

POST-OPERATIVE WOUND COMPLICATIONS

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IN ANY surgical clinic wound complications occur from time to time to impede the post-operative course of the convalescent patient. Fortunately, the majority of these complications are of minor importance, responding promptly to therapy. There is, however, a smaller group of patients who, following apparently clean surgical procedures, develop a post-operative wound complication of major importance, amounting almost to a catastrophe in certain instances. There are few surgeons of experience who cannot recall such examples in their own practice.

The incidence of imperfect wounds in any surgical clinic can be ascertained only by carefully analyzing the results in all cases operated upon over a period of years. With this in mind, we have undertaken a detailed study of all the wound complications which have occurred on Surgical Service "C" at the Hospital of the University of Pennsylvania during an eleven-year period extending from September, 1922, to September, 1933.

On this service every wound is classified at the time of the patient's discharge from the hospital. Imperfect wounds are graded as Types "A," "B" and "C." Type "A" represents serum collections or minor hæmatomata which do not delay convalescence or in any way interfere with the end-result of the patient's wound. Type "B" signifies the development of a definite wound infection which does not permanently interfere with the integrity of the wound or materially delay convalescence. Type "C" is reserved for cases of wound rupture or wound infection which impair the end-result or lead to the death of the patient.

In the past eleven years, 9,155 general surgical procedures have been carried out on Service "C." During this period of time 351 imperfect wounds have been observed, a general incidence of 3.81 per cent. In the accompanying table a tabulation of the incidence of the various complications is given. (Table I.)

In undertaking this study it was the purpose to analyze the various groups of wound complications encountered in an effort to better appreciate their incidence, the etiological factors contributing to their production, the optimal methods of treatment and the end-results in each series of cases.

A review of the literature indicates that imperfect wounds occur in approximately 10 per cent. of all clean cases. Carraway¹ reports 10 per cent., McKim² 8 per cent, Goff³ 12.1 per cent., Roberts and Roberts⁴ 12.8 per cent.,

ELIASON AND McLAUGHLIN

TABLE I

Wound Complications

Service "C." September, 1922—September, 1933
Series of 9,155 Surgical Procedures

Type of Complication	Number	Per Cent.	Incidence, Per Cent.
Type "A".....	248	70.6	2.70
Type "B".....	65	18.7	.7
Type "C"			
(a) Infection.....	13	3.7	.14
(b) Wound rupture.....	25	7.1	.27
	<hr/>	<hr/>	<hr/>
	351	100.0	3.81

Thorek⁵ 7.17 per cent., Coley⁶ 12.8 per cent. and MacFarlane⁷ 7 per cent. In this day of aseptic surgery with rigorous pre-operative preparation of the surgical field and highly developed technic of closure and post-operative care, the high incidence of wound complications in the various surgical clinics is striking.

Type "A" Wound Complications.—The occurrence of serum collections in clean wounds has presented a problem since the advent of modern surgery. These collections are considered to be the result of trauma to the subcutaneous tissue at operation, either from rough handling of the tissues, careless ligation of superficial vessels, rough use of retractors or undue tension exerted by stay or tension sutures. As would be expected, serum collections are especially prone to appear in incisions made through fat abdominal walls. In Table II a tabulation of the incidence of this complication is given:

TABLE II

Type "A" Wound Complications

Surgical Condition	Number of Operations	Number of "A" Comps.	Inc. Comp., Per Cent.
Appendicitis.....	1,216	68	5.59
Inguinal hernia.....	749	65	8.67
Duodenal ulcer.....	207	36	17.39
Gall-bladder disease.....	490	15	3.06
Gastric lesions.....	95	13	13.68
Lesions of bone and joints.....	—	13	—
Femoral and incisional hernia.....	—	12	—
Diagnostic laparotomies.....	—	10	—
Breast lesions.....	—	7	—
Lesions of extremities.....	—	6	—
Pelvic lesions.....	—	3	—
	<hr/>	<hr/>	<hr/>
Totals.....	9,155	248	2.70

This group of cases was much the largest of the three, comprising 70.6 per cent. of the entire series of imperfect wounds. It includes only cases in which a sterile serum collection or a minor hæmatoma developed. This complication is especially prone to develop following certain abdominal incisions. The accompanying table (Table II) shows that the highest incidence occurred

The many sources of contamination of the surgical wound from the time of incision to complete healing have been repeatedly enumerated by the various authors discussing the subject of imperfect surgical wounds. The fact remains that in the vast majority of cases pathogenical organisms gain access to the wound by implantation, either from the outside at the time of operation, from septic material at the time of operation or from faulty technic during the post-operative care of the wound.

The sterilization of drapes, instruments, suture material and gloves has reached that degree of perfection where it is rarely possible to trace a wound infection to one of these sources. There is not quite such an unanimity of opinion regarding the correct method of preparing the surgical field. Different antiseptics have come into favor and disappeared into oblivion as their shortcomings have been demonstrated. A thorough cleansing of the patient's skin with soap and warm water prior to operation followed by the single application of one of the standard antiseptics is now accepted as an adequate procedure to obtain a sufficiently sterile operative field. On Surgical Service "C" mercurochrome compound has been employed as the skin antiseptic during recent years, with very satisfactory results.

Meleney and Stevens⁸ have called attention to the rôle played by streptococcic carriers in the production of wound infections. In investigating a series of streptococcic infections developing within a short period of time, these authors found that one-third of the operating personnel were harboring the hæmolytic streptococcus in their throats. These authors suggest that both the nose and mouth of all the operating team be adequately covered to protect against this source of wound contamination.

It is well recognized that various refinements in operative technic may do much to reduce superficial wound infections. The frequency with which a scalpel may carry organisms from the skin into the deeper layers of the wound has been referred to by Sutton,⁹ Thorek,⁵ Cox,¹⁰ Van Alstyne¹¹ and Carraway.¹ The latter author cultured a series of 562 blades used to make the skin incisions and found that 117 or 20 per cent. of them showed a positive culture.

The effect of mass ligation of fat and the use of excessive amounts of catgut in the subcutaneous tissue have been referred to by Bowman,¹² Goff,¹³ Carstens,¹³ and Cutting,¹⁴ Cabot¹⁵ and others. Keith¹⁶ and Carstens¹³ both recommend the use of narrow strips of flamed adhesive tape to obtain coaptation of the skin and subcutaneous tissue in abdominal incisions in an effort to eliminate entirely subcutaneous and skin sutures.

Recently, on Surgical Service "C," a special effort has been made to limit the amount of catgut used in the subcutaneous tissues. All small bleeding vessels have been ligated with a single tie of No. 0 plain catgut, using flat knots only on larger vessels. The use of a subcutaneous stitch for approximation of this layer has been largely obviated by employing a deeply placed vertical mattress suture of silk for the closure of the skin and subcutaneous tissues. The results have been very gratifying since the adoption of this technic.

POST-OPERATIVE WOUND COMPLICATIONS

It is generally accepted that the abdominal wall is less able to cope with infection than the peritoneal cavity. Royster¹⁷ and McKim² have recently called attention to the frequency of wound infections following removal of gangrenous non-ruptured appendices. To reduce this incidence of wound infections in cases in which septic material is handled, McKim recommends the application of "bipp" at the time of operation while Thorek⁵ and MacFarlane⁷ both recommend the use of half strength tincture of iodine in similar cases. We have recently employed 2 per cent. aqueous mercurochrome in such instances with gratifying results.

Roberts and Roberts⁴ and Valdes¹⁹ have recently reported their results in treating clean abdominal incisions by the open method without dressings. They report their incidence of perfect wounds as 87 per cent. and 94 per cent. respectively, although both series of cases were small. While there are certain attractive features in the method they outlined, it is unlikely that it will ever be widely employed because of its obvious disadvantages.

Du Mortier¹⁸ in an excellent paper has shown that the surgical wound is most susceptible to post-operative infection during the first six hours after closure. After this period the wound is progressively less susceptible to infection. He was unable to demonstrate any decrease in the resistance of the wound to infection on the fifth or sixth day when the skin sutures are removed.

An analysis of our own series of Type "B" wound infections shows that over 56 per cent. of the infections made their appearance before the sixth post-operative day. In Table IV a tabulation of the cases and their time of appearance is shown.

TABLE IV
Time of Appearance of "B" Wound Infections
(Day of Convalescence)

Day Infection Appeared	Number of Cases	Per Cent. Cases
Second day.....	8	12.3
Third day.....	5	7.6
Fourth day.....	11	16.8
Fifth day.....	13	19.8
Sixth day.....	4	6.1
Seventh day.....	5	7.6
Eighth-sixteenth days.....	14	21.4
Sixteenth day on.....	1	1.5
Day not noted.....	4	6.1
Totals.....	65	100.0

A study of the histories of these sixty-five cases discloses the fact that in fourteen or 21.5 per cent. a possible source of contamination of the wound was determined. In three cases the wounds were contaminated with the patient's excreta, in four a hæmatoma in the wound became secondarily infected while in the remaining seven cases the abdominal wound was contaminated at operation by the pathological material handled at that time. It is

interesting to note that the infection in five of the above-mentioned cases followed the removal of non-ruptured gangrenous appendices in which it was not felt necessary to drain the peritoneal cavity.

In this series of sixty-five cases, general anæsthesia was employed in forty-seven and local in eighteen instances. The tendency of local anæsthesia to predispose to wound infections has received little attention, yet nine of the fourteen hernias listed in this series were operated under novocaine anæsthesia. Realizing that herniorrhaphy incisions are particularly prone to become superficially infected, one wonders whether local anæsthesia, which is so commonly employed in these cases, may serve as a predisposing factor by lowering the resistance of the tissues about the operative site.

Positive cultures were obtained in twenty-six of the group, the organisms found being listed in Table V.

TABLE V

Type "B" Wound Infections

Report of Cultures Taken from Infections of "B" Wounds	
Organism	Number of Cases
<i>B. coli</i>	8
<i>Staphylococcus aureus</i>	7
<i>Staphylococcus albus</i>	7
<i>Hæmolyticus streptococcus</i>	3
<i>B. mucosus capsulatis</i>	1
	—
	26

NOTE.—No report on cultures taken in thirty-nine cases.

In the remaining thirty-nine cases cultures either were negative or were not taken. As might be expected, the staphylococcus and *Bacillus coli* were much the most common offenders.

All wounds which developed the signs of infection were treated promptly but conservatively. If an area of redness was seen about one or more of the skin sutures, simple section of the suture was promptly done, leaving the suture in place. Hot wet dressings were then applied continuously and in many instances the signs of infection disappeared in from one to two days. If the appearance of the wound was not definitely improved the second day, the skin sutures were removed and the wound edges sufficiently separated to provide ample drainage. Hot wet dressings were then continued. Repeated irrigations of the infected wound were strictly avoided since such therapy interferes with, rather than aids, nature's protective efforts.

We have had no experience with the closed method of treating infected surgical incisions as advocated by Watkins,^{20, 21, 22} and by Miller.²³ These authors permit the skin sutures to remain and apply moist boric acid dressings until healing occurs. Although the tendency of undrained pus to burrow and destroy underlying fascial planes is well recognized, excellent success as

POST-OPERATIVE WOUND COMPLICATIONS

far as wound healing and end-results are attributed to the closed method of treatment. It would seem that one of the basic principles of surgery is being violated, that of adequate drainage in the presence of infection.

That these so-called minor wound infections represent a real economic problem as well as an unfortunate post-operative surgical complication is not generally recognized. In this series of sixty-five cases, there was a delay of 439 hospital days in convalescence, an average of 6.75 days per patient. Stated differently, every complication of this type occurring in a ward patient cost the individual, the hospital or the state approximately \$27.00, the cost per private patient being proportionately higher.

Fortunately superficial infections of this type have little permanent effect upon the integrity of the patient's wound. In this group of sixty-five cases, post-operative hernia attributable to the wound infection developed in only four cases, an incidence of 6.1 per cent. In more serious and extensive infections, the incidence would unquestionably be higher. Boyle²⁴ states that post-operative hernia will follow in from 40 per cent. to 80 per cent. of those cases operated through rectus incisions in which a suppurative process develops and persists for over two weeks.

Type "C" Wound Complications.—Classified as Type "C" wound complications are those cases of wound rupture and grave wound infections which lead either to an impaired surgical result or death of the patient.

Thirteen cases of serious wound infection were observed in this study. In Table VI the types of surgical procedures followed by this complication are listed.

TABLE VI
Classification of Type "C" Infections

Type of Operation	Number of Cases	Lived	Died
Operations on lower extremities			
(a) Amputation diabetic gangrene . . .	4	2	2
(b) Amputation traumatic gangrene.	1	1	—
(c) Amputation carcinoma of leg	1	1	—
(d) Fracture of patella	1	1	—
Operations on biliary tract	2	1	1
Carcinoma of stomach	1	0	1
Inguinal hernia	2	2	—
Appendicitis	1	1	—
	—	—	—
	13	9 (69.2%)	4 (30.8%)

Operations on the extremities comprise over 50 per cent. of this group and of these, operations for diabetic gangrene were the most common. The striking tendency of serious infection to develop in the amputation stump of the diabetic patient has been recently stressed by one of us.²⁵ Although pus was not present at the time of operation in any of the thirteen cases, drainage was instituted in five instances. In Table VII the organisms responsible for the wound infections are noted.

TABLE VII

Type "C" Infections. Organisms Found

Organism	Number of Cases	Lived	Died
Staphylococcus.....	5	3	2
Hæmolyticus streptococcus.....	1	1	0
<i>B. welchii</i>	1	1	0
Anærobic organism (not gas).....	1	1	0
Colon and streptococcus.....	2	1	1
Totals.....	10	7	3

NOTE.—Type of organism not noted in three cases.

In each of the thirteen cases the wounds were treated by immediate removal of all skin sutures and wide separation of the wound edges. Dakinization was instituted in three instances in which an oxidizing agent was indicated to combat an anaërobic infection.

There were four deaths in this group of thirteen cases, a mortality of 30.8 per cent. In three instances the fatal outcome was partially attributable to the wound infection while in the fourth case, which died with a general peritonitis, it was felt that the peritoneal infection was secondary to the imperfect wound.

The average number of hospital days for those cases which survived the wound infection was fifty. The average length of life of the four fatal cases was 17.5 days following operation.

Post-operative Rupture of Surgical Wounds.—The subject of post-operative rupture of the surgical wound is one of great importance to everyone interested in surgery. This complication, when it occurs, presents a serious problem in the post-operative management of the patient.

Starr and Nason²⁶ state that this complication occurred in .61 per cent. of their cases following laparotomy. Finche²⁷ reports an incidence of 1.1 per cent., Meleney and Howes²⁸ 1-2 per cent., Colp²⁹ .9 per cent. and Horner³⁰ .29 per cent. in a series of 1,010 cases of cæsarean section. In our own series of 9,155 cases we have observed this complication twenty-five times, an incidence of .27 per cent. Madelung³¹ states that wound rupture occurs three times as commonly in women as in men. This does not agree with our experience since only six cases, or 24 per cent., of our series have been females.

Many contributing factors have been suggested as possible causes of wound rupture. These may be summarized as follows:

(1) Improper closure of the abdominal incision; that is, inadequate hæmostasis, failure to securely suture the peritoneum, failure to approximate the fascial layers and the use of excessive suture material in the various planes of closure.

(2) Too early discontinuation of the anæsthetic on the table with straining before all the fascial planes are closed.

(3) Overenergetic use of carbon dioxide during the final moments of the operation to prevent post-operative atelectasis.

POST-OPERATIVE WOUND COMPLICATIONS

(4) Unusual strains upon the incision during the early post-operative period from protracted vomiting, marked distention, epilepsy, delirium tremens, post-operative psychosis or post-operative pulmonary complications associated with excessive coughing.

(5) Early dissolution of suture material in non-infected cases due to defective catgut.

(6) Wound infections with resultant dissolution of suture material.

(7) Age, debility and the cachexia of neoplastic disease with retardation of the healing process.

It has been repeatedly observed that operations upon the duodenum, stomach and biliary system are the ones most frequently followed by this complication. In the accompanying table (Table VIII), the type of lesion and the extent of the wound rupture in our own series of cases is shown.

TABLE VIII

Wound Rupture, Operations in Which Rupture Occurred

Type of Operation	Cases	Extent of Rupture			Number Died
		Fascia Perit.	and Fascia	Evisc.	
Duodenal and jejunal lesions.....	11	5	3	3	4
Liver, gall-bladder and pancreas.....	6	0	4	2	2
Gastric lesions.....	4	0	2	2	2
Colon and rectum.....	2	1	0	1	0
Appendix.....	1	0	1	0	0
Spleen.....	1	0	1	0	0
Totals.....	25	6	11	8	8

Operations on the duodenum and jejunum are seen to be most frequently complicated by wound rupture in this series, yet contrary to the reports from other clinics, only one of the eleven cases of duodenal ulcer listed was a perforated ulcer.

In nineteen cases of disruption, or 76 per cent., of the series, all layers of the abdominal wall were found to have separated, being associated with evisceration in eight cases. In the remaining six cases the peritoneum alone remained intact. As would be expected incisions in the upper abdomen were those most frequently affected. In Table IX the types of incisions followed by wound rupture are listed.

TABLE IX

Wound Rupture, Type of Incision

Upper abdomen	Number of Cases
(a) Right or left rectus.....	9
(b) Paramedian.....	6
(c) Mid-line.....	4
(d) Modified Kocher.....	3
Total.....	22 or 88 per cent.

ELIASON AND McLAUGHLIN

TABLE IX—(Continued)

Lower abdomen	Number of Cases
(a) Mid-line.....	2
(b) Right or left rectus.....	1
(c) McBurney.....	0
—	
Total.....	3 or 12 per cent.

The strength of different suture materials and the effect of wound infections upon sutures has been repeatedly discussed. Goff³ has reported a lower incidence of wound infections in a series of clean cases closed with silk as contrasted with a control series closed with catgut. Howes and Harvey³² have recently pointed out the dangers of using excessive catgut in abdominal wound closure and call attention to the fallacy of using excessively heavy catgut to insure firm closure. These authors have shown that the use of mattress catgut sutures to close the fascia only increases the strength of the suture from 10–20 per cent. and does not warrant the increased amount of catgut necessary. The use of strangulating through-and-through stay sutures was abandoned several years ago in our clinic with definite improvement in the healing of the surgical incision. Lahey³³ reports a similar experience.

The type of suture material used in this series of cases is shown in the accompanying table. (Table X.)

TABLE X

Ruptured Wounds, Type of Suture Material Used

Fascial Closure	Cases	Per Cent.
(a) Interrupted chromic No. "1".....	21	84
(b) Interrupted iodine gut No. "2".....	3	12
(c) Interrupted silk No. "12".....	1	4
Silkworm gut stays plus chromic.....	4	16
Drainage employed (intraperitoneal).....	8	32

NOTE.—Only three cases were soiled (pus or intestinal content) at the time of operation.

It is well known that any catgut used for wound closure acts as a foreign body and is associated with a certain amount of reaction. In the presence of infection it rapidly loses its strength and is absorbed regardless of chromatinization. For these reasons, the use of fine silk for the closure of the fascia has been recently revived and we have been using it with very satisfactory results during the past six months.

A review of the post-operative course of this group of patients from the time of operation until the wound rupture occurred brought to light some very interesting findings. In only three instances was the immediate post-operative course listed as uneventful. In the remaining twenty-two cases (88 per cent.) there was some additional factor which served to make the patient's convalescence stormy. (Table XI.)

Post-operative pulmonary complications were present in nine, or 36 per cent., of these cases and the associated coughing exerted an undue strain upon the line of closure. Undue distention, associated with excessive vomiting

POST-OPERATIVE WOUND COMPLICATIONS

TABLE XI

Ruptured Wounds, Associated Complications

Type of Complication	Cases
Post-operative pulmonary complications	
(a) Bronchitis.....	7
(b) Broncho-pneumonia.....	1
(c) Atelectasis.....	1
Distention associated with vomiting.....	7
Delirium (alcoholic and epilepsy).....	4
Debility (extreme anæmia).....	2
	—
	22

NOTE.—Of the series of twenty-five cases only three were listed as uneventful until wound rupture occurred.

was a feature in seven cases while delirium was observed in four cases in the series. All of these factors we believe contributed definitely to the later development of the wound rupture. Stormy anæsthesia means stormy convalescence.

This complication usually makes its appearance from the fifth to the ninth post-operative day, soon after the removal of the skin sutures. It is during this period that the dissolution of suture material takes place, tension sutures are removed and other existing post-operative complications become well established.

In this series of twenty-five cases, 80 per cent. appeared from the fifth to the seventh post-operative days, no cases having developed after the eighth post-operative day.

Although wound disruption appears to develop rather suddenly from five to eight days after operation, it is probable that the deeper layers of the wound give way early in the post-operative course. Omentum is then forced into the peritoneal defect and serves to exert pressure upon the line of suture until complete rupture occurs.

Clinically these patients often continue to have abdominal discomfort after their third post-operative day. They remain distended after an enema, peristalsis is slightly hyperactive and hiccough and belching are frequent symptoms. Such a symptom complex should always lead one to inspect a deep wound rupture and to carefully observe the patient from this stand-point.

TABLE XII

Wound Rupture, Day Complication Occurred

Post-operative Day	Number of Cases	Per Cent.
Fourth.....	3	12
Fifth.....	5	20
Sixth.....	6	24
Seventh.....	9	36
Eighth.....	2	8
	—	—
Totals.....	25	100

These clinical observations are quite in keeping with the experimental work of Du Mortier¹⁸ and Howes, Sooy and Harvey³⁴ who have shown that fibroblastic proliferation in wounds develops rapidly about the sixth post-operative day with a marked increase in the strength of the wound after the preliminary "lag" period has passed.

Separation of the deeper layers of an incision may often be diagnosed by the presence of a slight fullness or bulging of the wound during the post-operative period even though the skin appears to be perfectly healed. Palpation of the incision with the gloved hand usually makes the diagnosis apparent and careful separation of the skin edges discloses the presence of omentum immediately beneath the skin.

More frequently, however, one's attention is called to this complication by the appearance of fresh blood upon the dressings later in the same day that the skin sutures are removed. Examination discloses the presence of a variable degree of separation of the skin, often with the abdominal content presenting between the wound edges.

Less frequently the patient may suddenly experience severe pain in the operative site while straining, retching or vomiting and complete rupture of the wound suddenly occurs without warning.

When wound rupture occurred, all the patients in the series were seen immediately and the wounds carefully examined.

TABLE XIII

Ruptured Wounds, Immediate Appearance of Wound

Findings on Examination	Cases	Per Cent.
Fascia separated.....	6	24
Peritoneum and fascia separated.....	11	44
Evisceration (gut in wound).....	8	32
No suture material visible.....	7	28
Sutures visible, pulled out.....	3	12
Definite evidence of infection.....	6	24
Positive cultures obtained.....	4	16

The principal findings at the time of the primary examination are listed in the accompanying table. (Table XIII.) No suture material or even cat-gut knots could be found in seven of the cases and the wound disruption in these instances has been attributed to faulty suture material. This was further suggested by the fact that four of these cases were observed within a period of a few months with the same make gut. There was evidence of infection in only six of the twenty-five cases of wound rupture, positive cultures being obtained in four instances.

When wound rupture occurs the patient is a real surgical emergency and immediate treatment is necessary. Prompt secondary suture of the abdominal incision has been recommended as the most satisfactory method of treatment by Shipley,³⁵ Clute,³⁶ Holtermann,³⁷ Starr and Nason,²⁵ Horner,³⁰ and Lahey.³³ While local anæsthesia is the choice of most surgeons as the anæsthetic agent, Starr and Nason²⁶ favor the use of spinal in all cases in

POST-OPERATIVE WOUND COMPLICATIONS

which the condition of the patient warrants its use. Heavy silk, silkworm gut and silver wire are the suture materials most commonly employed. The stitches are usually of the interrupted type and are placed through the entire thickness of the abdominal wall. In those cases in which distention makes closure difficult or impossible, the performance of a simple enterostomy after the method of Witzel may be advantageous and often lifesaving.

Lahey,³³ and Starr and Nason²⁶ state that peritoneal infection following wound rupture is rare in their experience, a certain degree of peritoneal immunity apparently having developed by the time this complication makes its appearance. For this reason they advocate closing the wound completely without drainage.

In the experience of the senior author, immediate secondary suture of a ruptured wound has not proved to be the ideal method of handling these complications. Since the majority of these patients are desperately ill when the complication occurs, any operative procedure, no matter how simple it may be, is fraught with grave danger. For this reason, what appears to be a more rational and conservative method of treating these cases was adopted some years ago.

The method employed is not new but has recently been advocated by Clute³⁶ and others as a palliative method for desperately ill cases. The wound edges and the protruding viscera are first painted with 2 per cent. aqueous mercurochrome. The omentum and gut are then gently replaced down to the level of the parietal peritoneum. The skin edges are then closely approximated with narrow strips of flamed adhesive tape and a firm dressing is applied. The procedure is almost painless and no anæsthetic is required. This dressing is then left undisturbed for a period of five days, at which time the gauze packing may be replaced and the bottom of the wound will be seen covered with a layer of healthy granulation tissue. We believe the major advantages of this method to be its simplicity, omission of an anæsthetic, the speed with which it can be carried out and the fact that a certain degree of peritoneal drainage is provided. As soon as the patient has recovered from the immediate shock of the wound disruption and there is no evidence of infection in the wound, secondary suture may be performed with a much greater degree of safety, in those cases where it is deemed advisable.

Immediate secondary suture following rupture of a surgical wound is reserved for those cases which are not particularly ill when the complication occurred.

In Table XIV the various methods of treatment employed in this series of cases are given.

A review of the literature on the subject of ruptured wounds reveals a paucity of figures on the mortality associated with this complication. Horner³⁰ quotes the mortality in four German clinics following gynæcological surgery as follows: Sherer³⁸ 75 per cent. in a series of four cases, Holtermann³⁷ 47 per cent. in fifteen cases, Madelung³¹ 22.3 per cent. and Erhardt³⁹ 20 per cent. Recently Meleney and Howes²⁸ have reported a mortality of 44 per cent. in

TABLE XIV

Wound Rupture, Treatment of the Complication

Form of Treatment	Number of Cases	Per Cent. Cases	Cases Lived	Per Cent.	Per Cent.
				Cases Lived	Cases Died
Packed, adhesive strapping.....	15	60	10	66.6	33.3
Temporary strapping, later secondary suture.....	6	24	4	66.6	33.3
Immediate secondary suture.....	4	16	3	75.0	25.0
	<u>25</u>	<u>—</u>	<u>17</u>	<u>68.0</u>	<u>32.0</u>

fifty cases, Grace⁴⁰ 39 per cent. in forty-six cases and White⁴¹ 53 per cent. in thirty cases.

In our own series of twenty-five cases, there were eight fatalities, an incidence of 32 per cent. In Table XV an analysis of the eight fatal cases is given.

TABLE XV

Wound Rupture, Analysis of Eight Fatal Cases

Type of Treatment	Number of Cases	Peritonitis	Cause of Death	
			Cardiorenal	Shock
Packed and strapped.....	5	4	1	0
Temporary packing, secondary suture.....	2	1	0	1
Immediate secondary suture....	1	0	1	—
	<u>8</u>	<u>5 (62.5%)</u>	<u>2 (25%)</u>	<u>1 (12%)</u>

It is evident that peritonitis was the major cause of death, being responsible for five of the eight cases. In only two of these five cases was a positive culture obtained from the wound at the time the wound rupture was first examined.

One of the major objections to the treatment of ruptured wounds by the method here outlined has been the high incidence of hernia following its use. It is indisputable that herniæ are more frequent with the adhesive tape method than with immediate secondary suture, but it is felt that the major problem in these cases is to get the patient safely over the immediate crisis with the least possible interference. Herniæ which develop may be subsequently repaired with comparative safety. Watkins²² and Clute³⁶ state that they have seen no herniæ following secondary suture of ruptured wounds and Lahey³³ reports that few have occurred in his experience. We have not had as uniformly satisfactory results in preventing post-operative herniæ in the small group treated by immediate secondary suture.

Prolongation of the period of hospitalization has been suggested as another objection to the adhesive tape method of treatment. In the group of cases in this series that survived the complication, the average increase in hospital days was 11.2 days. This does not seem excessive when one considers the usual condition of the patient who develops a ruptured wound.

POST-OPERATIVE WOUND COMPLICATIONS

In Table XVI the follow-up findings in fourteen cases that returned for examination are listed.

TABLE XVI
Wound Rupture, Analysis of Follow-up Results in Fourteen Cases

Treatment	Number of Cases	Hernia		No Hernia
		Large	Small	
Packed and strapped.....	9	2	2	5 (55.5%)
Secondary suture.....	5	1	0	4 (80.0%)
Totals.....	14	3	2	9 (64.2%)

NOTE.—Two cases are too recent to be accurately classified.

Of the five cases treated by immediate secondary suture one developed an incisional hernia. Of the nine cases treated by the adhesive tape method four developed incisional hernia. Although it seems surprising that the incidence of hernia is not higher following the adhesive tape method of treatment, similar results have been observed elsewhere. Starr and Nason²⁸ believe that the occurrence of hernia is entirely dependent upon the presence of sepsis at the time of the wound rupture but this can hardly be accepted in all cases. In none of the five cases in this series which developed hernia was infection a feature.

Summary and Conclusions.—In a series of 9,155 general surgical procedures, 351 imperfect wounds were observed, an incidence of 3.81 per cent. Type “A” wound complications were much the most common, comprising 70.6 per cent. of the entire group. Type “B” complications developed in sixty-five instances or 18.7 per cent. of the series. Type “C” wounds, which include the serious infections and cases of wound rupture, were encountered thirty-eight times or 10.8 per cent. of the group. Our study of these cases suggests the following conclusions:

(1) Reduction of the amount of catgut under the subcutaneous tissue has been the most important factor in reducing the incidence of serum collections.

(2) Contamination of the wound by infectious material handled at operation is one of the most frequent causes of superficial wound infection.

(3) Drainage of the superficial layers of all wounds in which soiled material is handled will materially reduce the incidence of Type “B” infections.

(4) “Wide open” drainage with adequate separation of the wound edges is the most logical and satisfactory method of handling a wound infection.

(5) No effort should be made to close amputation stumps following operations for infected diabetic gangrene in which pre-tibial oedema, extending halfway to the knee, is demonstrable.

(6) A definitely stormy post-operative course usually precedes the development of a wound rupture. This was true in 88 per cent. of our series of twenty-five cases.

(7) Wound disruption is usually observed between the fifth and eighth

post-operative days. Eighty per cent. of our series were diagnosed during this period.

(8) The treatment of ruptured wounds with packing and adhesive straps is the safest method for the patient.

(9) Peritonitis is the most common cause of death following wound disruption.

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ELIASON AND McLAUGHLIN

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