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Kaiser Permanente Medicine 50 Years Ago An Analysis of Acute Perforated Peptic Ulcers

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Acute perforations of peptic ulcers continue as one of the real emergencies of surgery which require immediate attention and prompt operation.

Incidence

During the past fourteen months 31 patients with perforated peptic ulcers were treated at the Permanente Foundation Hospital. As indicated in Table 1, 28 patients (90.4 percent of this group) were treated surgically, with no fatalities. Three patients (9.6 percent) were treated non-operatively, with two deaths and a resultant mortality of 66.6 percent. Although our series is relatively small, several factors are revealed which may account for the absence of operative mortality.

For comparison, Table 2 lists several reported series of perforated peptic ulcers and their respective operative mortality incidence. The operative mortality rate as shown in the large series collected by DeBakey⁸ of 23.4 percent can be considered as an average. The low mortality rate in the 51 cases presented by Graham³ is in a group of cases that were operated within an average of seven hours from the time of perforation, and in which a simple operative procedure was used. As will be shown later, this time interval is probably the most important single controllable factor which can reduce the operative mortality incidence in acute perforated peptic ulcers.

During the year from September 1, 1942, to September 1, 1943, there were 22 patients with acute perforated peptic ulcers among the 3516 admissions to this hospital; that is an incidence of one patient with peptic ulcer perforation for every 160 hospital admissions. During the same interval there was an average of 57,940 members of the Health Plan. This indicates an incidence of one patient with a perforated peptic ulcer to every 2633 members (or of worker population) per year.

The incidence per hospital admission of patients with perforated peptic ulcers in this group of cases is considerably higher than that of other series presented in Table 3. It is suggested that the possible increased strain placed on the men due to anxiety, poorer eating habits, irregular and abnormal working hours, which are a result of the war, may at least account for part of the increased incidence. It was shown during the famine in Russia that the incidence of ulcer perforation was increased ten-fold.¹¹ In two series reported by Riley,¹¹ and Stewart and Winsor,¹² there has been noted an increase in the number of peptic ulcer perforations in London since the onset of the war. Chamberlin and Wallace¹³ reported an increased incidence of relapses in patients with peptic ulcers while in the Army.

All of the patients in this series were males; one was a Negro, the remainder were Caucasian. Large series¹⁰ show the incidence in females to be 7 percent in comparison to 93 percent in men.

Fifty-five percent of the patients with perforated peptic ulcers were between 40 and 60 years of age; 90 percent were between 30 and 60 years of age. The patients in our series definitely fall into an older age group, which have an associated higher mortality rate. A large series of 4137 case histories with perforation collected by DeBakey⁸ had a fairly constant mortality rate of 15 to 19 percent in patients up to 40 years of age, and then showed a definite increase of 10 to 15 percent mortality for each additional decade up to 70 years of age.

Two-thirds of the patients in this series were married. One-half were moderate or heavy drinkers of alcoholic beverages, one-fourth maintained very irregular eating habits, and one-half of the patients ad-

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Table 1. Analysis of operated and non-operated cases

	Number of cases	Percent of cases	Number of deaths	Percent mortality
Operated	28	90.4	0	0.0
Non-operated	3	9.6	2	66.6
Total	31	100.0	2	6.4

Table 2. Operative mortality statistics in perforated peptic ulcers

	Year	Number of cases	Percent mortality
Ross and Letourneau ¹ (Canada)	1924-38	228	17.7
Harrison-Cooper ² (Vanderbilt Univ. Hosp.)	1925-40	57	28.0
R. R. Graham ³ (Toronto)	1929-35	51	1.9
Thompson ⁴ (Los Angeles)	1921-34	424	28.7
Henry ⁵ (Detroit)	1939-42	179	13.4
Sallick ⁶ (United States series)		74	10.8
Sallick ⁶ (European series)		3121	22.6
Eliason ⁷ (collected series)	1934	1940	25.9
DeBakey ⁸ (charity hospital)	1940	209	18.2
DeBakey ⁸ (collected series)	1940	15340	23.4
Permanente Foundation Hospital	1942-43	28	0.0

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Table 3. Incidence of perforated peptic ulcers per hospital admissions

	Number of patients	Hospital admissions	Ratio
Barber and Madden ⁹ (yearly average, 5 years)	15	3821	1:210
Berson (New York) ⁶ (total)	154	132115	1:858
(highest)		5125	1:400
(lowest)		8684	1:2070
DeBakey ¹⁰ (charity hospital) (10 years)	211	544801	1:2582
DeBakey ¹⁰ (collected series)	1290	1478445	1:1264
Permanente Foundation Hospital (1 year)	22	3516	1:160

Table 4. Incidence of peptic ulcer perforations according to age of patient

Age (years)	Operated patients	Non-operated patients	Percent of cases	Number of deaths
20-30	2		6.4	
30-40	11		35.5	
40-50	9		29.0	
50-60	6	2	25.8	1
60-70	0	1	3.2	1

mitted considerable anxiety and nervous tension for various reasons. Eighty percent worked the "swing" and "graveyard" shifts. The type of work performed was well distributed throughout the many occupations.

Symptomatology and Diagnostic Procedures

As to previous ulcer symptoms of the 28 operated patients, 18 percent manifested no symptoms up to the time of perforation, 28 percent had mild symptoms for the previous few hours or few days; the remaining 54 percent showed moderate or severe symptoms for from three months to fifteen years previous to the time of perforation.

The onset of the initial acute symptoms in every case was very sudden with either a stabbing, tearing, or "doubling-up" epigastric pain. Only three patients, who were seen seven and one-half hours, nine, and twelve hours following the onset of severe symptoms were fairly comfortable when admitted. About 25 percent of the patients complained of severe shoulder or neck pain. Except in two instances, the almost pathognomonic "board-like" abdomen was invariably present. Vomiting occurred in one-half of the patients; markedly di-

minished or absent peristalsis was present in all.

The admittance temperature varied from 97.2 to 100 degrees (F), the majority averaging 98.6 degrees (F). Except in two patients, the admittance pulse rate was under 100 per minute. The respiratory rate on admission varied from 20 to 26 per minute. The blood pressure was within normal range in all but one patient with hypertensive heart disease.

The laboratory studies on admittance revealed the hemoglobin to vary from 62 percent to 114 percent; in two-thirds of the patients the hemoglobin was above 90 percent. The leukocyte count varied from 15,000 to 25,000 cells per cubic millimeter in 60 percent of the patients; the highest was 32,200 and the lowest 5900 cells per cubic millimeter. The percent neutrophil count was above 80 in 64 percent of the patients and was between 50 and 70 in 19 percent of the patients; the highest was 94 percent neutrophils and the lowest 57 percent. The percent stab cell count was below 10 in one-fourth of the patients, and between 20 and 40 percent in one-half of the patients; the lowest was 2 percent and the highest was 43 percent. Of interest are two patients whose leukocyte count changed from 12,900 to 16,850 cells per cubic millimeter, and from 5900 to 22,000 cells per cubic millimeter in a two-hour period.

Roentgenography revealed a pneumoperitoneum in two-thirds of the patients. Of those that had no demonstrable free air, one-half had received only a view of the diaphragm in the upright position. In nine patients the free air was visible under the right diaphragm, in three patients it was visible only under the left diaphragm, and in eight patients it was seen under both.

In a study of 227 cases, Hartzel and Williams¹⁴ reported 76.2 percent to be positive for free air in the abdomen with roentgenograms taken in the upright position, and 89.7 percent positive when taken in the left lateral decubitus position. Roentgenography should be performed in both the upright and left lateral decubitus positions in order to attempt to reveal free air in the peritoneal cavity.

Of the 28 patients with perforated peptic ulcers proven by surgery, 26 were diagnosed as such preoperatively, one patient was diagnosed as probable acute perforative appendicitis and improbable perforated peptic ulcer, and the other as probable perforated carcinoma of the stomach. In the literature,⁸ incorrect diagnoses are reported in from 10 to 15 percent of the larger series of perforated peptic ulcers.

Surgical Management

The interval from time of perforation to time of operation is probably the most important controllable single factor which can diminish the mortality in perforated peptic ulcers. Sixty percent of our patients were operated within six hours of the time of perforation (Table 5), and 94 percent were operated

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within twelve hours from the time of perforation. An analysis of the relationship between mortality rate and the interval between the time of ulcer perforation and time of surgery is shown in Table 5.

A study of Table 6 reveals that the mortality incidence doubles for every six-hour period from the time of perforation to the time of surgery; after twenty-four hours the mortality rate is maintained at the high rate of over 60 percent. Prompt diagnosis and immediate surgery is indicated.

At surgery the perforation was found to be in the duodenum in 18 patients. Ten patients had gastric ulcer perforations, which were demonstrated to be in the pylorus in three patients, in the prepyloric region in two patients, and in the fundus in five patients. The ratio of duodenal to gastric ulcer perforations of 2:1 is similar or slightly lower to that reported^{1,8,10} in most series of perforated gastroduodenal ulcers. All perforation sites were anterior in location. In two-thirds of the patients the size of the perforation was from 1 to 3 millimeters in diameter. The diameter of the area of surrounding induration varied from 1 to 3 centimeters. In only one-fourth of the patients was there a small quantity of gastroduodenal contents free in the peritoneal cavity.

Spinal anesthesia seems to be the favored anesthetic by the majority of surgeons⁸ for patients with perforated peptic ulcers and was used in all but two of the operated patients in this series.

A simple closure of the site of perforation was performed in all of the patients. In 23 patients the site of perforation was closed with Lembert sutures, and omentum was fixed to the suture line. In one instance a pyloroplasty was performed. In five patients the perforation was not closed, and omentum only was placed over the site of perforation and held with interrupted sutures. Cotton sutures No. 40 were used throughout in the majority of instances. In all except two patients, sulfonamides were used intraperitoneally. Ten grams of sulfathiazole were distributed intraperitoneally, and five grams were placed in the abdominal wound. No drains were used in the peritoneal cavity or wound.

We feel that a simple procedure should be the one of choice for an emergency operation, and not an extensive radical operative procedure as is favored by many European surgeons.⁸ Extensive procedures should be reserved specifically for well-trained gastric surgeons, and then only in selected patients. Our follow-up studies, and those of other series,^{3,8} indicate that good results are obtained with simple procedures. Graham³ in his series of 51 patients with a low mortality incidence of 1.9 percent does not close the site of perforation but merely sutures omentum over the defect. We have used a similar technique in our last five patients with excellent results. Several of these have had follow-up gastro-intestinal series and show the

usual deformity found in the patients in which the perforation was closed with Lembert sutures. This technique should be favored in pyloric and duodenal perforations with marked surrounding induration.

Smears and cultures were taken of the peritoneal contents of seven patients at the time of surgery. Almost one-half of the cultures were positive, and all were taken within nine hours from the time of perforation (see Table 7).

According to series collected by DeBakery,¹⁰ Graham,³ and Henry,⁵ it would seem that during the first six to twelve hours the peritoneal cultures will frequently be sterile, whereas after twelve hours they will probably be positive. When positive cultures were obtained, their series indicated that the mortality rate greatly increased.

Postoperative Management

The main factors in the postoperative treatment consisted of the immediate installation of a Wangenstein type of suction, and the administration of intravenous fluids fortified with vitamins. This was continued for two to three days or until there was less than 150 cubic centimeters of gastric residue after four hours trial without gastric suction. The following routine was then followed: on date of removal of the indwelling tube, the patient was given 1 ounce of water every hour; the day following he was given 2 ounces of water every hour in the morning, and 3 ounces in the afternoon; to this on the following day was added a coddled egg in the morning, and a baked potato in the afternoon; and finally on the next postoperative day he was fed six small feedings a day of a gastro-enterostomy diet which consisted mainly of soft solids, rather than liquids. This

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Table 5. Interval from time of perforation to time of operation

Interval (hours)	Number of cases	Percent of cases
0-3	1	3.5
3-6	17	60.6
0-6	18	64.1
6-9	5	18.0
9-12	3	10.7
6-12	8	28.7
12-15	2	7.1
Total	28	

Table 6. Mortality rate according to interval from time of perforation to time of surgery

	Time interval											
	0-6 hours		7-12 hours		13-18 hours		19-24 hours		24-48 hours		Over 48 hours	
	Number of cases	Percent mortality	Number of cases	Percent mortality	Number of cases	Percent mortality	Number of cases	Percent mortality	Number of cases	Percent mortality	Number of cases	Percent mortality
Barber and Madden ⁵	86	0.0	39	18.0	9	33.3	1	0.0	1	100.0	1	0.0
Berson ⁶ (New York)	146	5.2	48	74.2			10	30.0				75.0
Thompson ⁴ (Los Angeles)	425	21.5	168	22.0								
Eliason ⁷ (U.S. series)	167	7.7	48	29.1			30	70.0			47	65.9
Eliason ⁷ (foreign series 1934)	152	7.2	115	21.7			10	60.0			6	75.0
Eliason ⁷ (U.S. and foreign total)	329	7.5	163	23.9			40	67.5			53	66.0
DeBailey ⁸ (New Orleans)	7683	10.5	1830	21.4	179	38.5	85	62.4		(24+ hours)		61.5
Graham ³ (Toronto)			51	1.9								
Permanente Foundation Hospital	28	0.0	8	0.0	2	0.0						

diet was continued until dismissal. On about the eighth post-operative day, an antacid was administered.

During the time the gastric suction was functioning, 2.5 grams of sodium sulfadiazine were given intravenously three times per day. Following removal of the gastric suction, 2 grams of sulfadiazine were administered orally every six hours until the patient's temperature had remained at normal for one to two days. The blood sulfadiazine concentration was usually maintained at from 10 to 14 milligrams per hundred cubic centimeters.

The average highest temperature was 101 degrees (F) to 102 degrees (F). A normal temperature was maintained after the sixth to tenth postoperative day in the majority of patients. The average highest pulse rate was 116 to 130 per minute and was usually maintained at normal values after the eighth to tenth postoperative day. The average highest respiratory rate was 30 per minute, and the normal rate was usually maintained after the fifth to seventh postoperative day.

The majority of patients were dismissed from the hospital on the fourteenth postoperative day. One remained in the hospital thirty-five days due to a subphrenic abscess.

Wound infections developed in four patients, one of which remained in the hospital twenty-five days; the other three had only slight purulent drainage and were dismissed on the fourteenth postoperative day. Postoperative atelectasis occurred in two patients; bronchopneumonia, right subphrenic abscess, rectal induration with no abscess formation, incisional hernia, and an exacerbation of hyperthyroidism each occurred in one patient. Pulmonary complications and peritonitis should be recognized early and guarded against as they account for 75 percent of the causes¹⁰ of death and 60 percent of the complications.

Two-thirds of the patients resumed work in five weeks. The remainder, except for two, were working by the seventh postoperative week.

After dismissal the patients were maintained on a diet of antacid therapy for six months. The ingestion of alcohol and the smoking of tobacco were advised against.

Follow-up Studies

Only one of 25 patients, who have been followed from one to twelve months postoperatively, has had a recurrence of any ulcer symptoms.

In 19 patients upper gastro-intestinal roentgenologic studies were performed after a postoperative interval varying from two to twelve months. Seven patients were examined two to six months postoperatively, and 12 patients were studied six to twelve months postoperatively. All of these patients showed a deformity of the duodenal cap, suggesting old scarring or a chronic duode-



Hours perforated	Type of examination	Number of cases	Number sterile	Number positive	Organisms
0-3	smear	2	1	1	Yeast and gram positive cocci in short chains
	culture	2	0	2	(a) Staphylococcus albus (b) Non-hemolytic streptococci and yeast
3-6	smear	3	3	0	
	culture	3	3	0	
6-9	smear	2	2	0	
	culture	2	1	1	Streptococcus Viridans

nal ulcer. In none were there roentgenographic signs of activity of the ulcer. All had a normal gastric emptying time of within four hours. Two patients manifested a marked duodenal narrowing; in one a duodenal perforation had been repaired three months previously, and in the other a pyloric perforation had been repaired eleven months previously. Each of two patients, one four months and the other twelve months postoperatively, showed a pre-pyloric and duodenal roentgenographic deformity. Other series¹⁵ have reported similar findings.

In 13 patients gastric analyses were performed from two to twelve months postoperatively. Using the figures presented by Gradwohl¹⁶ as the normal, free gastric acidity ranges from 40 to 70 degrees. The following are noted in Table 9: of the 11 patients with duodenal perforations, 8 were normal, 2 low, and 1 was high in free gastric acidity; in regards to total acidity, 7 were normal, 3 low, and 1 was high. One patient with a duodenal ulcer had a complete absence of free acid and a very low total acidity.

The patients with pyloric and prepyloric perforations showed normal gastric acidity.

Non-operative Patients

Of the three patients who were not operated upon, two were admitted to the hospital in severe shock, and contemplation of surgery was impossible. The ulcer in one had been perforated for eleven hours, and the patient expired eight hours following admittance. The ulcer in the other had been perforated seventy-two hours, and the patient expired twelve hours following admittance. The ulcer in the third non-operative case had been perforated sixteen hours previous to admittance. The symptoms were subsiding, the clinical findings were only moderately severe, roentgenograms showed the presence of pneumoperitoneum, and the patient was quite comfortable. It was concluded that the perforation was well walled off by omentum, and he was voluntarily treated non-operatively. Sulfadiazine and other postoperative treatment previously mentioned was carried out, and an uneventful recovery was made by the patient.

Conclusions

A prompt correct diagnosis and immediate surgery is of prime importance in a patient with a perforated peptic ulcer. The mortality rate increases with the length of interval between the time of ulcer perforation and time of surgery. Roentgenographic studies in the upright and left lateral decubitus position should be performed to demonstrate a pneumoperitoneum.

A simple operative procedure should be used, preferably only the fixation of omentum without any attempt to close the site of perforation in patients with perforated pyloric and duodenal ulcers. Sulfathiazole should be used intraperitoneally and in the abdominal wound at the time of surgery, and sulfadiazine should be given intravenously following surgery. Sulfadiazine may also be of value if given intravenously before surgery.

Every attempt should be made to prevent complications, especially peritonitis and pulmonary conditions which together account for about 75 percent of deaths in perforated peptic ulcers.

Non-operative treatment should be rendered in perforated peptic ulcers only (1) when the patient shows definite signs of improvement both symptom-

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Months postoperative	Number of cases	Length of follow-up (months)	Symptoms
12	9	12	none
12	2	1	none
12	1	2	none
6	2	6	none
6	1	6	moderate
4	4	4	none
2	4	2	none
1	4	1	none

atically and clinically, and there is a definite "walling off" of the ulceration, or (2) when the patient's condition is too poor to permit operation.

We believe that our absence of operative mortality can be accounted for by the observation of the above controllable factors in patients with perforated peptic ulcers.

The recurrence of symptoms in patients operated upon for perforated peptic ulcers was infrequent. Gastric acidity rapidly returned to normal following operation. Follow-up gastro-intestinal roentgenograms showed a persistent deformity at the site of perforation suggesting scarring or a chronic gastroduodenal ulceration.

Summary

A review of 31 patients with perforated peptic ulcer treated at the Permanente Foundation Hospital revealed the following:

1. The operative mortality rate was zero percent in 28 operated patients.
2. The non-operative mortality rate was 66.6 percent in three patients treated without surgery.
3. The incidence of perforated peptic ulcer is 1 for every 160 hospital admissions. The incidence in the general worker population is 1 for every 2633 persons per year.

4. All of the perforations occurred in males.
5. Fifty-five percent of the patients were between 40 and 60 years of age; 90 percent were between 30 and 60 years of age.
6. Eighteen percent of the patients had no symptoms previous to the time of perforation.
7. Roentgenography revealed the presence of a pneumoperitoneum in two-thirds of patients.
8. Of the 28 patients with perforated peptic ulcers proven by surgery, 26 were diagnosed as such preoperatively.
9. Sixty percent of the patients were operated upon within six hours of the time of perforation, and 94 percent were operated upon within twelve hours of the time of perforation.
10. Perforations of the duodenum were twice as frequent as those of the stomach.
11. A simple closure of the site of perforation was performed in every patient.
12. Sulfathiazole was used intraperitoneally and in the abdominal wound during surgery, and sulfadiazine intravenously following surgery.
13. Ten postoperative complications occurred.
14. Only one of the operated patients had a recurrence of ulcer symptoms.

Table 9. Postoperative gastric analyses

Site of perforation	Months post-operative	Gastric acidity (degrees)					
		Fasting		60 minutes after alcohol meal		60 minutes after histamine	
		Free	Total	Free	Total	Free	Total
Duodenum	2	0	13	15	26		
Duodenum	2	38	50	98	110		
Duodenum	4	0	5	0	8	0	8
Duodenum	6	25	38	30	43		
Duodenum	6	0	8	18	30		
Duodenum	6	0	9	7	23		
Duodenum	9	70	83	75	83		
Duodenum	9	17	36	11	27		
Duodenum	11	42	58	52	68		
Duodenum	12	0	10	4	15	38	47
Duodenum	12	0	16	34	49		
Pylorus	3	7	20	29	54		
Prepylorus	11	0	8	41	51		

Bibliography

1. Ross, A., and Letourneau, Charles: Perforated Peptic Ulcers (228 cases), *Canad. M.A.J.*, 41:473-479 (Nov.) 1939.
2. Harrison, A., and Cooper, F.W.: Immediate and Late Results of Perforation of Peptic Ulcers, *Ann. Surg.* 194 (Aug.) 1942.
3. Graham, Roscoe R.: Treatment of Perforated Duodenal Ulcers, *Surg., Gynec. & Obst.* 64:235.
4. Thompson, Harold L.: Acute Perforation Peptic Ulcers, *J.A.M.A.* (Dec. 2) 1939, p. 2015.
5. Henry, Charles M.: Peritoneal Fluid and Gastric Contents in Cases of Perforated Peptic Ulcers, *Arch. Surg.* 45:565 (July) (Dec.) 1943.
6. Berson, Lewis H., Brooklyn, N.Y.: Acute Perforated Peptic Ulcers (18 years survey), *Am. J. Surg.* 56:385-394 (May) 1942.
7. Eliason, E.L., and Ebeling, W.W.: Catastrophes of Peptic Ulcers, *Am. J. Surg.* 24:63 (June) 1934.
8. DeBakey, Michael: Acute Perforated Gastroduodenal Ulceration, *Surgery* 8:1028-1076 (Dec.) 1940.
9. Barber, Robert F., and Madden, John L.: Acute Gastroduodenal Perforation, *Am. J. Surg.* 59:484-495 (March) 1943.
10. DeBakey, Michael: Acute Perforated Gastroduodenal Ulceration, *Surgery* 8:852 (Nov.) 1940.
11. Riley, Ian D.: Perforated Peptic Ulcer in War Time, *Lancet* 485 (Oct.24) 1942.
12. Chamberlin, D.T., and Wallace, W.C.: Perforated Peptic Ulcer in an Army Hospital, *Mil. Surgeon* 92:193, 1943.
13. Williams, A. Justin, and Hartzell, Homer V.: Perforated Peptic Ulcers, a More Accurate Method of Roentgen Diagnosis, *Surg., Gynec. & Obst.* 71:606 (Nov.) 1942.
14. Lewisohn, R.: Persistence of Duodenal Ulcers After Suture of an Acute Perforation, *Surg., Gynec. & Obst.* 64: (Jan.) (June) 1937.



Perforated Peptic Ulcer

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Despite the decline in peptic ulcer disease in this country and Western Europe over the past 30 years, the incidence of its complications remains much the same.¹ The decline started before the advent of Histamine #2 Receptor Antagonists (H2RA). The incidence of perforation remains in the range of 5% to 10%, and the associated mortality is still approximately 10%.

Perforation constitutes a serious surgical emergency. Although some have advocated nonoperative therapy,² urgent operative intervention after adequate resuscitation is the appropriate treatment for all but a few carefully selected patients. Of all aspects of surgical management, time from onset of perforation to time of operation remains the most important.

In Nannini's study from over 50 years ago, at the Permanente Foundation Hospital, Oakland, 31 patients were treated for perforated gastroduodenal ulcer: 28 patients were treated operatively with no mortality, and 2 deaths occurred among 3 patients treated nonoperatively.³ Of the 28 patients, Nannini described 10 as having gastric ulcer. According to current definition, an ulcer within 3 cm proximal to the pylorus behaves as a duodenal ulcer and should be treated as such; by this definition, Nannini, in fact, treated 23 duodenal ulcers and 5 gastric ulcers.

Because of the small numbers, the mortality rate in Nannini's series should not be compared to the larger studies, either of his era or our own. Nevertheless, Nannini's paper has much to teach us today. Clinical presentation and diagnosis are much the same. Based on his careful analysis, Nannini's chief observation that early surgery saves lives is astute. Table 2 shows relative mortality in perforated peptic ulcer as reported in several contemporaneous studies. Table 6 shows that the timing of operation is related to mortality.

The vastly superior intensive care given today and the availability of antibiotics have in no way changed the objective: early treatment within the timeframes suggested by Nannini. I believe an important observation to make about the paper is the fact that Nannini set out to answer some basic questions by the careful collection and analysis of data. That he did this in an era when surgeons typically practiced what they had been taught and did so without question is a great tribute and establishes him as a pioneer.

Today, we know that early operative treatment is but one of three important factors which together predict with 94% accuracy the outcome of surgery:

presence of preoperative shock, presence of concurrent illness, and perforation remaining untreated for more than 24 hours.⁴

In the study by Boey et al,⁴ mortality was 0% with no risk factors, 10% with 1, 45% with 2, and 100% with all 3 of the above risk factors. All risk factors are readily identifiable when clinically assessed. Somewhat surprisingly, age >70 yr and gross peritoneal soiling did not increase operative risk, and furthermore neither of these two factors affected the outcome of definitive surgery.

All 28 of Nannini's patients were treated with simple closure. For the first 23 patients, closure was achieved using Lembert's suture technique, a procedure no longer encouraged. For the last 5 patients, closure was achieved using the Graham patch omentoplasty (which, at the time, had been only recently described). To this day, the Graham patch is a standard procedure and is the safety standard to which other procedures are compared. Simple closure remained the standard in the United States and in the United Kingdom until the late 50s. However in Central Europe (and particularly in Russia), gastrectomy was widely practiced as treatment for perforation in the 1940s and 1950s.

With regard to the perforated duodenal ulcer, the area of major change in management in this country between the 40s and today is the role of definitive surgery. Before definitive surgery is undertaken, three criteria should be satisfied: The patient should be able to tolerate the procedure with no added risk; the procedure should add excellent protection against recurrent ulceration; and undesirable long-term sequelae should be minimal. Many surgeons would add to this list the criterion that the ulcer must be chronic.

Long-term follow-up after simple closure has shown a recurrent ulcer rate of almost 80%.⁵ Griffin and Organ⁶ have confirmed that simple closure carries with it a very high chance of poor long-term outcome: In this study of 122 patients, 48% either suffered death from complications of recurrent ulcer, required further surgery for ulcer disease, or required ongoing medical treatment for recurrent ulcer.

These studies were published before the advent of H2RA, and we might wonder whether simple closure combined with a lifetime use of H2RA would be effective therapy. This possibility has been examined and presents two problems. First, compliance with long-term drug therapy is variable; second, such treatment is considerably more costly than effective definitive surgery.⁷ The role of definitive surgery has been studied extensively, and I shall briefly try to place it in perspective.

Three procedures are practiced most commonly: truncal vagotomy with pyloroplasty, proximal gastric

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“... few surgical residents graduating from programs in this country today—and indeed, in the past fifteen years—have been adequately trained in elective ulcer surgery.”

vagotomy with patch omentoplasty, and truncal vagotomy with distal gastrectomy. Proximal gastric vagotomy is also known as parietal cell vagotomy and as highly selective vagotomy. The surgical literature of the past two decades is replete with excellent studies showing that these procedures meet all the aforementioned criteria for definitive surgery.⁸⁻¹² Selecting the appropriate definitive operation is beyond the scope of the article, and readers may refer to any of many excellent studies to help form an opinion.

Perforation of an acute ulcer, as opposed to a chronic ulcer, is widely believed to be best treated by simple closure and in this situation, definitive surgery is considered too aggressive. However, at laparotomy, to conclude that perforation has occurred in an acute ulcer is subjective. It is certainly appropriate to practice simple closure of a perforated duodenal ulcer that “looks acute,” in a patient who denies previous symptoms and who has not been taking nonsteroidal anti-inflammatory agents (NSAIDs).

However, Boey et al⁸ have shown that after 5 years of follow-up, perforated ulcers, both acute and chronic, which were treated by simple closure, in fact have a recurrence rate of approximately 50%. This certainly gives credence to the use of definitive surgery for acute ulcer perforation.

Today, the question of safely performing a definitive surgical procedure for perforation has more to do with surgical experience and skill than anything else. A good gastric surgeon using good judgment can perform definitive surgery whose mortality rate is less than 2%. In contrast, few surgical residents graduating from programs in this country today—and indeed, in the past 15 years—have been adequately trained in elective ulcer surgery. The cohort of surgeons competent to perform this surgery is diminishing yearly.

To this reviewer, the correct conclusion regarding perforated duodenal ulcer seems clear: Definitive surgery is safe and effective, when done by a well-trained gastric surgeon, but use of the Graham patch remains the standard of care today as it was for Nannini 50 years ago.

Compared with duodenal ulcer, gastric ulcer is less common and has a higher rate of mortality when perforation occurs.¹³ One study¹⁴ showed a mortality rate of 29% among 128 patients treated with simple closure and 11% among 53 patients treated with gastrectomy. All 10 patients who were treated medically—and who were presumably the sickest patients—died. The mortality rate was 53% among patients who were

in preoperative shock. The same predictive factors apply to definitive surgery, and in general, Billroth I gastrectomy is the preferable operation. If definitive surgery is not done, excision of the ulcer to rule out malignancy is strongly recommended.

This brief review of perforated gastroduodenal ulcer disease gives a short historical perspective and reasonable options for surgical management today. Reviewing Dr. Nannini’s paper I am reminded of the words of Isaac Newton: “If I have seen further ... it is by standing upon the shoulders of Giants.”

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References

1. Bardhan K, Cust G, Hinchliffe RF, Williamson FM, Lyon C, Bose K. Changing pattern of admissions and operations for duodenal ulcer. *Br J Surg* 1989;76:230-6.
2. Taylor H. Guest Lecture: The non-surgical treatment of perforated peptic ulcer. *Gastroenterology* 1957;33:353-68.
3. Nannini LD. An analysis of acute perforated peptic ulcers. *Permanente Foundation Medical Bulletin* 1944;2(1):1-11.
4. Boey J, Choy SK, Poon A, Alagaratnam TT. Risk stratification in perforated duodenal ulcers: a prospective validation of predictive factors. *Ann Surg* 1987;205:22-6.
5. Wangenstein SL, Wray RC, Golder GT. Perforated duodenal ulcer. *Am J Surg* 1972;123:538-42.
6. Griffin GE, Organ CH Jr. The natural history of the perforated duodenal ulcer treated by suture plication. *Ann Surg* 1976;183:382-5.
7. Sonnenberg A. Costs of medical and surgical treatment of duodenal ulcer. *Gastroenterology* 1989;96:1445-52.
8. Boey J, Branicki FJ, Alagaratnam TT, Fok PJ, Choi S, Poon A, et al. Proximal gastric vagotomy: the preferred operation for perforations in acute duodenal ulcer. *Ann Surg* 1988;208:169-74.
9. Jordan PH Jr. An interim report on parietal cell vagotomy versus selective vagotomy and antrectomy for treatment of duodenal ulcer. *Ann Surg* 1979;189:643-53.
10. Jordan PH Jr. Surgical management of acute complications from peptic ulcer disease. In: Najarian JS, Delaney JP, editors. *Advances in gastrointestinal surgery*. Chicago: Year Book Med; 1984. p. 167-76.
11. Tanphiphat C, Tanprayoon T, Na Thalang A. Surgical treatment of perforated duodenal ulcer: a prospective trial between simple closure and definitive surgery. *Br J Surg* 1985;72:370-2.
12. Christiansen J, Andersen OB, Bonnesen T, Baekgaard N. Perforated duodenal ulcer managed by simple closure versus closure and proximal gastric vagotomy. *Br J Surg* 1987;74:286-7.
13. Svanes C, Salvesen H, Espehaug B, Soreide O, Svanes K. A multifactorial analysis of factors related to lethality after treatment of perforated gastroduodenal ulcer. 1935-1985. *Ann Surg* 1989;209:418-23.
14. Hodnett RM, Gonzalez F, Lee WC, Nance FC, Deboisblanc R. The need for definitive therapy in the management of perforated gastric ulcers: review of 202 cases. *Ann Surg* 1989;109:36-9.