with gas, this, diffusing itself in all directions, may create space by passing into the general peritoneal cavity and pushing out the abdominal walls. Consequently when there is escape of intestinal gas, this is, as a rule, followed by fecal extravasation. This accident is of course far more likely to occur if the bowels are full.

Vastin[1] mentions a case where the bowel was completely torn across in two places, yet there was no fecal extravasation. Archer[2]

[1] Craig. Franc de Cherin, 1888. [2] N. Y. Med. Jour., vol. 15, p. 215.

reports an instance where, through a two-inch wound of the stomach the patient's dinner was discharged, a portion passing into the general peritoneal cavity. Nine days later there was suppuration in the groin. On evacuation of the abscess, pus and cabbage were discharged. The patient recovered.

The natural tendency of extravasation is to escape through the external wound, since in this direction only is the space not already filled. Guthrie notes this, and states that when the visceral contents are poured out through a small external wound, the latter should be enlarged, the gut wound being sutured.

As a result of extensive extravasation, excepting when the external wound gives free exit, a fatal peritonitis is nearly always developed. This is the most dreaded of all complications and terminates with the life of the patient in from twenty to forty-eight hours. It is not, however, the general, or even the usual result of abdominal gunshot wounds. In a record of 127 cases we found fecal extravasation mentioned in but 16 instances, giving a ratio of 12 per cent.

A very frequent complication, and one which is responsible for the great majority of deaths occurring very shortly after the wound, is internal bleeding. We found, in our experiments, that sixty per cent. of the dogs shot through the belly died within the hour of hemorrhage, or would have died had not the bleeding points been secured.

In our statistics we find thirty-three per cent. of cases in which internal bleeding was a grave complication. We know of no source from which may be determined the number of fatal cases due to this cause. Even in surgical war records, complete in other respects, the whole number lost in battle is simply classed as killed. As seen, abdominal hemorrhage results fatally in a few hours. It is impossible to say how great a proportion perish from the wounding of important bloodvessels.

It is claimed by many surgeons that the shock, which is such a frequent complication of intestinal wounds, is never present, except as a symptom of internal bleeding. This view cannot stand under careful examination, since there are many cases reported in which subsequent examination showed there was no bleeding, and yet in which shock was so profound as to threaten death. The symptoms of hemorrhage into the abdominal cavity

do not differ from those dependent on bleeding in any other part of the body. The same disorders of respiration, of sensation, and of heart action, are to be noted. In addition there are certain local signs which are of great value to the surgeon. Increasing dulness of the flanks, with deepening shock, particularly if associated with the desire to urinate frequently, would be almost pathognomonic of this complication.

To this bladder condition Baudens has called attention, stating that when there is much blood gravitating into the pelvis, there is a constant insupportable desire to urinate, due to the mechanical pressure. Of course if the hemorrhage be slight in amount it may be entirely circumscribed, ultimately being either absorbed, or breaking down, and discharging as an abscess. Where the bleeding is free it inevitably gravitates into the pelvis and dependent parts.

Shock is a condition which very commonly accompanies intestinal wounds; some surgeons consider it of diagnostic value, the amount of shock denoting the intensity of intra-abdominal injury. That patients, suffering from gunshot wound of the abdomen, are profoundly shocked, or even collapsed, from the very beginning, cannot be doubted, but it is found that this condition depends more upon individual peculiarities than the actual amount of injury, and that it is impossible to differentiate these symptoms from those characterizing bleeding. Our tables show many instances of most extensive wounds, where the shock was slight or wanting, and we have repeatedly seen burly men suffering from a light flesh wound, exhibit temporarily, all the symptoms of profound shock.

It is most important to determine whether the patient suffers from shock or internal bleeding, since the treatment for bleeding is immediate operation, while the treatment for shock is, of course, quite the reverse. It is certainly true that many of the cases, in which shock has been most profound, have been found to be suffering from internal hemorrhage; where the shock is prolonged and steadily deepening, even in the absence of other symptoms it is perhaps safest to act as though a diagnosis of hemorrhage had been made.

We think we have discovered a means by which this differentiation possibly may be determined, not under all circumstances, it is true, but with sufficient frequency to be of value to the surgeon.

The effect of rapid or prolonged hemorrhage upon the composition of the blood is well known; such patients will be found to exhibit deficient hæmoglobin, and the corpuscular count will be low. We have made several observations on the human to determine whether or not this condition is sufficiently constant to be of clinical value. We find that, with certain limitations, the percentage of hæmoglobin is a fairly accurate guide as to the amount of blood lost. This test may be made in two minutes. Of course it is impossible to know what the normal for each individual may be. Slight variations will be of no consequence, but serious bleeding so profoundly affects the blood that the hæmoglobin will necessarily show a diminution far below the line of individual peculiarity. Thus, in case of tumor in the neck, upon which an operation was performed, and in which there was much bleeding, the symptoms of hemorrhage were slightly marked, hæmoglobin count giving seventy-five per cent. In a case struck by a locomotive, and very profoundly shocked, temperature 96, pulse 138, the hæmoglobin was over 100. In a case lacerated by car wheels, the right leg and arm having been torn off, and in which it was alleged there had been no bleeding, there was thirty-eight per cent. of hæmoglobin, showing that the statements of those around this patient were not true.

The only instance where this test failed was in a case of severe shock from spinal injury. The temperature was 96⅘, the pulse 80, the respiration 30. The man was very pale. Capillaries seemed empty, there was much difficulty in obtaining blood. Hæmoglobin seventy-eight per cent. In this case other symptoms sufficiently excluded severe hemorrhage.

In instances where patients suffering from abdominal wounds exhibit the characteristic symptoms of either hemorrhage or shock, we think the hæmoglobinometer may aid in determining which of the two conditions is really present.

Diagnosis.—We have alluded to the difficulty of determining whether or not a ball has penetrated the abdominal cavity. The question of deciding as to the presence of one or more severe lesions of the abdominal contents is still more complicated.

As a general rule it is safe to assume that such lesions have occurred, but it is of extreme importance to the patient to be able to recognize the exceptions. To those who hold that visceral injury

is necessarily accompanied by shock, the distinction would be easy, but to the modern surgeon experienced in these cases or well read in the literature of to-day, a diagnosis is impossible.

Certain symptoms are classical, as characterizing bowel lesions. Either fecal extravasation or the escape of gas through the external wound would positively denote that the alimentary tract had been opened, but in the absence of these two signs, and they are both as a rule absent, there is absolutely nothing which can be always relied upon in making a diagnosis of this injury.

It is true that bloody vomit suggests a wound in the stomach, yet we know the symptoms may occur, although the stomach has not been opened. Thus a ball may produce simply a contusion, with the resultant rupture of bloodvessels of the mucous membrane and hæmatemesis; the same is true in regard to the evacuation of blood from the bowels.

Blood in the passages is extremely suggestive of a wound of the large intestine, if this blood be partially digested it has been probably effused from the small intestine, yet this symptom may be present without penetration of the bowel, and may be absent though there be multiple lesions of the digestive tube.

Prompt meteorism was considered by older surgeons to be of peculiar value in making a diagnosis. Jobert ascribed this phenomenon to the escape of intestinal gas from the bowel wound. This is not reliable, since many cases may run to a fatal termination and never exhibit this symptom; and simple contusion of the belly walls often produces extreme distention. Though as a general rule it is true that the belly does become tympanitic after penetrating wounds, it is due more commonly to intestinal paralysis, than to escape of gas into the general peritoneal cavity.

The direction of the ball, the shape of the orifice, the wound of exit, if it is present, the presence of blood in vomit or feces, the position of the patient when injured, the constitutional condition, pain, all must be carefully examined into, as all these points contribute to a diagnosis. Even after a most extensive examination of symptoms, however, it must be confessed that there is but one way to determine the presence or absence of bowel wounds, and that is by opening the abdominal walls and searching with eye and finger. Stimson says that exploration is justifiable in every case of doubtful penetration. Baudens advises searching for the

wound. Chauvel states that every penetrating wound of the abdomen by weapon of small calibre, with probable vascular or visceral lesions, requires exploratory examination of the wound.

Baudens states that the intestinal wounds are almost always seated behind the abdominal opening; hence, if there is any injury to the gut, enlargement of the peritoneal wound will probably successfully demonstrate it; if not, the finger should be carried into the peritoneal cavity in search of blood or feces, or even a sponge may be thrust down through the intestinal loops to the dependent portions of the abdominal cavity. After such an examination, if no hardening of the gut, no feces, no blood, and no bubbles of gas are discovered, there is either no wound or one with which nature can cope.

Prognosis.—This is unfortunately bad, and under any form of treatment the chances of recovery for a patient who suffers from a penetrating gunshot wound of the abdomen are not good. In military surgery there can be no question but that the vast majority of these cases perish on the field. Beck remarks, "I have never seen any hospital patients suffering from wounds of either the small or large intestine." In all, death came quickly. Otis gives the mortality of penetrating abdominal wounds, as shown in our Civil War, as 87 per cent. He states that a great number of recoveries were those in which the large intestine was wounded in one of its portions not covered by peritoneum, the cure being frequently complicated by the formation of an artificial anus. Cases of recovery where the solid or membranous viscera are wounded, with extravasation of their contents within the peritoneal cavity, Otis considers so rare that well authenticated examples can be counted on the fingers, while penetration of the peritoneal cavity without wound of its contents is nearly as rare. Gurlt states that in the Franco-German War of 227 cases of penetrating wound of the abdomen 59 recovered, 148 died and 22 were unaccounted for. In this last class it is possible that at least the majority recovered. Leaving them entirely out of the question, however, this would give a mortality of about 72 per cent. In the Crimean War 10 per cent. of cases were said to have recovered. In the Franco-Italian-Austrian War 34 per cent. The Franco-German War has shown a still larger percentage of recoveries (Chenu).

Nimier "gives out of 5003 cases, a mortality of 80 per 100."

In all these statistics, differing so widely in their results, the mortality is probably understated.

The only efforts at tabulating the result of gunshot wounds as inflicted in time of peace by weapons of small calibre, and not treated by operative interference are first that made by Stimson, who places the mortality at 65 per cent.; next the records of Reclus and Noguès, who in a total of 88 cases note a mortality of 25 per cent.

Against this last compilation must be urged, the objection which is applicable to all tabulations from reported cases. Hundreds of gunshot wounds terminating fatally are not reported by physicians simply because this termination is what is to be expected, and without interest to the medical reader. If, however, there is clear evidence that a ball has penetrated the peritoneal cavity, and in spite of this the patient subsequently recovers, the case becomes one of great interest and rarely escapes becoming a part of current medical literature. Hence the rate of mortality given by such a table is far too favorable.

Against Stimson's table it must be urged that the diagnosis of penetration was not positively made, he eliminated, however, many cases terminating favorably, in which there was no symptom beyond penetration to prove intestinal wound. It has been shown that such cases may recover in spite of multiple intestinal injury, hence we believe Stimson's figures represent more fairly the general result to be looked for from expectant treatment in wounds such as are ordinarily inflicted in centres of population, than any other compilation that has yet appeared. The same is undoubtedly true of his table upon abdominal section, to which we shall later make reference.

Reclus and Noguès have included in their tables mainly such cases as give positive evidence of penetration with visceral wound. These cases they divide into three classes. The first comprising six, three of whom recovered, represent cases where an autopsy confirmed the diagnosis of intestinal wounds, with, in the recovered cases, complete cicatrization. The second includes 56 cases, in all of which blood from the mouth or anus, or fecal extravasation evidenced visceral wound; 44 of these survived. The third class, numbering 26, comprises cases where visceral lesion is made probable only by the fact of penetration; 19 of these recovered.

This gives a general mortality of twenty-five per cent. We

have already given reasons for believing that it is by no means representative of the true mortality in these cases.

Otis and many surgeons grant that wounds of the large intestine may heal, but are inclined to reject the possibility of this termination in wounds of the small intestines. Our table shows that of 130 cases of abdominal wound, in 48 the small intestines only were wounded. In 4 the stomach only was wounded, in 8 the colon only. Unless the bullet enters antero-posteriorly in the lumbar region, no surgeon can say that the large intestine only has been injured, since shot wounds are nearly always multiple and the small intestine is commonly involved; still there is an almost universal belief in the greater mortality of wounds of the lesser bowel. This is perhaps owing to its more fluid contents, and greater mobility. Our statistics show that of 48 wounds of the small intestines only, 36 (75 per cent.) died; while of 8 wounds of the large intestine only, 5 died, giving a mortality of 62.5 per cent. Of course it must be remembered that the small intestine wounds were usually multiple, while those of the colon were single, or at most through and through.

Treatment.—As in the treatment of obstruction, the opinion of medical men is divided between expectant treatment and operative intervention. Just now a great wave of surgical ardor has swept over our country, and the almost unanimous opinion seems to be that since these wounds usually penetrate, usually injure the viscera, and that when this occurs death is the rule, the first resort of the surgeon should be a formal section, with the idea, primarily, of determining whether or not the ball has entered the peritoneal cavity, next to find the seats of lesion, and apply to them the proper surgical treatment.

The advocates of this treatment have pointed with much pride to the statistical record of cases operated upon, and of those treated expectantly. As types of the former they have taken patients wounded by weapons of small calibre, and in cases where medical aid was promptly rendered, comparing these results with those obtained when the wound was by a large musket ball, and was inflicted many hours before the patient could have the benefit of professional assistance. Because the results of operation have been slightly better than those following non-operative treatment under

the circumstances described, it has been held that these figures constitute an absolute justification for the use of the knife. It is certain that not only is such a comparison unfair from the very nature of the two series of cases, but also because the tables compiled from reported cases are absolutely misleading. Stimson has given most positive proof of this fact in his analysis of the operative treatment of these cases in the city of New York. Whereas, for the purposes of the statistician, there were on record 12 cases of section, with 4 recoveries, giving a mortality of 66⅔ per cent., in reality there have been 31 operations performed, of which 25 resulted in death, thus raising the mortality to 80.6 per cent. Applying these figures to the general tables, our own for instance, it will be seen that for purposes of comparison, the latter are of little value. A comparison of cases treated by operation with those treated expectantly, in two hospitals in New York, each set of cases being under the charge of men prominent for their skill, gave about the same mortality for each method of treatment.

From a statistical point of view Stimson's paper is undoubtedly the most powerful argument yet advanced against formal section as a routine treatment for intestinal gunshot wounds. The various objections to this procedure have been most ably collated by Reclus and Noguès who, as the result of a careful examination into statistics and after a certain amount of experience in these cases, formulate their ideas in the following words:—

"In the present state of science, we believe that systematic abstention is less murderous than laparotomy." "By probing of the wound, introduction of the aseptic finger preceded by enlargement if necessary, we can determine whether or not the peritoneum is opened. From this we decide as to whether the wound is in the stomach or intestine. We close the external wound by a pledget of iodoform and collodion, uniformly compress the abdomen by bandage, use morphia hypodermically, insist upon abstention from food, and by the mouth give only a few coffee spoonfuls of iced milk. Under this method we have had three successes from penetrating wounds by revolver balls."

It is certainly true that the vast bulk of the profession favor immediate abdominal section and there can be no question but that this procedure has many times saved lives which would otherwise have been lost; but it must be carefully considered whether inter-

vention saves more lives than can be preserved by non-surgical treatment.

A very brief perusal of our tables will show that the many deaths occur so shortly after laparotomy that the inference as to this being the direct causative agent is most direct. It is clearly recognized that the success of operation diminishes in proportion to the time intervening between the infliction of the wound and surgical interference. Trélat states that after twenty-four hours the operation is practically fatal, and that septic peritonitis is the most frequent cause of death.

An examination of the reported cases shows that hemorrhage, shock, and collapse must take the place of prime importance in case of death within twenty-four hours of operation.

We believe that the advice given by Baudens fifty years ago is still in advance of the latest surgery of the day. His counsel is neither for formal abdominal section nor for abstention. Believing, as he did, that practically all penetrating gunshot wounds of the abdominal cavity wounded viscera, but that these wounds were capable of spontaneous closing unless fecal extravasations had occurred, he counselled enlarging the wound and primarily discovering whether or not the peritoneum had been punctured. If this were the case he made a careful exploration of the abdominal cavity with the finger. If profuse bleeding or fecal extravasation was discovered he did not hesitate to make as large an opening as was necessary to find and remedy the cause of trouble. If, however, neither of these complications were present he advised closing the parietal wound, even though intestinal injuries were almost certainly present, holding that nature was able to cope with these.

Still earlier (1801), Dufort performed exploratory section, but as suture of the intestine was not then formulated, he fixed the wound in the external opening.

It may be claimed that incision along the track of the ball renders accessible only a very small portion of the peritoneal cavity, that where a ball has traversed from side to side or obliquely from above downward, such an incision may be absolutely inadequate for a thorough dealing with all lesions. This procedure constitutes, however, no contraindication to formal abdominal. It is used, primarily, simply as a diagnostic means. It decides whether or not the formal operation should be performed. In itself it but

slightly complicates the original wound. We believe with Baudens, with Stimson, with many surgeons, that a wound of the intestine is not in itself an indication that the latter should be sutured. That this is the preferable course cannot for a moment be doubted, but where there is profound shock, where every moment of continuance of operative procedure imperils a life already hanging in the balance, we think there is less risk in leaving these wounds for nature to take care of than in unduly prolonging the operation.

It will be seen from our tables that some of the operations lasted between three and four hours, hundreds of sutures being applied, the bowels being turned out from the peritoneal cavity, and subjected to an incredible amount of handling. Where the vitality is already weakened by severe traumatism, it is difficult to understand how life can be preserved under such treatment even for a few hours, and more than one case has perished on the table.

The statistics of Reclus and Nogués are absolutely conclusive not only as to the possibility of cases of wound of the viscera by weapons of small calibre recovering spontaneously, but also as to the relative frequency with which this occurs.

Where fecal extravasation has taken place, as ascertained by the exploratory incision, death is practically certain unless the gut wound be closed. Here the surgeon is justified in searching for and closing the source of leakage, no matter how grave the patient's condition may be. Where there is extensive hemorrhage into the peritoneal cavity, we believe that the formal operation should be performed and the source of bleeding sought, though, in one instance where this was done, the surgeon, after failing to discover and check the bleeding, finally produced hæmostatis by closing and tightly compressing the belly wall.

Manier advises in cases of hemorrhage where there is no indication as to the vessel injured, medical treatment, compression of the belly, ligature of the extremities, and morphia hypodermically.

There is fortunately in the treatment of gunshot wounds of the belly, not the same contest between the advocates of salines and morphia as there is in the treatment of other pathological conditions of the abdominal contents. All are agreed that morphia should be given and given freely in the first stages of these injuries, not so much for its direct effect upon the intestinal walls as for its constitutional effect.

It must be borne in mind that every severe injury to a segment of the gut produces a temporary paralysis of that segment, hence morphia given with the idea of checking peristalsis is not indicated. If the physician adheres to the older method of feeding by the mouth active peristalsis may be excited, but where the stomach is given entire rest there is nothing to inaugurate peristalsis until the wound is sufficiently advanced for it to do no harm.

These cases should be fed by the rectum, should be stimulated hypodermically, and should be kept comfortable and quiet by the use of morphia administered beneath the skin.

It must be recollected that fecal extravasation is most likely to occur in the neighborhood of the external wound, consequently this should be kept carefully under observation, and on the first symptom of inflammation should be promptly opened, since by this treatment fecal abscesses have been evacuated, which, if left to themselves, might have ruptured into the general peritoneal cavity.

Senn's hydrogen test in the diagnosis of intestinal perforation is a means which if properly applied may be of service to the operator though it is not without decided disadvantage. The possibility that it might fail to detect wounds, even though these were present, was suggested to us when Senn's paper first appeared, and we performed a number of experiments which proved as conclusively as work upon the lower animals can, that this was the case.

We stabbed one dog, making two wounds in the ileum, each a quarter of an inch in length, we then passed gas from end to end through the dog without getting the slightest escape through the parietal wound, although this was held open. We shot a dog, making two wounds in the stomach, one of the cæcum and two of the lower portion of the ileum. The calibre of the ball was $\frac{22}{100}$; again we passed gas through and through without having any escape from the wound. We then opened the peritoneal cavity and passed the gas, when it bubbled up from the region of the cæcum, this wound was secured; the bubbling still continuing, we secured the wounds of the ileum. Gas was now passed until it was belched up. Careful examination showed two stomach wounds through which only by the insertion of a probe we could make the gas escape. The ball had passed through the stomach obliquely, making a valvular opening.

Even though the gut be widely opened it is conceivable that this

breach may be closed by fragments of food or of hardened feces. There are nearly a dozen reported cases where this test has failed on man. It is readily conceivable that it may determine a fecal extravasation which would not otherwise be present or act as the starting point of paretic distention, which might have been avoided.

It is quite true that a wound that would not allow the gas to escape would probably not permit fecal extravasation, and if the surgeon accepts the teaching that only such wounds as are accompanied by extravasation imperatively demand formal laparotomy the test may be of value. If, however, he believes that all wounds must be sought and sutured whether primarily occluded by nature or not, he can place little confidence on this test.

It is not for a moment claimed that wounds which primarily permit no escape of intestinal contents may not subsequently, from imperfect adhesions, from sloughing, or from too early establishment of peristalsis, gape widely and permit extravasation of intestinal contents with resulting diffused peritonitis. The standpoint taken is that the mortality will be better if the surgeon is content to treat cases in which there is neither primarily extravasation nor hemorrhage expectantly, reserving the formal operation for cases in which these complications are present.

As in obstruction, we would strongly protest against evisceration, unless this procedure be absolutely necessary, and would urge the importance of hastening all operative details. It is generally acknowledged that very small wounds need not be closed, that the first effort should be made at repairing the larger breaches, that if resection is necessitated by extensive laceration, or wound of the mesenteric attachment of the bowel, the quicker operations of lateral, or end to end approximation, are to be perferred to circular enterorraphy. In some instances it may be justifiable to form an artificial anus. Finally the peritoneal cavity should be thoroughly flushed with hot saline solution, and in all these cases drainage should be established for twenty-four hours. Symptoms other than those due to local peritonitis would indicate reopening of the belly with treatment appropriate to the condition found. (See Paretic Distention, Peritonitis, etc.) A high rate of success can never be expected, but it is certain that the mortality now prevailing can be lowered by proceeding with all the dispatch possible,

and with the sole view of preserving life rather than of making an absolutely perfect operation.

CONCLUSIONS.—Penetrating gunshot wounds of the abdomen wound the contained viscera in over 95 per cent. of cases; in 65 per cent. of all cases the small intestines are involved. The lesions are generally multiple.

(2) These visceral wounds are capable of spontaneous closure and healing by prolapse of the mucous membrane, exudation of plastic lymph, and adhesions to neighboring peritoneal surfaces.

(3) The common causes of death in abdominal gunshot wounds are hemorrhage and septic peritonitis. Though shock is generally a symptom of hemorrhage, especially if prolonged and deepening, it may, in itself, cause a fatal termination.

(4) The mortality of gunshot wounds as treated by abdominal section is not better than that of those treated expectantly.

(5) Beyond extravasation of feces there are no pathognomonic symptoms of wound of the viscera, though bloody vomit, blood in the passages, and long continued shock, suggest that such wounds are present.

(6) Internal bleeding may be diagnosed from shock by means of the hemoglobinometer.

(7) Wounds of the small intestines are more fatal than those of the large.

(8) The treatment of abdominal wounds with probable wound of the intestine is, enlargement of the external wound for the purpose of proving penetration and injury to the viscera. If no blood or fecal extravasation is found in the peritoneal cavity, the external wound may be closed. If the visceral wounds are sufficiently patulous to allow of extravasation these must be sutured, formal abdominal section being performed if necessary.

(9) Suture methods or other surgical procedures requiring much time are contraindicated, the mortality depending directly upon the length of operation. Evisceration should only be performed when absolutely necessary for the speedy completion of the operation.

(10) Nothing by the mouth for from two to four days; morphia to control pain, stimulants hypodermically and by the rectum, and food by the rectum constitute the after treatment.

CHAPTER XIV.

RUPTURE OF THE INTESTINES.

THE term as here used is meant to imply a laceration or tearing of the bowel without rupture of the abdominal parietes. It may be consequent upon severe trauma applied to this part of the body, or may result from blows, jars, or falls, involving the body as a whole.

Curtis, who has written most elaborately upon this subject, states that the rupture is really of the nature of a lacerated and contused wound, the gut being crushed between the contusing body and the bony walls. The jejunum and ileum are most frequently injured.

The injury may tear completely across the lumen of the bowel, may produce a small rent, or may involve simply the outer coat. Extravasation is very frequent, though spontaneous healing may take place. Curtis describes two cases in both of which, although the bowel was torn across, the open ends were practically entirely closed owing to the mucous membrane prolapse, muscular contraction, and adhesions of surrounding parts.

The mesentery is very frequently involved, and when this is the case we have a most serious form of the injury, since bleeding commonly occurs, and in a form so violent as to be rapidly fatal.

The form of violence which is most commonly followed by bowel rupture is that which is severe and concentrated, as by the kick of a horse, or of a man, or by the passage of a heavy wheel over the abdomen.

The theory of laceration against bony parts would seem to be sustained by the fact that in general jarring, such as comes from falls, or from large bodies travelling with great momentum, the intestines commonly escape, the liver more frequently exhibiting the effects of the violence.

Guthrie[1] instances a case where the ileum of a child was ruptured

[1] Wounds and Injuries of the Abdomen.

by contusion against the thumb of a person tossing it up and catching it. At times the intestinal coats may be only partially torn through, no extravasation taking place for some days when, as a result of secondary sloughing, the wound may involve all the intestinal coat, and give rise to a general peritonitis.

Jobert says that a person frequently recovers from the shock of an abdominal contusion, but suffers from pain in but one spot, the rest of the abdomen remaining in a normal condition; there is here produced a slough which may be subsequently thrown off without harm to the patient, may lead to perforative peritonitis with localized abscess, or to general peritonitis with all its sequelæ. As an example of this Poncet records the case of a soldier struck in the left hypochondrium by a spent fragment of shell. There was no rupture of the skin, but symptoms of peritonitis developed immediately. Opium was given in full doses and the peritonitis was localized to the contused area, the rest of the belly being free from pain or inflammatory symptoms. An emphysematous tumor with central softening was shortly formed, which, on incision, yielded fecal matter. The patient died on the eighth day. Spaeth[1] records a somewhat similar case, the patient recovering with an artificial anus. As an instance of how the intestines may escape in spite of extensive wounds, Vaslin[2] describes a case in which the right flank was torn out by a shell, completely exposing, but not injuring the intestines.

It has been shown that nature is equal to the temporary and permanent closure of a rent in the bowel even though this be extensive. Guthrie, in one instance, saw a patient aged 22, who had been run over by a carriage. The belly immediately became distended and tympanitic; there was practically no shock. Recovery was nearly complete when death took place from lung hemorrhage. A healed rupture of the small intestines, occluded by a button of omentum, was found. Guthrie states that apparently some effusion of air took place before the wound was plugged.

When fixed viscera are wounded, or the mesentery is involved, rapid death from hemorrhage commonly occurs. When the intestines are ruptured, however, septic peritonitis is the factor in the fatal determination.

[1] Berlin. Klin. Woch. 21, Nov. 1887. [2] Cong. Franc. de Chirur., 1888.

Prognosis.—The prognosis of severe contusion, followed by symptoms of hemorrhage, or of intestinal wound is exceedingly gloomy. The outlook for contusion without visceral injury, though threatening is comparatively favorable. Chenu,[1] out of 130 abdominal contusions, states that 106 were cured. In the Civil War out of 125 cases, but five died. Under the heading, "Wounds of viscera without involvement of the abdominal wall," 41 cases are recorded of which number 21 died. Opposed to these figures are the statements of Albert,[2] who, in 60 recorded cases, found but one recovery. The practical experience of every surgeon will at once lead him to contradict the truth of this appalling mortality. In the general wards of a large hospital it is not rare to have patients brought in suffering with the symptoms characteristic of abdominal contusion with visceral lesions. We have lately seen four of these cases, two of whom recovered after exhibiting the symptoms of a sharp peritonitis. One of the most striking instances of recovery after abdominal contusions is that narrated by Fryer.[3] A lad, after a blow in the hepatic region, suffered from severe abdominal symptoms. He was jaundiced on the fourth day. Twenty-one days after the accident there was great abdominal distention. Thirteen pints of apparently pure bile were withdrawn by means of a trocar. In the next three weeks twenty-eight more pints were removed. The patient recovered.

Since, in cases of recovery, it is impossible to say whether or not the gut has been ruptured, in a given case of injury of this kind the chances for life cannot be calculated from statistics. Judging from the symptomatology of observed and of reported cases we believe that the mortality is not nearly so absolute as is generally believed, yet we freely grant that the chances of recovery, when the symptoms of bowel rupture are well marked, are few.

Symptoms.—The first symptoms following intestinal rupture are usually those of shock, though this may be entirely absent as was noted in one of our fatal cases.

Following this, extensive abdominal meteorism is the most char-

[1] Cong. Franc. de Chirur., 1888.

[2] Lehrb. der Chirur., 1885, Bd. 3, S. 39.

[3] Medico-Chirur. Trans., vol. iv.

acteristic and ominous sign. The pulse is very quickly affected, becoming rapid and weak, and either the characteristic symptoms of diffuse peritonitis, with vomiting, constipation, tenderness, thoracic breathing and fever, or those of abdominal septicæmia with sub-normal temperature developed. Beck[1] holds that the seat of rupture may be determined by local pain and dulness on percussion, and by increased resistance on palpation. This was particularly marked in Spaeth's case, developing within twelve hours of the original wound.

Diagnosis.—Since rupture of the intestine is an exceedingly fatal accident, it is most important to determine whether or not this has really taken place. We believe the intensity of primary shock is misleading, since we have seen this condition far more marked in cases of contusion than in those where the gut was ruptured. Meteorism, too, may be well developed after simple contusion, and may be complicated by bilious vomiting and constipation.

Where the vomiting continues and increases in frequency, where local pain, dulness on percussion, and sense of resistance are marked early in the case, and where other symptoms of peritonitis rapidly develop, then the diagnosis of rupture can be made almost positively. The fact of recovery after the development of these symptoms does not prove that rupture was not present.

Treatment.—When the features of bowel rupture as detailed above, are present, we believe that an immediate abdominal section is indicated. It is well recognized that these lesions may be multiple, that the mortality of section in such cases is over 90 per cent., that the chance is desperate. We think, however, that it should be taken *provided the characteristic symptoms are present.* In the absence of these symptoms expectant treatment is indicated. In any case morphia and alcohol, particularly the latter, and in full doses, are indicated. Absolutely nothing should be given by the mouth.

In cases characterized by deepening shock we should endeavor to exclude hemorrhage by means of the hæmoglobinometer, and by careful palpation and percussion of the abdomen. If still in

[1] Deutsch. Zeithschr. f. Chirur. Bd. 15, S. 14.

doubt, there should be no hesitation in making a small median exploratory incision, since this would add but little to the gravity of the case, and would at once decide whether or not bleeding were present. In cases of internal hemorrhage, no matter how desperate the patient's condition an effort should be made to secure the torn vessel.

CASES OF CŒLIOTOMY FOR GUNSHOT WOUNDS OF THE ABDOMEN.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Abbe. N.Y. Med. Jour., 1886, 554.	53.	22.	2 feet.	3 hours.	Bullet wound in median line; two perforations of intestines; perforation of peritoneum between bladder and rectum, with wound of former.	Slight shock; vomiting; abdominal pain; pulse 90, moderate temperature; tympanites.	Med. incision; 1 pint green watery fluid, with lymph and feces encysted in abdominal cavity; all wounds sutured.	Did not come out of ether well; restless; died in 9 hours; suppression of urine; pulmonary œdema.	Purulent peritonitis; ball found lodged in bladder.	Died.
Allis, O. H. Morton's Tables Jour. Am. Med. Assn.	22.	—	—	30 hours.	Wound through liver; ball imbedded in spine; violent gen'l peritonitis.	Violent peritonitis and shock.	— — —	Died in 24 hrs.	—	Died.
Andrews. Jour. Am. Med. Assn., Aug. 15, 1885.	—	38.	—	15 hours.	Ex. wound border of cartilage of ribs left of umb.; no wound of intestine.	Moderate shock; vomited considerable blood.	Median incision; considerable bloody serum; no clots; no fecal extravasation.	Vomited after operation, but no blood.	—	
Andrews, E. Chicago Med. Jour. & Exam., Aug. 1887.	Female, Adult.	—	Long range.	16 hours.	Ex. wound, 2 inches below and 1 in. internal to ant. sup. spin. process of ilium; 1 perforation of intestine.	At first wound not thought to be penetrating; evidence of peritonitis at time of operation.	Small incision (med.); abdomen full of bloody serum; intestines red and adherent.	Pulse hardly felt; death next day.	—	Died.
Annandale, S. Lancet, 1885, 1, 740.	Male, 15	—	—	1 hour.	5 wounds in small intestine; 2 wounds in colon; 2 wounds in rectum.	Shock; slight pain in abdomen; considerable hemorrhage.	Section; all wounds closed with Lembert sutures.	Death in 24 hrs.	—	Died.
Armstrong, S. T. Rep. U. S. Mar. Hos., S. 1886, 133.	26.	—	—	3 days.	— — —	Weak; abdominal pain; some shock; belly tender and swollen.	Section; advanced peritonitis; no visceral lesions found; drainage-tube.	Died in 60 hrs. after operation.	Peritonitis; wound of liver; much free blood.	Died.
Barker, A. E. Brit. Med. Jour. March 17, 1888, 571.	Male, 23.	60 gr.	Near.	3½ hours.	External wound level of lower end of sternum; 1 in. from med. line; no wound of intestine; 2 oz. of clots; wound of omentum.	No vomiting; moderate shock; no dulness; marked tenderness; temp. 98.2°.	Med. incision; ecchymosis of liver; no wound of viscera; ball found in omentum.	Temp. rose to 103°, then fell to normal; discharged well on 21st day.	—	Recov'd.

Reference.	Age and Sex.	Size of bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Barker, A. E. Brit. Med. Jour. March 17, 1888, 571.	Male, 37.	143 grs.	Near.	5 hours.	External wound just internal to right sup. iliac spine; second 3 in. from first; 2 wounds of small intestine.	No shock.	Four in. incision parallel to fibres of external oblique muscle; only ½ in. between 2 wounds of intestine; 3 to 4 oz. blood clots.	Did well for 6 days, and then died without any apparent cause.	Wounds of bowel all healed; 5½ oz. bloody serum in cavity; hypostatic pneumonia in both lungs.	Died.
Barrow, David. Jour. Am. Med. Assn., June 18, 1889, 833.	29.	—	—	6 hours.	None found; whole of small intestine explored.	Very little shock; no pain.	Four in. incision; irrigation; operation 1 hour.	Recovered.	—	Recov'd.
Barrow, David. Ibid.	31.	Colts No. 44.	—	3½ hours.	Ent'd ½ in. to left and 1½ in. below umbilicus; passed down and back; 7 large perforations of small intestine; 5 lascerations of meso-colon; branches of sup'r mesenteric artery cut and bleeding; omental prolapse; fluid in peritoneum; gas from wound.	Collapse.	Wounds sutured; evisceration; bowels wrapped in bichloride towels (warm); operation 2 hours; hot water enemata subsequently given.	Died in 3 hours of shock (from primary loss of blood).	—	Died.
Barrow, David. Ibid. 834.	25.	38.	—	5½ hours.	Ball entered 1 in. below and 3 in. post. to ant. sup. spine; lodged below liver, in skin to rt. of med. line; 9 perforations of small intestine; several of meso-colon; 1 qt. bloody fluid in cavity; branch sup. mes. artery bleeding.	Weak; no food for 16 hours; some shock; vomiting; condition fair.	Abdominal incision 7 in. long; 4 in. small intestine resected; wounds sutured; Czerny-Lembert sutures; cavity sponged out; had to puncture bowel to restore; operation 2 hours; immediately after, collapse.	Died in 15 hrs.; vomiting; pain.	—	Died.
Barrow, David. Ibid. 836.	25.	—	—	13 hours.	Wound of entrance 1½ below ensiform cart. and 1½ inches to right of med. line.	Slight shock; much pain in right shoulder; temp. 99°.	Exploratory section; wound through right lobe of liver; one of the bile ducts cut; hemorrhage from liver wd.; much blood and bile in peritoneal cavity; liver w'nd packed with gauze; warm water irrigation; chloroform anæsthesia.	Bowels moved by glycerine enemata; death in five days from cholæmia.	—	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Barrow. Ibid. 1890, 203.	Male, 15.	32.	Close.	4 hours.	Entrance 1½ in. to left of umbilicus; four perforations of small intestine; two of large intestine.	Pain; vomiting; hard retracted belly.	Section; Czerny-Lembert suture; irrigation; drainage; operation 1¼ hours.	Morphine in small doses for ten days.	—	Recov'd.
Barrow. Ibid.	Male, 13.	32.	—	—	Entrance 2 in. to right and 1 in. below umbilicus; two perforations of ileum; 3 of cæcum.	No shock; pain and vomiting absent.	Incision including wound of entrance; Czerny-Lembert suture; irrigation; operation ½ hour; no drainage.	On third day temp. rose to 101°; reopened and drained; peritonitis; death on third day.	Several ounces bloody fluid in peritoneal cav.	Died.
Barton, J. M. Pittsburgh Med. Review, 1888, 291	Female, 35.	—	—	24 hours.	Wound over stomach; no visceral injury found.	— —	Abdomen cleansed and drained.	Died in 20 days.	Died from sepsis spreading from ball track to peritoneum; P. M. 2 wounds of stomach.	Died.
Baudens. Chirurgie d'Armes à Feu.	—	—	—	Shortly after.	External wound near umbilicus; 2 wounds of small intestine.	Pulse contracted; cold sweats; great abdominal pain.	Abdominal wounds enlarged; 8 in. of intestine resected; Lembert suture.	Died in 3 days; peritonitis.	A wound of colon, and fecal matter extravasated; adhesions; clots of blood.	Died.
Baudens. Clinique des Plaies d'Armes, 326.	—	—	—	—	Wound of trans. colon; omental prolapse.	— —	Fecal extravasation; wound enlarged; intestine sutured.	—	—	Recov'd.
Bell, C. E. Brit. Med. Jour., March 16, 1889, 589.	18.	Large.	Near.	2 hours.	Wound of entrance to the left below the ribs; 7 perforations of small intestine.	Shock; vomiting; diffused pain in abdomen; small quick pulse.	Lembert suture; abdomen cleansed.	Recovered in 6 weeks.	—	Recov'd.
Bernays, A. C. Pittsburgh Med. Review, April, 1888.	12.	—	—	12 hours.	Wound posterior, midway between ilium and last rib; 1 wound of small intestine.	Tympany; pain; nausea; no vomiting.	Bullet lodged in mesentery; piece of cloth removed from peritoneum; much blood; Lembert suture; abdomen cleansed; no drain.	Recovery slow.	—	Recov'd.
Bernays, A. C. Ibid.	Female, 9.	3 turkey-shot.	—	1 hour.	Three perforations of right colon with shot in its lumen; extravasation of blood and feces.	Condition good.	Lembert sutures; abdomen cleansed; no drain.	Died in 3 days; septic peritonitis.	—	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Bernays. Lancet, Sept. 13, 6.	Male, 22.	—	Close range.	16 hours.	Wound of entrance 2 in. above umbilicus and 1 in. to right of median line; perforat'n of duodenum and lacerated renal vein.	Great abdominal tenderness; stomach perforated 3 in. from pylorus; enormous post-peritoneal hæmatoma.	Abdominal section; Lembert sutures.	Death 40 hours after injury.	—	Died.
Bernays. Ibid.	—	—	25 feet.	—	Ball entered 2½ inches above umbilicus, 2 in. to the left; wound of stomach, duodenum, and ileum.	Shock.	Abdominal section; operation 1½ hours.	Recovered.	—	Recov'd.
Bernays. Ibid.	Male, young man.	32.	—	—	Wound 2 in. below and 1 in. to left of umbilicus, stomach wounded in two places and right gastro-epiploic artery cut and bleeding; liver wounded.	Great pain; no shock.	Abdominal section; sutures and ligation.	Abdominal incision burst opened by cough.	—	Recov'd.
Billroth. R. Von Hacker Billroth. Klin. 1886.	Female, 63.	—	—	32 hours.	Wound of entrance under nipple, 7th intercostal space; wound of stomach, liver, aorta, and right kidney.	Great pallor; small pulse; bloody vomit; tympanitis.	Transverse incision 6 in. long from linea alba to 6th rib; 7th and 8th ribs resected; 29 Lembert sutures.	Died following evening of peritonitis and pleuritis; bullet found in right kidney.	—	Died.
Bolles, W. Bost. Med. Surg. Jour., Oct. 17, 377.	Female, 34.	32.	2-3 feet.	6 hours.	1 wound of stomach; 2 of jejunum; 2 of transverse colon.	Shock; vomiting; pulse feeble and rapid.	Incision 6 inches long; considerable blood in cavity; slight trace of fecal matter.	Did not rally from operation well; pulse could not be felt at wrist; died in 6 hours.	All wounds closed.	Died.
Bramann. Deutsch. Med. Woch. Aug. 1, 1889.	Male, 26.	Medium cal.	—	3 hours.	Entered in left mam. line, just below border of ribs, bullet found to left lumbar vertebræ near post. sup. spin. proc. of ilium.	Abdomen distended, slightly tender; in 3 hours begin. collapse; exudation demonst. in dependent parts of abdominal cavity; int. bleeding.	Section in 3 hours; incis. at level of ant. sup. spin. proc. of ilium; along the outer border of rectus muscle; also transverse cut extending to quad. lumb.; 2 wounds of small intestine; 1 of trans. meso-colon with hemorrhage; intestinal wounds closed by prolapsed m. m., so that pressure was unable to cause the escape of gas and feces.	Recovery.	—	Recov'd.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Briddon, C. K. N. Y. Med. Jour. March 9, 1889, 255.	20.	—	—	2 hours.	Blood in urine; 15 perforations of intestine.	Moderate shock.	Resected 1½ in. small intestine; other wounds sutured; operation 3½ hours.	Died in 36 hrs.	Overlooked wound of bladder.	Died.
Briddon. N. Y. Med. Jour. 1887, XIV., 75.	Female, Adult.	—	Near.	17 hours.	External wound 3½ in. above umbilicus and 1½ in. to left med. line; 2 wounds of stomach; 4 wounds of jejunum.	No collapse; pulse 80 and regular; temp. 101.4°; vomited, thick and dark; slight tymp.	Med. incision from ensiform cartilage to umbilicus; condition critical; time of operation 2 hours.	Died 3d day of acute peritonitis.	——	Died.
Brown, G. S. Med. News, Feb. 18, 1888, 180.	Male, 32.	38.	15 feet.	12 hours.	External wound level with and 3½ inches to right of umbilicus; no perforation of intestine.	Six hours after injury pulse 95, temp. 100°; 12 hours after pulse 130, temp. 103°; no shock.	Med. incision from umbilicus to pubes; no wound of intestine, but 6 oz. bloody serum effused into abdomen. cav.; irrigated with 1-6000 bichloride; time of operation 1½ hours.	Wound dressed 5th day, almost healed; drain removed 10th day; 14th day sutures remov'd	——	Recov'd.
Bull, W. S. Med. News, XLIX., 609.	Male, 24.	44.	—	6 hours.	4 perforated wounds; 2 in jejunum; 2 in colon.	Temp. 98°, pulse 92; hepatic dulness diminished; no distention.	Incision from 2 in. above pubis to 3 in. below sternum; meso-colon stained with blood; time of operation 1¾ hours; 1 to 100 carbolic.	Patient died in 8 hours; shock.	——	Died.
Bull, W. S. Med. News, 1886, XLIX., 524.	57.	—	—	2½ hours.	Ball entered 3 inches above and 2¾ inches to left of umbilicus; exit right side axillary line, midway between ribs and iliac crest; 2 wounds of small intestine; 3 tears of meso-colon; omentum and anterior epiploic appendages torn and bleeding.	Vomited once; 700 c. c. saline into cephalic vein; pulse 112, temp. 96.25° at time of operation.	Incision downward from 1 in. below ensiform cart.; Lembert sutures to intestine; wounds of omentum and appendix excised.	Recovered.	——	Recov'd.
Bull, W. S. Ann. Surg., 1886, 4, 479.	Male, 57.	32.	Near.	12½ hrs.	External wounds 3 in. above umb., and 1¾ in. to left; wound of exit right side med. line, half-way between ribs and crest of ilium; wound of liver.	Pale, surface of body cold; pulse 100, temp. 94° (ax.); shock from loss of blood.	Section to stop hemorrhage; intestines floating in blood; blood sponged out, but continued to be effused; pulse began to fail before hemorrhage could be checked.	Died ½ hour from time ether was begun.	No wound except of liver.	Died

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Bull, W. S. Med. News, XLIX., 524.	Male, 25.	38.	Near.	2 hours.	External wound 2 in. below umbil.; 2 in. to right of med. line; 2 wounds of intestine.	Tenderness on pressure; no emphys. about wound.	Med. incision; 7 oz. bloody serum in cavity; no feces; piece of bleeding omentum tied and cut off.	Recovery delayed by giving way of sutures.	—	Recov'd.
Bull, W. T. Med. News, 1885, 1, 171.	22.	32.	—	17 hours.	Entered 1½ in. below umbilicus and ½ in. to left of median line; 7 wounds of small intestine; 1 wound of sigmoid flexure.	Pulse 96, temp. 97.8°, resp. 18; condition good; vomiting; pain; tenesmus; involuntary micturition.	Exploratory incision over wound; then med. incis.; 2 pints bloody serum and clots in cavity; ball found among intestines; Lembert suture; iodoform gauze; operation 2 hours.	Discharged cured in one month; pulse went up to 150 during operation.	—	Recov'd.
Carson, N. B. St. Louis Courier Med. Mar. 1887.	Male, 29.	—	—	6 hours.	Perforation of small intestine and mesentery.	Good condition.	Section; bowel sutured; drainage-tube; resected 2½ in.; peritoneal cavity not cleansed.	—	—	Died.
Case, C. E. Med. News, Sept 24, 1887, 379.	Male.	32.	—	—	Wound of entrance 2 in. from umbilicus.	— —	Section; considerable quantity of blood in cavity and a doubtful wd. of intestine.	No bad symptoms.	—	Recov'd.
Cupples. Daniel's Tex. Med. Jour. VII., 10, 163.	Female, 21.	—	Near.	1½ hours.	4 wounds of small intestine.	Shock.	Med. incision 4 in. long; large hemorrhage in cav.; time 1 hr. 55 min.	Patient died in 5 hours; reaction imperfect.	—	Died.
Dalton, H. C. Ann. Surg., 1888, VIII., 100.	22.	38.	4 or 5 ft.	2 hours.	2 perforations of stomach; 1 of left lobe of liver; considerable hemorrhage in cavity.	No shock, pain, or vomiting; pulse 82, temp. 98.8°.	Median incision; Lembert sutures (silk) to stomach; large catgut to liver; 3 sutures to wound of entrance; 4 to wound of exit.	Recovered.	—	Recov'd.
Dalton, H. C. Ann. Surg., Feb. 1889.	29.	—	—	3 hours.	15 perforations of small intestine.	Intense epigastric pain; vomiting.	Hydrogen test successful; 2 excisions of gut each 3 in.; Lembert sutures; operation 3 hours.	Death in 1 hour.	—	Died.
Dandridge. Trans. Am. Surg. Assn., 1887, 216.	Male, 30.	38.	Near.	19 hours.	External wound 1½ in. to the left and 3 in. below umbil.; 9 wounds of small intestine.	Little pain; no distention; temp. 97.4°; no vomiting.	Section; evidence of peritonitis; cavity washed out with 1-10,000 bichloride solution; time of operation 2 hours.	Died in 43 hrs.	All wounds firmly closed.	Died.
Dean, D. V. Jour. Am. Med. Assn., Nov. 1887, 579.	Male, 16.	—	—	—	Wound of intestines.	Shock.	Exploratory section; intestines sutured and cavity cleansed.	—	—	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Dennis. Med. News, 1886, 253.	Male.	32.	—	Short time.	External wound 1 in. below sternum; no intestinal injury; wound in left lobe of liver and in portal vein.	Shock.	Section, med. incision; abdom. cavity full of blood; violent hemorrhage from liver wound; failure of pulse; transfusion of 12 oz. of salt solution into radial vein.	Death in 48 hrs. from hemorrhage from large vein in transverse fissure of liver.	Brain showed signs of meningitis from alcoholism; bullet lodged in liver; lungs œdematous.	Died.
Dennis. Ibid. 254.	Female. 26.	32 Colts.	—	Short time.	External wound ½ in. to left of umbilicus; 7 wounds of small intestine; 1 of mesentery; also wound of iliac vein.	Temp. 100°; slight abdominal pain; hepatic resonance; some shock.	Section; median incision; abdominal cavity full of venous blood; uncontrollable deep-seated hemorrhage; operation had to be stopped; 7 wounds of intestine closed by Lembert sutures.	Lived 48 hours.	All wounds water tight; cavity filled with blood; ball found in psoas muscle.	Died.
Dickinson. Medical Record, Sept. 27, 1890, 345.	Male, 21.	32.	—	3 hours.	Wound of entrance 2½ in. to left and ½ in. below umbilicus; 12 perforations of intestines and omentum; 1 mesenteric art. wounded.	Respirat'n 30; pulse rapid; vomited; much shock at first, but rallied before operation.	Section; wounds closed by Lembert sutures; ball found in abdominal cav.	Death in 36 hrs.	Two other openings were found in ileum; gut above full of gas.	Died.
Douglass, Richard N. Y. Med. Jour. June 9, 1888, vol. I., 631.	Adult.	Pistol.	—	8 hours.	Wound of entrance 3 in. above umbil., 1⅛ in. to left of median line; 4 wounds of small intestine; 2 of colon; extravasation of feces; much free blood.	Profound shock; great pain; tympany; vomiting; pulse good.	Eight in. incision; Lembert suture to wounds; abdomen cleansed; no drain; operation 1½ hours.	Died in 50 hours of septic peritonitis.	—	Died.
Durante. Tr. Acad. Med., Rome, June, 1887.	Adult.	—	—	—	Gunshot wound of abdomen, and 1 perforation of small intestine.	— —	Wound closed by Lembert suture.	Recovered.	—	Recov'd.
Fenger, C. Am. Med. Assn., 1888, II., 85.	50.	—	8 feet.	6 days.	No visceral wnds. found; purulent fluid with fecal order in abdominal cavity; intense abdominal pain.	Slight shock; hydrogen test unsuccessful.	Section; incision 5 inches to right of umbilicus; abdomen partially irrigated; drained.	Peritonitis and collapse; died 8 hours after operation.	Number of abscesses were found, also intestines congested; no perforation or visceral wnds.	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Fenger, C. Am. Med. Assn., 1888, II., 48.	23.	32.	—	1½ hours.	14 perforations of small intestine; 2 abrasions of bowel; 4 wounds of mesentery; much free blood in cavity; hydrogen test successful.	Marked shock; pain in abdomen; blood from rectum.	Two resections of intestine; Czerny-Lembert suture to wounds; gas insufflation demonstrated no unclosed wounds; time of operation 2¾ hours; transfusion at end.	Died 1 hour after operation.	Another wound discovered near pylorus.	Died.
Fenger, C. N. Am. Pract., Feb. 1889, I., 85.	26.	32.	—	2½ hours.	Wound of entrance ½ in. below and 1 in. to left of umbilicus.	No shock; no pain; negative air test.	Section; no visceral wounds found.	Recovered, 12th day discharged.	—	Recov'd.
Fitzgerald, T. H. Austral. Med. Jour., 1883, V., 33.	Male, 20.	Shot-gun.	Near.	1 hour.	External wound of right lumbar region 3½ in. long; protrusion of small intestine.	Good.	Wound enlarged; 10 inches of jejunum resected and a V-shaped piece of mesentery; washed with carbolic solution; operation 1 hour.	Death in 123 hours from peritonitis; sloughing of external wound.	Bowel on line of resection perfectly united; no constriction.	Died.
Fox. Med. News, 1887, vol. 2, 567, 568.	Male, 18.	Pistol shot.	Near.	3½ hours.	External wound 1½ in. below and to the left of umbilicus; 4 wounds of small intestine; 2 wds. of transverse colon; 1 wound of meso-colon.	Fair; pulse 110, temp. 98.50°; dull pain; fluid blood in cavity.	Median incision from 2½ in. above to 4 in. below umbilicus; Lembert sutures; rubber drainage-tube; time of operation 1 hour and 10 minutes.	Discharged well in 4 weeks.	—	Recov'd.
Freyer. Deut. Med. Wosch., July 15, 1886.	Male, 19.	—	—	6 hours.	— — —	Good.	Abdominal wound enlarged.	—	—	Recov'd.
Frick, A. P. Phila. Med. Times, XVIII., 459.	Male, 57.	44.	1–2 ft.	6 days.	Entrance midway between axilla and right anterior sup. spine of ilium; 5½ inches from median line; fract. 7th, 8th, 9th ribs; long lacerated wound of liver; abscess 1½ in. deep.	Not found until 25 hours after injury; brought to hospital 2 days later; temp. 99.40°; on 3d day temp. 101; on 4th day temp. 102.60°.	Incision 6 in. long between wounds of entrance and of exit; lacerated liver tissue removed; irrigated with 1-1000 bichloride; drainage-tube; time of operation 35 minutes.	Discharge of bile for 10 days; well in 10 weeks.	—	Recov'd.
Gaston. Med. and Surg. Rept., Phila., June 12, 1886, vol. 54.	Male, 30.	—	Near.	96 hours.	External wound below end of last rib on left side; abrasion of colon.	Intense abdominal pain; on 4th day great prostration; almost pulseless; temp. 103°.	Median incision; intestines greatly distended; considerable decomposed bloody fluid in cavity.	Died soon after.	Colon so firmly bound down by adhesions that intestinal obstruction resulted.	Died.
Griffith, J. D. Ann. Surg., 1888, VIII., 100.	26.	38.	2½ ft.	6 hours.	3 perforations of small intestine; clots in cavity.	Considerable shock.	Incision 6 in. in median line; Lembert sutures used, 26 stitches.	Died.	Nothing more found.	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Griffith. Ibid.	21.	—	—	8 hours.	Two balls entered left side anterior to margin of quadratus lumborum muscle causing 2 perforations in descending colon; 11 wds. of small intestine; 2 inch wound in pyloric end of stomach and extravasation of food.	Intense shock.	Median incision 11 in.; graft from meso-colon stitched into stomach wound; could not approximate stomach end without producing pyloric stenosis; 122 Lembert sutures used; time of operation 4 hours and 20 minutes.	Did not come out of shock; died in 11½ hours.	—	Died.
Griffith. Northwest Lancet.	Male.	Gunshot.	—	—	Wound of small intestine near umbilicus.	— —	Wound enlarged; silver suture; slight escape of fecal matter through wound; bullet not found.	—	—	Recov'd.
Hamilton, G. Trans. Am. Med. Assn., 1885, II., 202.	Male, 19.	32.	—	2 hours.	Ent. wd. 1½ in. to right and 1 in. above navel; 11 wounds of small intestine; 2 of ascending colon; 1 of mesentery.	Considerable shock.	Median incision, 6 inches long; Lembert suture.	On 13th day rectal tenesmus due to fluctuating tumor in pelvis; rectal incision and 3 pints of pus evacuated.	—	Recov'd.
Heddon, J. W. Trans. Mo. State Med. Assn., 1886.	Male, 30.	—	—	—	External wound in epigastrium; wound of liver.	Great pain in side and back; dyspnœa.	Section; incision through wound 5½ in. long; piece of clothing and 4 oz. blood removed from abdomen.	Recovered with no bad symptoms.	—	Recov'd.
Jersey. Med. Rec., Oct. 16, 1886.	Male, 44.	32.	Near.	20 hours.	5 wounds of small intestine; 2 of mesentery.	Intense abdominal pain and tenderness; no tympany; pulse rapid and full; temp. 98°; no vomiting.	Median incision from 3 in. above to 9 in. below umbilicus; bloody serum in cavity; washed out with warm water.	Temp. 102°, which cont'd to 4th day, with retching, vomiting, and great restlessness.	Edges of mesenteric wound separated and sloughing.	Died.
Keen, W. W. Med. News, May 14, 1887.	Female, 18.	32.	—	8½ hours.	External wound 4½ in. above umbilicus and 3¾ in. to right of med. line; wound of liver, stomach, kidney, and of mesenteric artery and vein.	Patient pale and weak, with considerable pain; moderate tenderness; hepatic dulness not changed; vomited f3ij pure blood.	Kidney removed, but peritoneum was not sutured on account of condition (weakness) of patient; no blood or serum in cavity; no feces; no signs of peritonitis.	Patient did well for 4 days, and then had a chill; temp. 104°; next day a second chill; temp. 105.4°; belly reopened and explored; patient died on 15th day.	General peritonitis caused by gangrene of area of contusion near mesenteric border.	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Kinlock. Med. News, 1887, II., 66.	27.	—	—	2½ hours.	Four perforations of ilium; 2 perforations of jejunum; mesentery torn and perforated in two places; bleeding from mesenteric art.; much free blood in abdominal cavity.	Good.	All wounds closed by Lembert sutures; cavity cleansed and irrigated; no drain.	Died in 48 hrs.	General peritonitis; ½ pint sanguinolent fluid in cavity.	Died.
Kinlock. North Carolina Med. Jour., 1882, X., I.	Adult.	32.	—	11 hours.	Five wounds of small intestines; 2 of mesentery; blood and feces in peritoneal cavity.	Slight shock; pain in abdominal and sacral regions.	Section; wounds sutured with Lembert suture; drainage employed.	Died in 16 hrs.	Wound of bowel, not found at operation.	Died.
Kinlock. Trans. Am. Surg. Asso., 1887.	Male, 27.	38.	Near.	5 hours.	External wound 1½ in. to left of umbilicus; 6 wounds of small intestine; 2 of mesentery.	Slight shock; pulse 88; temp. 99°; condition good.	Section, median incision 8 in. in length; good condition at end of operation.	3d day, temp. 102°; slight vomiting; death on 4th day.	Abdomen much distended; no adhesions; ½ pint sanguineous fluid in cavity; gaping wound of mesentery.	Died.
Kocher. Correspondenzbl. f. Schweiz. Aerz. 1883, No. 23.	Male, 14.	—	—	3 hours.	External wound near umbilicus; perforation of stomach 1½ in. in diameter.	Severe abdominal pain; hiccough; vomiting; pallor; tympanites; collapse.	Large amount of dark blood in abdominal cavity; no aperture of exit from stomach; wounds closed by sutures of fine silk and catgut.	Recovery delayed by formation of abscess in abdominal wall.	—	Recov'd.
Kollock, C. Med. News, 1887, 480.	Male, 15½.	38.	6 feet.	7 hours.	Two wounds of colon (descending); 1 wound of small intestine.	Restless; anxious; hepatic resonance; temp. subnormal; emphysema at edges of wound.	Median incision, 3 in. long; considerable blood and fecal matter found in cavity; washed out abdomen with warm carbolic solution.	Patient recovered without a single bad symptom; sutures removed on 8th day; wound healed by 1st intention.	—	Recov'd.
Labbé. Revue d'Chirurgie, April, 1888.	Male, 29.	9 mm.	—	15 hours.	Five double perforations of ileum; 1 wound of mesenteric artery.	Cold, almost pulseless; temp. 36° C.; collapse.	Abdominal section; wound of mesenteric artery; 1½ quarts of blood and large amount of fecal matter in abdominal cavity; peritonitis begun; irrigated with boiled water; time of operation 1 hour and 10 min.	Seemed a little better after operation; but died 20 hours later.	—	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Lange. Med. News, 1887, 630.	Male, 14.	22.	Near.	24 hours.	External wound 1¼ in. below, and 1 inch to left of median line; 7 wounds of small intestine.	No shock; no pain, but great tenderness over abdomen; some tympany; pulse 112.	Abdominal incision in line of bullet wound; 4 oz. bloody fluid in cavity.	Recovered without a bad symptom.	—	Recov'd.
Link. Miss. Med. Assn., 1887.	11.	Fragment of percussion shell.	—	Shortly.	2 perforations of ileum; 2 of mesentery.	— —	Wounds sutured.	—	—	Recov'd.
Lloyd. Brit. Med. Jour., 1883, 1, 560.	Female, 19.	—	—	72 hours.	External wound to left and below umbilicus; 2 wounds of sigmoid flexure, and contused wounds of small intestine and bladder.	Little shock, no vomiting; pain.	Abdominal cavity found to contain a considerable quantity of foul smelling brown fluid; wounds stitched; drainage.	Died ½ hour after operation.	Wound of mesentery found.	Died.
Lutz. St. Louis Cour. of Med., 1886, 16, 260.	Male, 21.	22.	—	10 hours.	Seven wounds of jejunum; 4 wounds of mesentery.	— —	Abdominal section; all wounds closed with Lembert sutures.	Temperature gradually rose, and patient died 65 hours after operation.	Considerable sero-sanguineous fluid in cavity; bowels glued together; intest. wound in good condition; purulent peritonitis.	Died.
Lutz, F. J. Annals of Surgery, VII., 1888, 91.	30.	Revolver.	—	3 hours.	Four wounds of small intestine; 6 wounds of mesentery; profuse hemorrhage.	Condition good; resonance over hepatic region.	Peritoneum cleansed; Lembert sutures.	Died in 4 hours.	—	Died.
MacKellar. Lancet, 1887, 1, 37.	Male, 23.	Revolver.	18 feet.	2 hours.	External wound 2 in. above and to inner side ant. sup. spn. of ilium; 2 perforations of sigmoid flexure; contused wound of small intestine; wounds of bladder and rectum.	Pain; vomiting; no blood in urine for 12 hours; small amount of shock; symptom of peritonitis.	Exploratory incision; 2 wounds of sigmoid flexure and contused wound of small intestine; drainage; bullet found in posterior wall of bladder.	Died 12 hours after operation.	Fecal matter and clots in abdominal cavity.	Died.
Mackie, Wm. Med. News, June 9, 1888.	27.	—	—	3 hours.	Two perforations of stomach; 2 of duodenum; 2 of mesentery; 1 of meso-colon; profuse hemorrhage.	Copious blood-stained vomit; excruciating pain referred to umbilicus; successful hydrogen test.	Wounds sutured; abdomen cleansed.	Died in 36 hrs.	Septic peritonitis; 1 pint of blood-stained fluid in cavity.	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Manly. Trans. Int. Med. Congress, Med. News, Sep. 24, 1887.	39.	—	—	2 hours.	Two wounds of descending colon; wound of sup. mesenteric artery.	Abdomen much distended; evidence of fluid in cavity.	Abdominal section by median incision; double perforation of colon; wound of inferior mesenteric artery from which ½ gallon of blood escaped; artery ligated; Lembert sutures; drainage.	Abdominal wound did not unite by 1st intention; recovery delayed.	—	Recov'd.
McGraw, T. A. Ann. Surg., Nov. 1887.	Female, 24.	32.	—	9 hours.	External wound 2 in. above and internal to right anter. sup. spine of ilium; 2 wounds of ascending colon.	Bowels moderately distended; pulse 120, temp. 102°; vomited bile; no hepatic resonance.	Incision 4 in. long, parallel to fibres of external oblique; Czerny-Lembert sutures.	Temp. on 2d and 3d days 102°; 6th day 99°; discharged 6th week.	—	Recov'd.
Miles, A. B. Med. News, 1890, 690.	Male, 24.	Revolver, 32.	Suicidal.	2 hours.	Wound of entrance midway between umbilicus and symphysis pubis; much blood in peritoneal cavity; 3 mesenteric and 16 intestinal wounds.	Slight shock; abdominal pain; pulse 108.	Incision 5 inches, middle line; Lembert suture; cavity douched with boiled water.	Recovered.	—	Recov'd.
Moore, E. M., Jr. Medical Press, Western New York, April, 1889, 181.	47.	—	—	8 hours.	Five perforations of intestine; 7 of mesentery; 1 of omentum.	Some shock; unsuccessful gaseous injection.	Excision of intestines, including 3 perforations; other wds. sutured; cavity irrigated and drained.	Died in 10 hrs. of shock; operation lasted 2½ hours.	Post mortem showed nothing further.	Died.
Morton, T. G. Trans. Phila. Co. Med. Soc., vol. VIII., 1887.	36.	—	—	1½ hours.	Four wounds of stomach; 1 of transverse colon; omentum much lacerated.	No shock; some pain; vomiting blood copiously.	Lembert sutures to all wounds.	Died in 6 hours.	Large hemorrhage into left pleura from cut of intercostal artery; other wounds in same condition as after operation.	Died.
Mudd, H. H. Jour. Am. Med. Assn., 1887, 579.	Male, 17.	—	—	72 hours.	Wound of liver and stomach.	Good.	Abdominal section; wound of stomach sutured.	Died.	Wound of stomach healed; extravasation of blood in meso-colon.	Died.
Murphy, J. B. Jour. Am. Med. Assn., 1887, 579.	Male. 57.	38.	15 feet.	3 hours.	External wound, level with 9th rib and in front of axillary line; wound of liver; 2 wds. of transverse colon.	Pulse 78 (strong); no shock.	Lateral incision; fecal extravasation; the two openings in colon converted into 1 long slot; time of operation ¾ hour.	10th day dressings removed; complete primary union.	—	Recov'd.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Murphy, J. B. Ibid. March 10, 1888, 290.	Male, 26.	—	—	2 to 3 hrs.	External wound, 1½ in. below umbilicus; 11 wounds of small intestines.	Little shock; pulse 90, temp. normal; no pain; in good condition; no vomiting.	Median incision, 3½ inches long; 1½ per cent. solution of carbolic acid used in irrigating cavity; operation 2 hours.	Patient died in 7 hours.	Large amount of blood in cavity; renal artery lacerat'd.	Died.
Murphy, J. B. Ibid. 291.	Male, 22.	—	—	2 hours.	External wound 1 in. above and 2 inches to right of umbilicus; wound of liver; none of intestines.	Pulse (good vol.) 66; some shock.	Median incision; abdominal cavity full of blood and clots; time of operation 30 minutes.	Temp. did not go above 99°; ten days later bullet was removed from back; discharged well on 20th day.	—	Recov'd.
Murphy, J. B. Ibid.	Male, 26.	—	—	2 hours.	External wound, right side, just below ribs, axillary line; 2 wounds of stomach; none of intestines; 1 of mesentery.	Profound shock; collapse.	Median incision; patient had been given 2 subcutaneous injections of morph. sulph. gr. ⅓, and showed signs of opium poisoning; operation 70 minutes.	Patient died in 13 hours.	Abdominal cavity clean; no blood.	Died.
Nancrede, C. B. Phila. Acad. of Surgery, 1886.	—	—	—	—	Two wounds of stomach; 2 wounds of duodenum.	Little pain or shock; bloody vomit later.	Section; Lembert sutures used.	—	—	Died.
Ohage, N. Western Lancet, March 1, 1889, 58.	21.	—	—	7 hours.	Two perforations of stomach; large hole through spleen; much blood; perforation of diaphragm.	Great pain; vomiting of blood and food; condition, however, fair.	Sutures to gastric wound, and cautery to injury of spleen.	Died in a few hours.	Another wound of stomach discovered.	Died.
Packard, J. H. Medical News, March 26, 1887, 339.	Male, 33.	38.	Near.	18 hours.	External wound 2 in. to left and 1½ in. below umbilicus; 11 wounds of small intestines; 1 of ileocæcal valve.	Marked collapse; vomited food and slight amount of blood; pulse 120, temp. 97.5°.	Med. incision from umbilicus to just above pubis; no fecal matter in cavity; considerable blood; peritoneal cavity irrigated with bichloride of mercury 1 to 5000.	Patient steadily sank and died in 17 hours.	Slight evidence of peritonitis.	Died.
Parham, F. W. New Orleans Med. and Surg. Jour., 1887, 508.	Male, 34.	38.	Near.	½ hour.	External wound 2 in. to right of median line and 2 inches below umbilicus; 7 wounds of small intestine; also wounds of ascending colon and bladder.	Shock; rapid, small compressible pulse; great distention and rapid respiration.	Median incis. 3½ in. long; no blood or urine found; intestines not turned out; large wound of bladder felt by rectal examination; visceral wounds sutured; cavity sewed up; drainage-tube into bladder through rectum.	Death in 44 hrs. after operation.	Wound of bowel not found at operation.	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Parham, F. W. 512.	22.	—	—	3 hours.	Entrance wnd. to right of middle line and 2 in. below umbilicus; 7 wounds of small intestine, and exter. iliac artery injured.	Shock not marked; abdom. distended.	Incision 2 in. long below umbilicus; fecal extravasation; much effused blood; Lembert suture.	Died in 17½ hours.	Hemorrh. from iliac wound; bullet lodged in muscle; some extravasation along femoral sheath.	Died.
Park, A. V. Journ. Amer. Med. Assn., 1885, 5, 494.	Male, 16.	22.	45 feet.	22 hours.	External wnd. midway between symp. pubis and umbilicus; 2 in. to left; 2 wnds. of small intestines.	Great exhaustion; pulse 130, weak, temp. 100°; tympany.	Incision over wound; abdominal cavity washed out with a 1 per cent. carbolic acid solution.	Died 16 hours after operation.	Peritonitis; extravasat'd blood in cavity; contused wnd. of intestines found.	Died.
Park, Roswell. Med. News, Aug. 4, 1888, 116.	32.	—	—	6 hours.	Entrance wound just below margin of liver; shot passed through body, making its exit on the left side of back; 2 wnds. of small intestines; 1 of mesentery.	Severe shock.	Med. incision; large amount of blood in abdom. cavity; irrigated; drainage; chloroform used; Lembert sutures; time of operation 1 hour and 40 minutes.	Rallied well after operation; but died 53 hrs. after from acute pericarditis.	No peritonitis; wounds healed.	Died.
Parkes, C. T. Ann. Surg., Nov. 1887, 380.	Male, 45.	Large.	—	16 hours.	External wnd. 2 inches inner side right iliac spine; 1 large wound of small intestine.	Thoracic breathing; abdom. wall hard; fiery red blush over half of abdomen.	Median incision; suture; drain left in cavity.	Died 16 hours after operation apparently from shock.	—	Died.
Parkes, C. T. Ibid. 379.	Male, Adult.	32.	Near.	4 hours.	Five perforated wounds of small intestine; left kidney perforated and torn; vomited blood.	Moderate collapse; much vomiting.	Median incision; kidney not removed; considerable blood in peritoneal cavity.	Death in 24 hrs. after operation from bleeding from kidney wound.	—	Died.
Pickett, M. Med. Press W. N. Y., 1886, 5, 6, 1, 247.	Male, 13.	32.	—	—	External wnd. 3 inches above anterior sup. spinous proc. of ileum.	No shock.	Exploratory incision.	—	—	Recov'd.
Pirogoff. Langenbeck's Archiv. XXVII. 278.	Adult.	—	—	—	External wound near umbilicus; 4 perforat'd wounds of small intestine.	— —	Section; 4 inches of small intestine resected.	Case was lost sight of at end of 5 days, was then doing well.	—	
Pozzi. Revue de Chir., 1887, 178.	13.	7 mm.	—	8 hours.	Three wounds of small intestine; wound of bladder.	Vomiting and bloody urine.	Median incision; intraperitoneal infiltration of urine; bowel partially resected; wounds sutured; time of operation 2½ hrs.	Died 52 hours after operation.	—	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Price, M. Trans. Phila. Co. Med. Soc., 1888.	Female, 14.	—	—	24 hours.	Wound of liver and kidney.	Badly shocked.	Nephrectomy; drainage.	Liver abscesses.	—	Recov'd.
Priddy. Jour. Am. Med. Assn., IX., 649.	Male, 60.	32.	Near.	108 hours; rode a horse 4 miles after injury.	Lacerated wound of descending colon 6 inches in length; wounds of meso-colon, mesentery, and jejunum.	Profound shock; pulse rapid and weak; great abdominal pain and tympany; no vomiting; hiccough.	Median incision from umbilicus to pubis; considerable quantity of bloody serum and pus in cavity of abdomen; irrigation, bichloride solution 1 to 10000; drainage; operation lasted 55 minutes.	Collapse on table; repeated 2 days later; pulse 180; perfect recovery in 6 weeks.	—	Recov'd.
Prince, David. Trans. Am. Surg. Assn., vol. V., 1887, 212.	Male, 30.	Rifle, 22.	Long range.	2 hours.	External wound 1 in. above middle of crest of ileum; wound of colon.	Pain in right inguinal region; temp. 99.8°; evidence of shock.	Lateral incision; intestines turned out and examined; colon sutured; time of operation 1 hour and 40 min.	Following week temp. 99.5° to 102°; considerable nausea and vomiting; 18th day temp. 103°; 45th day pain severe, constipation; 372 c.c. pus aspirated.	—	Recov'd.
Prince, David. Ibid. 213.	Male, Adult.	—	—	6 hours.	Shot by a mob; 5 wnds. of intestines; 2 of bladder.	Condition fair.	Incision; wound of bowel sutured; cavity washed out.	Patient died in 12 hours after operation.	Probably acute peritonitis.	Died.
Ramsey. North West Lancet, Aug. 1885, 378.	Male, 7.	32.	—	6 hours.	External wound 2 in. to right of med. line and 3 in. above umbilicus; 1 wound of duodenum; contusion of colon; profuse extern'l hemorrhage.	Pulse 110, temp. 97°; cold, vomiting (frequent), contained no blood; blood, gall, and mucus oozed from wound.	Med. incision; abdominal cavity full of bright red blood; washed out with 1-10000 bichloride solution; Lembert sutures; temperature 100° Fahr.	Patient died 1 hour after operation, probably from hemorrhage.	—	Died.
Richardson. New Orleans Med. and Surg. Jour., XIII., 867.	Male, Adult.	38.	5.	14 hours.	External wound ¼ in. to left of umbilicus; 3 wnds. of small intestines; 1 of mesentery.	Great pain and tenderness; legs flexed; profound shock.	Incision; peritoneal cavity contained much blood, which was effused as rapidly as it was removed; operation 1½ hours.	Died 14 hours after operation in collapse.	—	Died.
Roberts, W. O. Amer. Pract. and News, 1888, VI., 5.	37.	—	—	2 hours.	Patch of emphysema size of hand around entrance wound; 4 wounds of colon.	Shock, later tympanites; umbilical pain.	Wounds sutured, irrigated, and drained.	Died in 60 hrs.	Peritonitis; drain had not worked; drunkard.	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Rodman, W. S. Amer. Pract. and News, Mar. 31, 1888, 196.	20.	—	—	2 hours.	Two wounds and 1 abrasion of small intestine; large wound of liver; bleeding from branch of superior mesenteric artery; much free blood in abdominal cavity.	Great pain and shock; collapse; peritonitis.	Abdominal section.	Died in 25 hrs.	Much blood in cavity; 2 perforations of stomach; sup. mesenteric artery wounded.	Died.
Schachner. Annals of Surgery, vol. II., 409, 1890.	Male, 20.	32.	—	—	Wound of entrance in left hypochondrium; half severed descending colon and a lumbar artery.	Belly filled with blood; condition good.	Abdominal section and suture.	Died in 12 hrs.	—	Died.
Schenck, W. L., Jr. Amer. Med. Assn., vol. II., Oct. 15, 1888, 521.	49.	42.	—	16½ hours.	External wound 4 in. to left and 2 inches above umbilicus; 9 perforations of small intestine; 1 of mesentery.	Much shock; successful hydrogen test.	Lembert sutures; abdomen cleansed; time of operation 3½ hours.	Died in 2 hrs.	No further injury.	Died.
Scott. Med. Record, XXXVIII., Nov. 8, 1890.	Male, 27.	38.	—	4 hours.	Wound of entrance 1¾ inches to right of ant. superior spinous process of ileum.	Complicated by urethritis bubo on both sides, cystitis, and bronchitis; condition otherwise good.	Abdominal section; Czerny-Lembert suture.	—	—	Recov'd.
Senn, N. Med. News, 1888, II., 203.	72.	Bull-dog pistol, 44.	Near.	4 hours.	Entrance wound in 6th left intercostal space; 7th rib fractured; 1½ inch wound in greater curvature of stomach; also perforation of posterior wall (located by gas); hemorrhage.	Partial collapse; severe pain; bloody vomit.	Successful hydrogen test; incision; Lembert sutures; abdominal cavity cleansed.	Died on table.	Bullet passed thro' pancreas and spinal canal; lodged in subcutaneous connective tissue of lumbar region.	Died.
Senn, N. Ibid. 529.	18.	22.	Facing, 40 feet.	12 hours.	Entrance wnd. in outer margin of left rectus, 1 in. below umbilicus; 5 perforations of small intestine; great amount of free blood; intestines distend. by blood clots; 4 wounds of mesentery.	Immediate pain and shock; vomiting.	Successful hydrogen test; Czerny-Lembert sutures; mesentery ligated *en masse*; abdominal cavity irrigated with ⅓ per cent. salicylic solution; operation 2 hrs.	Died 8 hours after operation.	General peritonitis; bullet found in soft tissue spinal column, betw'n 4th and 5th vertebræ.	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Senn, N. Med. News, Nov. 10, 1888, 528.	16.	Rifle, 22.	150 feet.	3 hours.	Ten perforatio's of small intestine; 4 of mesentery; 1 of anterior portion of rectum; much free blood and extravasations of feces and food; bullet brought away by rectal enema.	Some shock; pain; signs of fluid in peritoneum.	Successful hydrogen test; median incision; Lembert sutures; abdomen cleansed; glass drainage-tube; operation 2½ hours.	Recovered; discharged in 2 months.	—	Recov'd.
Senn, N. Jour. Amer. Med. Assn., Sept. 6, 1890.	Male, 14.	Rifle, 22.	A few feet.	2 hours.	Ball entered at umbilicus; 2 wounds of colon.	Good.	Czerny-Lembert sutures; drainage; insufflation successful.	Died in 5 days from peritonitis.	—	Died.
Senn, N. Ibid.	Male, 6.	Pistol, 38.	4 feet.	7 hours.	Wound of entrance ½ in. to left of linea alba and 1½ in. above umbilicus.	No shock; pain; vomited once.	Insufflation negative; wnd. of entrance enlarged; no lesions.	Recovered.	—	Recov'd.
Senn, N. Ibid.	Male, 30.	22.	—	—	Wound of entrance tip of cartilage of 7th rib, left side.	No shock; bloody urine.	Track of bullet laid open to peritoneum; gas insufflation negative.	Recovered.	—	Recov'd.
Levastopouol. Société Chir. de Paris, vol. 13, 1887, 274.	Male, 30.	5.5 mm. (Small pistol-ball.)	2 or 3 ft.	1 hour.	External wound middle of line between right iliac spine and umbilicus; large oval wound of small intestine.	Cold and pale; fecal fluid escaping from wound.	Wound enlarged to 6 in.; wounded portion resected and edges invaginated; Lembert sutures; about a quart of blood and clots in cavity; abdomen washed out with carbolic acid solution.	Patient recov'd with no bad symptoms; sutures remov'd on 8th day.	—	Recov'd.
Seymour. N. Y. Med. Jour., XLIV., 209, 1886.	Male, 16.	Rifle pistol, 0.32.	—	13 hours.	External wound 2 in. above and 1¼ in. to left of umbilicus; 2 wounds of colon; 1 wound of duodenum; 1 of mesentery.	Vomited; great prostration; severe pain but little tenderness; pulse 100.	Median incision, 4 inches above umbilicus to 3 in. below; intestine distended, brick-red color; 2 inches of colon resected; Lembert suture.	Death in 8 hrs.	Intestine slightly adherent; wound united.	Died.
Sherry, Henry. Ann. Surgery, 1888, VIII., 257.	19.	38.	Near.	4 hours.	External wound 3 in. to right and 1 inch below umbilicus; 3 perforations of colon; blood and feces in peritoneal cavity.	Pain; shock; temp. 101.8°.	Wounds sutured.	No peritonitis.	—	Recov'd.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Skelly. Ann. Surg., July, 1887, vol. 6, 49.	Male, 21.	Pistol, 32.	—	2 hours.	External wound 2 in. below and 3 in. to right of umbilicus; no wnd. of intestines; six (6) bullet wounds in different parts of body.	Pale; weak; pain in right iliac region.	Median incision from umbilicus to 1 in. above pubis; venous blood in peritoneal cavity; washed with carbolized rain water.	In bed 21 days; wound healed in 1 week, with suppuration.	—	Recov'd.
Smart, W. S. Brit. Med. Jour. 1885, 1, 379.	Male, Adult.	Revolver.	3 yards.	½ hour.	External wound right side over 6th rib, 1 in. from sternum; wound of liver.	Extreme collapse.	Gtt. 60 of laudanum; no anæsthetic; incision 2¼ in. in length over edge of cartilage of 8th rib; bullet found imbedded in liver; silk sutures used.	Seven hrs. after operation patient in extreme collapse; returned to work in 18 days.	—	Recov'd.
Stimson, Lewis A. New York Med. Jour., Oct. 26, 1889.	Male, 27.	32.	—	12¼ hours.	Perforation of colon; 2 of upper jejunum; wound of pancreas, meso-colon, stomach, and of kidney.	Slight shock; pain severe in abdomen; vomiting and bloody urine.	Abdomen opened; large quantity of bloody serum and clots found; Lembert sutures used.	Died in ½ hour.	No other wound of intestine found.	Died.
Stimson. Ibid.	Female, 20.	Flobert, 22.	—	—	Entrance wound 2½ in. to left of median line, 1½ in. below umbilicus; 2 wounds of small intestine, 2 of sigmoid flexure, artery in mesentery bleeding; quart of blood in cavity.	Vomit; epigastric distress; slight shock.	Exploratory incision thro' wound showed penetration and blood in cavity; 7 in. incision in median line; evisceration; quart of blood effused; no irrigation.	Cured.	—	Recov'd.
Stimson. Ibid.	Male, 37.	38.	—	7 hours.	— —	Did well for 24 hrs. when septicæmia set in.	Median incision; omentum ligated; cavity flush'd with hot water; Lembert suture; flakes of lymph and feces in peritoneal cavity.	Died in 48 hrs. after operation.	General peritonitis and congestion of left lung.	Died.
Stimson. Ibid.	Male, 32.	38.	—	5 hours.	Entrance ¼ in. below umbilicus; 1½ in. to right of median line; 2 wounds of ileum; feces in abdom. cavity.	Beginning peritonitis.	Abdominal section.	Recovery.	—	Recov'd.
Strong, A. B. Pittsburgh Med. Rev., 1888, 206.	20.	—	—	20 hours.	Four perforations of small intestine; cavity filled with blood; violent hemorrhage.	Shock; collapse.	Wounds sutured; cavity cleansed; drainage.	Never rallied; no post-mortem record.	—	Died.

Reference.	Age and Sex.	Size of Bullet.	Distance.	Interval between injury and operation.	Character of Injury.	Condition of Patient.	Details of Operation.	Subsequent Progress.	Autopsy.	Result.
Strong, A. B. Ann. of Surg., Nov. 1887.	25.	—	—	—	General peritonitis.	No visceral wounds.	Section; no drain.	Died.	—	Died.
Summers, J. E., Jr. Pittsburgh Med. Rev., 1888, 240.	38.	—	—	24 hours.	Wounds of liver and of kidney; abdomen full of blood.	— —	Iodoform gauze packing; abdomen cleansed.	Died in 28 hrs. of recurring hemorrhage.	—	Died.
Thorpe, V. G. Lancet, 1888, II., 1118.	Female, 39.	Revolver.	—	30 hours.	Ball passed thro' thigh and entered abdomen through right rectus muscle slightly above umbilicus.	Collapse; pale, cold, faint; pulse 100; abd. tympanitis; pain and vomiting.	Laparotomy; next day median incision from umbilicus to 3 in. below; no peritonitis.	Died in 25 hrs. after operation; 55 hours after injury.	Much blood in cavity; 2 perforations of stomach; supr. mesenteric artery injured; ball penetrated the rectus mus.	Died.
Vance, A. P. M. Pittsburgh Med. Rev., 1888, 63.	17.	—	—	1 hour.	Six large wnds. of small intestine; no blood from bladder before operation.	Great shock.	Wound was closed by continuous suture; drain.	Died in 95 hrs.	Ureter divided by ball; blood in urine after operation.	Died.
Wheaton, C. A. Western Lancet, March 1, 1889, 57.	Adult.	—	—	2 days.	Large wnd. of ascending arch of colon; notch of liver border; wound of kidney.	Rode 5 miles on horseback after injury; general peritonitis and sinki'g rapidly.	Wound sutured.	Died in 1 hour.	Another wound of posterior wall of colon found.	Died.
Whittaker. Southern Med. Rec., 1890, 366.	Male, 25.	—	—	—	Wound of entrance ¼ inch to right of umbilicus; no wounds of ileum.	Weak pulse; nausea; severe pain in belly.	Abdominal section and suture of wounds.	Ball passed in stools on 3d day.	—	Recov'd.
Willard, DeForest Trans. of Amer. Surg. Assn., Sept., 1888.	17.	—	—	4 hours.	Very extensive extraperitoneal bloody effusion; kidney perforated; bloody serum in peritoneal cavity; perforation of ureter.	Intense shock, pains in back and on left side in lumbar and inguinal regions; flat on percussion.	Nephrectomy and removal of clots.	Death in 68 hrs.; albuminuria after operation; peritonitis and incessant vomiting.	None.	Died.

SUMMARY OF THE TABLES OF GUNSHOT WOUNDS OF THE ABDOMINAL CONTENTS.[1]

Gunshot wounds of abdomen	130.	
Result not determined	1.	
Mortality of 129 cases		66.6 per cent. (86 cases).
Wounds of small intestines only	48.	
Recovered 12. Died 36.		Mortality 75 per cent.
Wounds of small and large intestines	14.	
Recovered 10. Died 4.		Mortality 28.6 per cent.
Wounds of large intestines only	8.	
Recovered 3. Died 5.		Mortality 62.5 per cent.
Wounds of stomach only	4.	
Recovered 1. Died 3.		Mortality 75 per cent.
Wounds of hollow viscera (stomach, intestines, and bladder)	15.	
Recovered 2. Died 13.		Mortality 86⅔ per cent.
Wounds of solid viscera	12.	
Recovered 5. Died 7.		Mortality 58⅓ per cent.
Wounds of solid and hollow viscera	12.	
Recovered 3. Died 9.		Mortality 75 per cent.
No visceral wound	8.	
Recovered 6. Died 2.		Mortality 25 per cent.

TIME INTERVENING BETWEEN THE INFLICTION OF THE INJURY AND SURGICAL INTERVENTION.

Two hours	24.	Recovered 11.	Died 13.	Mortality 54⅙ per cent.		
Four hours	20.	" 10.	" 10.	" 50	"	
Eight hours	21.	" 3.	" 18.	" 81.8	"	
Twelve hours	7.	" 3.	" 4.	" 57.1	"	
Twenty-four hours	22.	" 3.	" 19.	" 86.3	"	
After twenty-four hours	11.	" 2.	" 9.	" 81.8	"	

TIME INTERVENING BETWEEN OPERATION AND DEATH.

Two hours	8 cases	(shock or hemorrhage).
Four hours	2 "	" "
Eight hours	8 "	(shock or hemorrhage, except 1 from peritonitis).
Twelve hours	6 "	(shock, hemorrhage, and peritonitis).
Twenty-four hours	13 "	" " " "
After twenty-four hours	32 "	(peritonitis, intestino-peritoneal septicæmia, hemorrhage).

Death within twenty-four hours is usually due to bleeding or shock.

Death after twenty-four hours is usually due to peritonitis.

---

[1] In preparing the preceding table we freely consulted the statistics of Coe and Morton.

TIME CONSUMED IN OPERATING.

One half hour . .	2	cases.	Recovered	1.	Died	1.	Mortality	50	per	cent.
One hour	4	"	"	3.	"	1.	"	25	"	
One and a half hours	6	"	"	4.	"	2.	"	$33\frac{1}{3}$	"	
Two hours	8	"	"	2.	"	6.	"	75	"	
Two and a half hours	3	"	"	1.	"	2.	"	$66\frac{2}{3}$	"	
Three hours or more	5	"	"	0.	"	5.	"	100	"	

CALIBRE OF BULLET.

Shot by No.	22	bore.	10	cases.	Recovered	5.	Died	5.	Mortality	50 per cent.
" "	32	"	26	"	"	10.	"	16.	"	61.5 "
" "	38	"	17	"	"	9.	"	8.	"	47 "
" "	44	"	5	"	"	1.	"	4.	"	80 "

Intestines resected 10 cases. Died 10. . . . Mortality 100 per cent.

The tabulation also shows that multiple wounds and profuse internal bleeding may be accompanied by very slight shock; that comparatively slight wounds may produce profound shock. The mortality in cases of severe shock is about 90 per cent. In cases of moderate or slightly marked shock about the same as for intestinal wounds in general.

INDEX.