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 DeBakey of 23.4 percent can be considered as an average. The low mortality rate in the 51 cases presented by Graham 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. In two series reported by Riley and Stewart and Winsor, there has been noted an increase in the number of peptic ulcer perforations in London since the onset of the war. Chamberlin and Wallace 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 series 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 DeBakey 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 admitted to have taken aspirin.
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.

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 admitted 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**

In a study of 227 cases, Hartzel and Williams 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, 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...
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 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 surgeons 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 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. 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, indicate that good results are obtained with simple procedures. Graham 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, Graham, and Henry, 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 Wangensteen 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

<table>
<thead>
<tr>
<th>Interval (hours)</th>
<th>Number of cases</th>
<th>Percent of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>3-6</td>
<td>17</td>
<td>60.6</td>
</tr>
<tr>
<td>0-6</td>
<td>18</td>
<td>64.1</td>
</tr>
<tr>
<td>6-9</td>
<td>5</td>
<td>18.0</td>
</tr>
<tr>
<td>9-12</td>
<td>3</td>
<td>10.7</td>
</tr>
<tr>
<td>6-12</td>
<td>8</td>
<td>28.7</td>
</tr>
<tr>
<td>12-15</td>
<td>2</td>
<td>7.1</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>
The Permanente Journal / Winter 1999 / Volume 3 No. 1

Clinical contributions

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 causes 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-
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 series have reported similar findings.

In 13 patients gastric analyses were performed from two to twelve months postoperatively. Using the figures presented by Gradwohl 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 admission. The ulcer in the other had been perforated seventy-two hours, and the patient expired twelve hours following admission. The ulcer in the third non-operative case had been perforated sixteen hours previous to admission. 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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**Table 7. Bacteriological examination of peritoneal fluid**

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

---

**Table 8. Follow-up summary regarding recurrence of symptoms**

<table>
<thead>
<tr>
<th>Months postoperative</th>
<th>Number of cases</th>
<th>Length of follow-up (months)</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>9</td>
<td>12</td>
<td>none</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>1</td>
<td>none</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>2</td>
<td>none</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>6</td>
<td>none</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>6</td>
<td>moderate</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>2</td>
<td>none</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>none</td>
</tr>
</tbody>
</table>
atrically 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

<table>
<thead>
<tr>
<th>Site of perforation</th>
<th>Months post-operative</th>
<th>Gastric acidity (degrees)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Fasting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free</td>
</tr>
<tr>
<td>Duodenum</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Duodenum</td>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>Duodenum</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Duodenum</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Duodenum</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Duodenum</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Duodenum</td>
<td>9</td>
<td>70</td>
</tr>
<tr>
<td>Duodenum</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Duodenum</td>
<td>11</td>
<td>42</td>
</tr>
<tr>
<td>Duodenum</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Duodenum</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Pylorus</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Prepylorus</td>
<td>11</td>
<td>0</td>
</tr>
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</table>

Bibliography

Perforated Peptic Ulcer
Commentary by Paul Smith, MD; Kaiser Permanente, Oakland

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. 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, 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. 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.

In Nannini’s study, 28 of his 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%. Griffin and O’Ran 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. 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
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. 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 al.15 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.”

Acknowledgment: Michael Udkow, MD, Division of Gastroenterology, Department of Internal Medicine, Kaiser Permanente Medical Center, Oakland reviewed the manuscript.

References