CANCER OF THE STOMACH

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WITH AN APPENDIX BY

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The seriousness of cancer of the stomach cannot be overstated, since it causes more deaths than cancer of any other organ, and since in the majority of cases encountered by the surgeon, the disease is too far advanced to permit complete removal of the involved tissue. In its various forms, cancer of the stomach may be considered either one of the most hopeless or one of the most curable types of cancer. The pessimistic attitude which has always existed in the minds of members of the medical profession would seem to be justified, for there apparently has been an increase in the incidence of malignant processes of the stomach. This increase, however, is undoubtedly partially the result of those achievements in preventive medicine which have increased the span of life, until a larger number of persons than formerly now reach the "cancer age."

On the other hand, because of progress in clinical and roentgenologic diagnosis, cancer of the stomach is being recognized in its earlier stages, and on this more than on any other single factor depends the possibility of cure. Experience has now shown that a malignant process of the stomach may be curable if diagnosed early enough in its growth, and every effort should be made to detect the lesion while it may still be possible to remove it.

It is true, of course, that permanent cures are rare in relation to the number of cases encountered. If, however, the fact that early removal is the only known method of cure were emphasized more before both laymen and members of the medical profession, a larger number of persons would undoubtedly submit promptly to examination and operation, with consequent increase in the number of satisfactory results. Cases in which results are satisfactory should constantly remind the surgeon of his responsibility, and of the fact that, in the light of present

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knowledge, only he can offer the patient the possibility of permanent relief. Claims of non-surgical "cures" depend for their success to a large extent on erroneous diagnosis, the ignorance of the layman, and the willingness of the patient to grasp at anything which promises relief, particularly if it does not call for the use of the knife.

In any consideration of cancer of the stomach it should be kept in mind that death will inevitably occur within a period of months if the disease is not interrupted in its course. The purposes in treatment, therefore, are twofold: to effect a cure if possible; to assure the patient a minimum of suffering during the remaining months of life, for even when the disease is obviously incurable he may be greatly relieved by an operation designed purely for palliation. In the light of such experiences surgeons gradually will evolve certain principles in the treatment of cancer of the stomach and will advocate exploration more frequently. We feel that exploration is warranted in any case of cancer of the stomach, unless it is clearly incurable because of distant metastasis or unless the lesion itself is definitely inoperable, as evidenced by roentgenologic examination.

Etiology

_Cancer from Ulcer:_ Little is known regarding the etiology of cancer of the stomach, as is true, also, of malignant lesions in other parts of the body. Almost as many theories have been advanced as the number of persons contributing to the knowledge of the subject, but it is hard to escape the conclusion that dietary habits play an important rôle. The most obvious immediate result of irritation of gastric mucosa is an inflammatory reaction characterized by areas of gastritis or definite ulceration. Dunham has stated that "the possibility of a malignant lesion developing in cases of acute or chronic ulcer of the stomach was suggested first by Cruveilhier in 1835. Extreme views have been taken even by observers whose opinions have been based on the study of adequate pathologic material. Rokitansky, in 1839, noted the coexistence of ulcer and cancer of the stomach. Kollmann stated, in 1890, that he had never observed a case in which the lesions were coexistent, whereas Zenker believed that every cancer of the stomach developed on a previous ulcer. Fuetterer, in 1902, expressed the opinion that if cancer develops from a chronic gastric ulcer, it arises from those parts of the edges of the ulcer which are most exposed to mechanical irritation by the content of the stomach. He believed that malignant lesions developed from ulcers in the pyloric region with great frequency, but were less likely to occur in other parts of the stomach. For this reason he advocated early gastro-enterostomy to prevent development of cancer by eliminating the mechanical factors of irritation.

Wilson and MacCarty, in 1909, reported a study of 218 specimens obtained by gastric or duodenal resection, or by excision for ulcer or cancer. Eight of the specimens were from the duodenum and all were simple ulcers. Of the remaining 210 specimens, all of which were from
the stomach, 47 were ulcers without suspicion of cancer, 2 were sarcomas, 2 were adenomas, and one was a diverticulum. In five instances in which ulceration had occurred, the microscopic appearance of aberrant epithelial proliferation was such as to cause the lesions to be considered as possibly in transition from ulcer to cancer. Of 153 cases of undoubted cancer, "109 (71 per cent) presented sufficient gross and microscopic evidence of previous ulceration to warrant placing them in a group called 'carcinoma developing on preceding ulcer.'" Careful review of the clinical histories revealed that in almost every instance signs and symptoms suggestive of gastric ulcer had been present for many years preceding the relatively short period when the history became that of gastric cancer. Several years previous to this contribution, W. J. Mayo had stated that among 145 cases of cancer of the stomach in which he had operated, a high percentage gave a history suggestive of ulcer, and that years may have elapsed before the cancerous process had begun.

Of 684 specimens of ulcerating lesions which were either excised or were included in resected portions of the stomach, 191 were found by MacCarty and Broders to be chronic ulcers in which no histologic evidence of cancer was present; 472 specimens presented the characteristics of simple ulcer together with the presence of cancer. According to these investigators, in the ulcers which contained the smallest numbers of cancer cells, these cells were in the mucosa of the borders and not in the base.

All observers admit that malignant lesions of the stomach may arise in chronic gastric ulcers, but many hold that the incidence is probably low. Bloodgood has said: "Ulcer prevention and ulcer cure are part of cancer prevention and cancer cure." There is agreement, therefore, on two points: a chronic gastric ulcer may become malignant, and it is impossible clinically to make a positive distinction between simple chronic gastric ulcer and early cancerous ulcer. The clinical application of these facts is obvious and will be considered in greater detail.

Adenoma: Askanazy has mentioned the importance, in the genesis of cancers, of ulcers and of adenomas associated with chronic gastritis. This observer emphasized the occasional development of a cancer of the stomach from congenital epithelial cell rests in the gastric wall. In his experience nodules in the gastric wall occurred more frequently with developmental disturbances of the bile passages. They consisted of invaginated gastric mucous membrane, occasionally pancreas, and rarely Brunner's glands. Rosenbach and Disqué also considered the question of gastric adenomas and their relationship to cancers of the stomach. One hundred and twelve cases were studied, in which adenomas and cancers were present. The most common situation of these neoplasms was the prepyloric region. With a single exception, analysis of the gastric content revealed achlorhydria.

Papilloma: Malignant changes may occur in papillomas of the stomach, but as there is no known etiologic factor responsible for the production of papillomas, the relatively rare coexistence of the two
lesions is of no assistance in determining the causative factors of cancer.

Submucous Epithelial Rests: The production of cancers of the stomach from embryologic submucous epithelial rests has been suggested, but such an explanation is not widely accepted. If such congenital groups of cells exist, there is no proof that they might not become malignant. Many pathologists, however, deny the presence of embryologic rests.

Chronic Irritation: Of the innumerable factors that have been mentioned in the etiology of malignant disease of the stomach, chronic irritation has been found to be present with impressive frequency. Craver recently completed a study of this problem in a thorough investigation of the clinical features in more than 36 cases of gastric and esophageal cancer. As W. J. Mayo has pointed out, unwise habits of eating, particularly hasty ingestion of large quantities of hot foods, may set up in the stomach certain chronic changes which may make more likely the development of cancer by the person who has a predisposition to the disease or who lacks immunity to it. This may possibly explain the greater frequency of cancer of the stomach among men than among women. It will be interesting to observe if there is a change in the sex ratio in the next ten years as a result of alterations in the habits of women.

We do not know definitely the relationship of chronic gastritis to gastric cancer. Chronic irritation has been emphasized repeatedly as an etiologic factor of greatest importance in malignant processes elsewhere in the body, and there is every reason to believe that a similar situation exists relative to cancer of the stomach. Prolonged achlorhydria probably has no other relationship to a malignant lesion of the stomach than that the achlorhydria is a result of the concomitant gastritis, although the significance of this relationship is as yet doubtful.

Miscellaneous Factors: Vascular disturbances, such as arteriosclerosis, variations in hydrogen-ion concentration of the tissues, and deficiencies of the various glandular structures, have been suggested as general factors in the production of cancer, but with present information, all lack proof.

Age and Sex

That more of the patients afflicted with cancer of the stomach are men than women has been mentioned above. In the last ten years, in The Mayo Clinic, the ratio has been slightly more than three men to one woman. Whether this bears any relationship to the sex incidence of gastric ulcer is questionable. Most persons with malignant processes in the stomach are seen between their fortieth and sixtieth years. Each reported series of cases includes isolated patients in the second or third decade, but only with such frequency as to emphasize the necessity of considering the condition even in the young. Cullingworth, in 1877, reported a case of cancer of the stomach of an infant aged five months.
The data in Table I have been compiled from the reports of several observers of large series of cases.

**Table I: Incidence by Age and Sex of Cancer of the Stomach**

<table>
<thead>
<tr>
<th>Year</th>
<th>Observer</th>
<th>Cases</th>
<th>Average age, years</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Males</td>
</tr>
<tr>
<td>1914</td>
<td>Friedenwald</td>
<td>1000</td>
<td>65 per cent between 40 and 60</td>
<td>58.8</td>
</tr>
<tr>
<td>1915</td>
<td>Smithies</td>
<td>712</td>
<td>75 per cent between 50 and 80</td>
<td>67.8</td>
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<tr>
<td>1921</td>
<td>Masson</td>
<td>1912</td>
<td>58.7</td>
<td>78.5</td>
</tr>
<tr>
<td>1927</td>
<td>Balfour and Hargis</td>
<td>1000</td>
<td>54.0</td>
<td>79.0</td>
</tr>
<tr>
<td>1928</td>
<td>Walton</td>
<td>204</td>
<td>50 per cent between 40 and 60</td>
<td>73.5</td>
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</table>

Some means of comparison of the incidence of cancer of the stomach with the incidence of cancer in other regions is desirable. It has been found that of the total number of patients who registered in The Mayo Clinic between 1921 and 1930 inclusive, a diagnosis of cancer of the stomach was made in 4,773 instances. In the same period, cancer of the other organs was diagnosed as follows: breast 4141, colon and rectum 4128, uterine cervix 1775, fundus of the uterus 950, prostate gland 1182.

**Diagnosis**

Golob remarked that "the easier it is to diagnose a cancer, the harder it is to operate on it." Unfortunately, until roentgenologists demonstrated that the lesion could be visualized, there had been a general tendency to insist on a clinical history typical of those present in text-books before serious consideration was given to the possibility of a malignant lesion of the stomach. It cannot be emphasized too strongly that there is no picture of this text-book sort until late in the disease. The condition may be present with few, if any, clinical signs. In a review of 100 cases, Moynihan was impressed by four clinical types, which were described in order of frequency of occurrence. In the first group the symptoms mimicked those of duodenal ulcer; usually the interval of remission was absent. In the second group, the patients had experienced vague dyspepsia for a varying length of time. In the third and fourth groups "early obstructive features and hemorrhage as an initial symptom were noted."

Saltzstein and Sandweiss reviewed the clinical histories in 287 cases in which the patients had succumbed to malignant disease of the stomach. In 24.7 per cent of cases, the malignant disease was preceded by long-continued indigestion. In 75.3 per cent, the clinical evidence of disease appeared suddenly in persons previously in good health. In one-third of the cases in which long-continued indigestion had been diagnosed, a typical history of ulcer was obtainable. Half of the patients had been under medical care for ulcer. In Blackford's series, of
45 patients with gastric cancer, 17 (38 per cent) presented histories suggestive of preceding ulcer.

A study recently made by one of us (Gray), of the clinical histories in 373 cases in which resection was done for malignant growth of the stomach, revealed that two distinct clinical groups could easily be recognized. The larger group was composed of patients whose symptoms had persisted for a varying length of time, without remarkable change. It is to be noted especially that approximately 75 per cent of this group had experienced symptoms for less than one year, and 40 per cent for less than three months. The impression is commonly held that three months constitutes a history of short duration, but even three months is a relatively long time when a malignant process is developing. Not infrequently a syndrome suggestive of ulcer was described, but more often the distress consisted of vague digestive features, which often were bizarre. In the smaller of the clinical groups were found those patients who had experienced symptoms referable to the stomach for a varying length of time, but who had noticed a recent change which was not similar to any previous complaint. The earlier symptoms in this group were in most respects similar to those in the first group mentioned. The recent change consisted in most instances in the onset of obstructive features, hemorrhage, rapid loss of weight, anorexia, or other features suggestive of a large tumor.

A rough estimate would indicate that approximately 75 per cent of the patients included in the study mentioned were in the first group, and 25 per cent were in the second group. A negligible percentage had not experienced symptoms suggestive of gastric pathologic change, and in these cases carcinoma of the stomach was accidentally found. Also included in this negligible percentage were patients who underwent exploration for some other condition and in whom cancer of the stomach was found as the only lesion, or as an associated one. Among 700 cases in which duodenal ulcer had been diagnosed clinically, Hartman and Rivers noted associated cancer of the stomach in 0.14 per cent; in a series of 375 cases in which a diagnosis of gastric ulcer was made, there were definite cancerous changes in 2.1 per cent.

From this study it is apparent that there is no syndrome characteristic of malignant disease of the stomach. The text-books mention the following points as important in early diagnosis: a person aged forty to sixty years; dyspepsia associated with anorexia, pain and vomiting, all four of which have resisted treatment for three months; steady loss of weight; progressive anemia. These symptoms are observed in most instances of advanced cancer, but if the patient is to receive the greatest benefit from surgical removal of the malignant process, the disease must be recognized before they are present.

It is the duty of members of the profession to impress on the general public the necessity of seeking medical advice for any digestive disturbance that does not respond immediately to the usual measures. Hurst has emphasized this fact and also has insisted that if the symptoms are not the result of some obvious cause, and do not respond
rapidly to simple treatment, the patient should undergo complete investigation with the object of settling the diagnosis.

In a study of 1408 patients with gastric carcinoma, Eusterman found that in 777 no operation was carried out. Of the 631 patients who underwent operation, 80 had carcinomatous ulcers. Palpable masses were found in 51 per cent of these cases, gastric retention in 60 per cent, and anacidity in only 55 per cent. The major complaints were found to range from asthenia to the pain, vomiting, and cachexia of a perforating, obstructing lesion. In 47 per cent of the proved cases of gastric carcinoma encountered in The Mayo Clinic, the history was that of the accepted syndrome of benign ulcer. Eusterman emphasized the fact that the familiar clinical picture of carcinoma, with the characteristic findings on gastric analysis or physical examination, represents a frank or advanced stage.

The importance of diagnosis of malignant lesions of the stomach is receiving increasing recognition. To 1892 the Catalogue of the Library of the Surgeon General's Office of the United States listed 955 titles of papers and publications dealing with cancer of the stomach, of which 124 (12.1 per cent) were on diagnosis. From 1892 to 1911, articles on cancer of the stomach numbered 1,722; on diagnosis, 462 (26.8 per cent); on treatment, 652 (37.8 per cent). From 1911 to 1926, articles on cancer of the stomach numbered 670; on diagnosis, 345 (51.4 per cent); on treatment, 160 (23.9 per cent).

Successful treatment of cancer of the stomach rests to a considerable extent on diagnosis. Earlier in this paper it has been indicated that very little progress has been made in early recognition by interpretation of the clinical symptoms alone. In the two decades between 1910 and 1930, innumerable tests and suggestions were made which were intended to assist in reaching a diagnosis. Many of these, prior to the introduction of roentgenology, were most ingenious.

Digestion Leukocytosis: The absence of digestion leukocytosis was believed by Schneyer, Harttung, Douglas, and Capps to be of significance.

Specific Proteolytic Enzymes: Müller suggested that malignant tumors contain one or more specific proteolytic enzymes, and Emerson utilized this observation in diagnosing cancer of the stomach by tests for the simplest products of protein digestion. Neubauer and Fischer, Weinstein, Warfield, Hirshberg, Sanford and Rosenbloom, Ramond, Parturier and Zizine, and Austin have contributed valuable observations relative to the production of those specific proteolytic enzymes by malignant processes of the stomach.

Lactobacillus boas-oppleri (Boas-Oppler Bacillus): The presence of the so-called Boas-Oppler bacillus in the stools was first utilized as an aid to the diagnosis of cancer of the stomach by Schmidt. Elliott, Brown, Allen, Sick, Fricker, Chambers and Gammage are a few of the many who have been interested in this phase of the problem.

Wolf-Junghans Test: Wolf and Junghans first reported a special method for estimation of the soluble albumin in the gastric extract;
this was claimed to be of great value as an aid in diagnosis of gastric cancer. Smithies reported a positive or suspicious result in 80 per cent of cases of gastric malignancy. Kahn and Jacobowitz, Riabow and Smotrow and Friedenwald and Kieffer studied the problem from various aspects, and it was generally concluded that the test was of particular value in the absence of free hydrochloric acid.

The presence of lactic acid in the gastric content was thought to be intimately associated with the Boas-Oppler bacillus. Mendel and Engel, however, concluded that a ferment originating from the cancer itself produced the lactic acid.

Miscellaneous: Many other tests have been mentioned. Ramond and Zizine found that there was an increase of all the nitrogen bodies in the blood and urine of 17 persons with gastric cancer. From their study of the sugar tolerance test, Friedenwald and Grove concluded that there is a characteristic curve in cancer of the stomach which in no way approximates the normal, and which differs somewhat from that observed in malignant conditions of other regions. Fricker found occult blood in examination of 170 of 176 patients who had definitely proved cancer of the stomach, and Hurst has almost invariably noted occult blood.

The Einhorn thread tests and their modification, suggested by Steinfield, have been of definite value. Schlesinger noted a reflex spasm in the upper part of the esophagus as the first sign of cancer of the stomach. Gundermann and Düttman found that when malignant conditions existed in the stomach, only a small proportion of salt was eliminated, whereas water was voided freely for a short time after ingestion of 1,500 gm. of water by a fasting patient. The situation was reversed in persons with benign gastric lesions.

Anemia: The urobilinogen content of the stools of thirteen (11 per cent) of Scholz's series of patients with cancer of the stomach was materially decreased. He regarded this as an indication of destruction of blood, and thought that this evidence might be valuable in the differential diagnosis between gastric cancer and severe anemia. Conner and Birkeland have stated that certain cases of carcinoma are distinguished with difficulty from pernicious anemia. Competent roentgenologists, however, should have no difficulty in the vast majority of instances in recognizing definite gastric pathologic change. The chief point of controversy seems to have arisen when, in rare instances, the two conditions coexisted, the question being whether this relationship was accidental, whether the blood picture of pernicious anemia may have occurred as a result of the carcinoma of the stomach, or whether the cancer had any relationship to the gastritis that is so frequently associated with pernicious anemia. Weakness, anorexia, gastric symptoms, insidious onset, and anemia are common to both conditions. The most important clinical features characterizing pernicious anemia rather than gastric cancer are sore tongue, paresthesia, and other neurologic symptoms that suggest subacute combined degeneration of the posterior and lateral columns of the spinal cord. The anemia asso-
associated with cancer of the stomach usually has been found to be of the hypochromic, secondary type, though occasionally it has been hyperchromic, like that of pernicious anemia. Eleven cases are reported by Conner and Birkeland in which the coexistence of pernicious anemia and cancer of the stomach was certain.

**Hydrochloric Acid:** According to Palmer, the first observations on the concentration of hydrochloric acid in cancerous stomachs were made by Golding-Bird in 1842. He examined only the vomitus, and estimated the acidity by distillation and incineration of the residue. In 1895, Faulkner cited evidence to prove that free hydrochloric acid was never present in the stomach of man unless introduced from without. He quoted Hay as saying that free hydrochloric acid would seriously injure the stomach if present, and that it was impossible for free hydrochloric acid to be found for the reason that its liberation from a salt of any kind required the presence of a concentrated acid, and any concentrated acid in the stomach would quickly destroy the organ. It was thought that free mineral acid was not a product of the stomach of man or animal and that its absence was not a sign of cancer.

The following year Weber reported his observations that in chronic gastritis, or atrophy of the mucosa from any cause, the concentration of hydrochloric acid might be diminished, or there might be complete absence of hydrochloric acid. Wainwright, in his discussion of Weber's paper, remarked that he had made an early diagnosis of cancer of the stomach based on chemical analysis of the gastric content. Palmer was of the opinion that diminution in hydrochloric acid in cases of cancer of the stomach might be the result of the presence of cancer anywhere in the patient's body and not necessarily of cancer in the stomach itself.

Hartman observed achlorhydria in a little less than half of the cases in which there were malignant processes in the stomach, and found that the situation of the growth did not materially influence the degree of acidity.

Bennett emphasized the value of fractional analysis of the gastric contents, and the importance of searching the fasting contents for evidence of stagnation, hemorrhage, and aberrant secretion. In his experience, free hydrochloric acid was secreted by the stomachs of most patients suffering from gastric cancer. Of 100 cases in which Friedenwald and Bryan made fractional analysis, 26 per cent showed normal acidity, and in 6 per cent hyperchlorhydria was present. Fractional analysis disclosed achlorhydria in 52 per cent of cases as compared to 79 per cent when one analysis only was made after the Ewald test meal. In Blackford's series of cases free hydrochloric acid was absent in all of 19 cases in which there was no history suggestive of gastric ulcer. Free hydrochloric acid was present in 9 of 12 cases (75 per cent) in which the history was suggestive of ulcer.

Eusterman believed that high values for combined acids, and evidence of retention, in the absence of free hydrochloric acid, were invariably significant of cancer with actual pyloric obstruction or marked
impairment of gastric motility. He found all obstructing lesions associated with achlorhydria to be cancerous.

In order to determine whether Bloomfield and Polland were justified in employing determinations of volume and acidity for distinguishing benign from malignant gastric lesions, Comfort and Osterberg used histamine as a stimulus to gastric secretion. Cases of gastric cancer were encountered in which the concentration of free hydrochloric acid and the volume of the gastric contents were almost as great as in cases of duodenal ulcer. This was contrary to the experience of Bloomfield and Polland. We do not believe that determination of the free hydrochloric acid in the gastric contents is a criterion on which to base the differential diagnosis of benign gastric ulcer, malignant ulcer, or ulcerating cancer.

Intragastric Photography: The inventive genius of F. G. Bock, working in Wenckebach's clinic in Vienna, with Porges and Heilpern, produced, in 1929, an instrument which has been termed the "Gastrophotor." It is claimed that by means of this instrument, a permanent and visible record of portions of the interior of the stomach can be obtained. Wyard has found that this record is of considerable value as a supplement to the roentgenologic examination which demonstrates the size and shape of the stomach. Extended use of the instrument will be required to determine its practical value.

Roentgenology: The most outstanding advance in the diagnosis of cancer of the stomach can be attributed to roentgenology. All other measures in comparison become so insignificant that their importance can be disregarded. At present this method constitutes the only positive procedure in diagnosis. As early as 1914, White and Leonard were able to report correct roentgenologic diagnosis in 89 per cent of cases. In no case in which a "normal" stomach was found was cancer proved to exist. Carman found that 95 per cent of gastric cancers gave roentgenologic evidence of their presence. Often they could be thus revealed early in the course of the disease, when they could be discovered by no other method of examination. Carman found roentgen rays valuable in demonstrating the size, shape, and position of the stomach, as well as the size, shape, and position of the tumor. Also, it was possible to determine whether a stomach suspected of being diseased was normal, whether a tumor was present and, if so, whether it was intrinsic or extrinsic, and whether a cancer or other lesion of the stomach was operable.

In the differential diagnosis of intragastric lesions, McVicar pointed out the necessity of distinguishing cancer, syphilis, benign tumor, and benign ulcer. The qualified roentgenologist will detect a gastric lesion with almost uncanny accuracy, but he will be most conservative concerning his ability to distinguish between benign and malignant lesions. In a series of 524 cases of cancer in which resection was possible, and therefore the presence of malignant growth was proved, the roentgenologist had been unable to decide that the lesion was malignant in 30 per cent, whereas in 10 per cent of the cases the roentgenographic
appearance of the lesion had simulated that of benign ulcer. Kirklin and Eusterman, on the basis of roentgenologic appearance, were able to lay down the principle that a perforating ulcer with an accessory pocket outside the stomach was benign, whereas an ulcer the crater of which was surrounded by an elevated wall, was malignant. Niche ulcers larger than 3 cm. in diameter were found to be malignant in a high proportion of cases.

A most important point was emphasized by McVicar. It had been suggested by many that, if the roentgenologic appearance of a lesion left doubt as to its malignancy, the patient could be submitted to a course of medical treatment, and, if he was relieved, it might be assumed that the lesion was benign. McVicar found this to be an erroneous impression, since a patient may respond temporarily to medical treatment even if the process is malignant, and such delay may allow an operable lesion to proceed to inoperability.

A more complete consideration of this topic, by Dr. B. R. Kirklin, appears as an appendix to this paper.

TREATMENT

Indications: The purpose in treating cancer of the stomach is twofold. The first is to effect a cure if possible, and the second to prolong life and reduce to a minimum the suffering which may be associated with the disease. In the absence of pyloric obstruction, which of itself is usually an indication for operation, proof of the existence of distant metastasis is a contraindication to surgery. A definite distinction should be made, however, between metastasis and extragastric extension. Cures may follow resection of a malignant process of the stomach in spite of extragastric extension. The prognosis in such cases is, of course, less favorable than in cases without such extension, but it should not be taken as a contraindication to resection if the latter is technically feasible.

The presence of a large tumor, as demonstrated roentgenologically or by palpation, is not necessarily a positive indication that the growth cannot be removed. In most instances, as shown by Carman, the question of operability, from the roentgenologic standpoint, depends on the situation, the extent, and the character of the cancer. Carman divided the stomach into three zones: the operable zone, corresponding to the pars pylorica; the borderline zone, to the pars media; the inoperable zone, to the pars cardiaca. Tumors of the borderline zone presented the most puzzling problem to Carman, and he found that the position and size of the stomach determined to some extent the removability of the growth. The small, high-lying stomach of the robust person offered much greater difficulty to the surgeon than the relaxed stomach of the asthenic individual. Tumors of the inoperable type were usually those in the cardiac end of the stomach or those that had spread from a pyloric or fundal position to within this uppermost zone. Only rarely is a preoperative report of inoperability of a lesion in this situation not confirmed when an incision is made for exploration. In one case re-
cently encountered, the roentgenologist reported that the esophagus was abnormally inserted into the stomach, and that this would aid in anastomosis of esophagus and duodenum, or jejunum, following total gastrectomy. This was borne out at operation.

*Preoperative Treatment:* The most serious complications of cancer of the stomach from the standpoint of preoperative treatment are pyloric obstruction and anemia. It is well recognized that in association with pyloric obstruction and dehydration, the products of protein metabolism are retained in the blood, and that this retention is indicated by a rapidly elevated value for blood urea. Under ordinary circumstances, intravenous administration of 10 per cent glucose in physiologic saline solution will successfully combat the dehydration and will bring the chemical constituents of the blood within normal limits. From 2,000 to 2,500 c.c., divided into two or three injections, should be administered each day for four to five days. If the obstruction is marked, frequent aspiration of the gastric contents will prove to be of distinct benefit in improving the general condition of the patient. Furthermore, it will assist materially in the surgical procedure, for the stomach will thus have been cleansed thoroughly of all retained material. Correction of the effect produced on the stomach by the mechanical obstruction will reduce congestion of the gastric walls and will restore them to a state in which more satisfactory and safer suture is possible. Every patient with obstruction should be hospitalized for a few days of observation and rest in order that these measures can be carried out. Under any circumstances, the gastric content should be aspirated immediately before operation.

Satisfactory treatment of anemia associated with cancer of the stomach is difficult without removal of the growth. Most of the cases, as has been said, present features of secondary or hypochromic anemia. If the value for hemoglobin is less than 40 per cent, it has been the practice, in the Mayo Clinic, to give transfusions of blood. However, unless there has been recent, massive hemorrhage, little change is noted in the concentration of hemoglobin after transfusion, and it has been found unwise to delay operation too long in efforts to improve the condition of the blood.

*Anesthesia:* In our experience spinal anesthesia has not been entirely satisfactory for operations on the upper part of the abdomen. For this reason, general anesthesia by inhalation usually has been employed. As basic anesthesia, in skilled hands, this leaves little to be desired. Under ordinary circumstances induction is effected by the use of a gas, preferably nitrous oxide or ethylene. Sufficient quantities of ether to produce adequate relaxation are then added, together with appropriate use of carbon dioxide and oxygen. For the stages in the operation in which marked relaxation is not essential, the quantity of ether may be reduced to a minimum; it can then be increased for closure of the wound in the abdominal wall. The incidence of postoperative pulmonary complications has been decreased by combination of block of the abdominal wall and inhalation anesthesia. In some instances,
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satisfactory exploration can be carried out with local anesthesia only. We have found small quantities of sedatives of the barbital group the night before operation, and again in the morning, helpful in assuring a night’s rest and in decreasing the dread of operation. Morphine sulpha ½ to ¼ grain (0.01 to 0.016 gm.) should be given immediately before operation. An associated dose of atropine sulphate, ¼ grain (0.0004 gm.), is useful in decreasing secretions in the respiratory tract during anesthesia.

We have found the intratracheal method of administering anesthetics by inhalation to be extremely valuable in certain cases. The chief objection lies in the necessity of having available the services of one particularly skilled in passing the intratracheal tube. By its use a clear airway is assured at all times, and quiet, unstrained respiration is obtained, with a minimum of the anesthetic agent. One of the more important causes of postoperative pulmonary complications is the aspiration of infected material into the trachea. With a snugly fitting tracheal tube the possibility of this accident is reduced, and a means is offered of aspirating with a suction device any secretions that may have accumulated in the upper part of the respiratory tract.

Technic: The technic of partial gastrectomy for cancer will vary according to the situation and extent of the growth, and the type of operation chosen. Under ordinary circumstances, resection can be begun at the pylorus, unless the lesion is firmly attached posteriorly, and unless the pylorus itself is not involved. A small opening is made in the gastro-hepatic omentum, through which the forefinger of the left

![Diagram of mobilization of the pylorus, stomach, and duodenum.](image-url)
hand is thrust behind the duodenum and pylorus. With the thumb on the anterior surface of the duodenum, near the pylorus, tension is made on the gastrocolic omentum and an anemic area is selected (Fig. 1), far enough distal to the pylorus to make possible wide removal of the sub-

![Diagram of duodenum and pylorus]

**Fig. 2.** Left: Space Opened in the Gastrocolic Omentum, Showing Clamp on the Right Gastro-epiploic Artery; Right (b and c): Space Opened in the Gastrohepatic Omentum, Showing Division and Ligation of the Pyloric Artery on the Superior Border of the Duodenum

pyloric group of lymph nodes, and also to provide sufficient mobilization of the first portion of the duodenum so that a portion of it can be included in the removal, since it has been recently shown that cells do invade the duodenal wall. The gastrohepatic omentum is mobilized in a similar manner, and sufficient portions of the lesser and greater curvatures are exposed in order that clamps can be applied to the duodenum. In this process the pyloric artery (continuing from the gastric artery on the lesser curvature of the stomach) is clamped, ligated, and doubly tied (Fig. 2), and the right gastro-epiploic artery, in the gastrocolic omentum, is treated in a similar manner.

A small clamp is applied on the gastric side of the lower end of the resected portion (Fig. 3). A gauze pack is placed behind the duodenum and pylorus in order to protect against soiling. Whether or not a clamp is to be applied to the duodenal stump depends to some extent on how well mobilization of the duodenum has been effected. A clamp can be applied or the duodenal stump can be closed without clamps.

If clamps are not used, the edges of the duodenal mucosa are approximated by a continuous Connell suture of fine, chromic catgut. Retraction of the stump is prevented by applying two Allis forceps to the wall of the duodenum, well below the cut edge. A second row of chromic catgut is used in a running, blanket suture, the extremities of
which are so placed that tension will invaginate the opposite sides of
the duodenum. A third row of interrupted mattress sutures of silk is
made. A useful practice, and one which is most helpful in reducing the
possibility of duodenal fistula, is to include in separate sutures of this
row the stumps of the gastrohepatic and gastrocolic omenta, which con-
tain the pyloric and right gastro-epiploic arteries respectively.

With the use of a clamp, the details of technic are similar except for
the first row of sutures. In this instance, the first row consists of a
running mattress suture of chromic catgut taken over the clamp in
order that the edges can be inverted when the clamp is withdrawn
(Fig. 4).
As the first step in resection, mobilization of the stomach and its omental attachment is now begun. First, it is wise to determine how high the resection should be carried, and the proper points on the greater and lesser curvatures are marked with small Allis forceps; these are placed at least an inch and a half (4 cm.) above the apparent limits of the lesion (Fig. 5). A wide strip of gastrocolic omentum is divided, with great care not to injure the blood supply to the colon, which is carried in the transverse mesocolon immediately behind this region. In certain cases it may be impossible to determine whether injury has been done to the middle colic artery, for this artery may be included in the extension of the malignant process. In the rare instance in which doubt exists as to adequate circulation to the colon, the questionable portion of transverse colon should be exteriorized on the abdominal wall.

The gastrohepatic omentum is divided about 1 inch (2.5 cm.) above the level at which the resection is to be made (Fig. 6). If the stomach is ballooned by gas and retained material, a small opening may be made in the posterior wall at this point, and the contents aspirated by means of a suction apparatus (Fig. 7). The opening in the posterior wall can then be closed quickly with a running suture. The gastric and left gastro-epiploic arteries are clamped, cut, and doubly ligated. A rubber-covered clamp is now placed across the upper border of the stomach, after thorough inspection has established that the line of

![Diagram](image-url)
FIQ. 6. MOBILIZATION OF THE STOMACH: MAKING AN OPENING IN THE GASTROHEPATIC OMENTUM, PREPARATORY TO LIGATION AND DIVISION OF THE GASTRIC ARTERY

fig. 7. Stomach being emptied by suction pump
resection is made well above the growth. The portion of the stomach that is to be cut away is left in place for the time being.

The type of anastomosis employed for reestablishment of gastrointestinal continuity depends in great measure on the extent of the operation. In most instances, and usually if resection is moderate, the posterior transmesocolic end-to-side type of gastrojejunostomy can be accomplished. This operation is usually referred to as a "posterior Polya." For more extensive resections the antecolic end-to-side anastomosis associated with entero-anastomosis has distinct advantages.

![Diagram of the arrangement of the jejunum and stomach for posterior Polya anastomosis](image)

**Fig. 8. Arrangement of the Jejunum and Stomach for Posterior Polya Anastomosis, with Beginning of the First Row of Sutures**

In the posterior type of anastomosis a loop of jejunum about 15 cm. from the ligament of Treitz is selected. The colon is retracted upward, and an anemic portion of the transverse mesocolon, well to the left, is identified and an opening made. The loop of jejunum is carried through the opening in the transverse mesocolon, and two Allis forceps are applied in order that tension can be made for application of a rubber-covered clamp. The loop of jejunum contained within the clamp should be sufficient to reach well across the end of the stomach that has been held in place previously by a similar clamp, and the distance from the ligament of Treitz to the juncture with the lesser curvature should be about 11 or 12 cm. (Fig. 8).

The first row of sutures of chromic catgut or linen is begun at the greater curvature, uniting the stomach and jejunum by seromuscular stitches. Great care should be taken in applying several close-locked sutures at the lesser curvature. Another rubber-covered clamp is now applied to the stomach in order to decrease the possibility of soiling from spilling of gastric contents, and the portion of the stomach that
is to be resected is cut away (Fig. 9). The advantage in leaving the stomach in place until the first row of sutures has been made is in lessening the possibility of having the upper segment of stomach slip back between the jaws of the rubber-covered clamp. This is particularly important when an unusually large portion of the stomach has been removed. The jejunum is opened for a distance comparable to the width of the cut end of the stomach, and a second row of chromic catgut sutures is begun, also at the greater curvature, including all coats of both stomach and jejunum. A third row of interrupted sutures is

Fig. 9. a. After completion of the first row of sutures, the portion to be resected is cut away; b. Second row of sutures posteriorly is half completed

optional. In returning over the anterior aspect with the second posterior row, only the mucosa of the stomach and jejunum are included, and clamps on the stomach and jejunum are loosened while the posterior suture line is still in view and any bleeding points are transfixed (Fig. 10). Before closing the clamps, more of the anterior wall of the stomach and jejunum are drawn through them, in order to facilitate closure. The second anterior row inverts the exposed and approximated mucosa. This suture begins at the greater curvature and is carried to the lesser curvature, where it is tied to the first posterior row (Fig. 11) if that row is of a similar suture material. The latter is continued anteriorly as a third row and is applied as a running blanket suture.
After completion of the posterior transverse mesocolic end-to-side anastomosis, as described, the suture line is brought down through the rent in the transverse mesocolon, and the transverse mesocolon is attached to the stomach on all sides of the anastomosis.

In the antecolic type of anastomosis, a longer loop of jejunum will be necessary in order to dip below the colon. Approximately 30 cm. will be necessary, but the amount will vary in individual cases. In order to drain this long, proximal loop of jejunum, a small entero-anastomosis between it and the distal part of the jejunum will be necessary. The most dependent portion of the proximal loop is selected, and a small entero-anastomosis is made with two rows of chromic catgut or silk anteriorly and posteriorly. The loops of intestine are now arranged in their normal position to the left of the median line, and the abdominal wound is closed.

When total gastrectomy is indicated we have found that an antecolic type of anastomosis is most satisfactory. It will be necessary to use a long loop of jejunum in order to approximate the bowel to the terminal portion of the esophagus. In this instance, entero-anastomosis should invariably be made in the dependent portion of the proximal loop of jejunum in order to effect adequate drainage, and a catheter should be introduced into the distal loop for feeding. Walters has drawn attention to the chemical and physiologic changes in series of cases of total gastrectomy performed by him.
The operations described are used most commonly in the Mayo Clinic for cancer of the stomach and are based on the general principle of the Billroth II method. The Billroth I method, or its modifications, should be avoided if possible, because of the obstruction which will occur if recurrence of the disease takes place in or around the anastomosis.

**Postoperative Care:** With the usual poor physical condition of the patient before operation, attention to detail in all measures is essential. General measures, such as meticulous efforts to maintain body heat, are of particular importance. The stomach must be kept clean and retention must be avoided. Old, partially digested blood has a particularly foul odor, and although retention rarely occurs following the types of operation under consideration, the patients are grateful for the comfort which follows lavage of the stomach.

With the return to consciousness the patient should be placed in the Fowler position. Prior to this, slight Trendelenburg inclination is indicated to decrease the possibility of aspiration of infected material into the trachea before the return of the cough reflex. Fluids are maintained by proctoclysis; at least 2,000 c.c. of plain water, or preferably physiologic salt solution, should be introduced daily. In selected cases in which there is no suggestion of decrease in cardiac reserve, physiologic salt solution, or 10 per cent glucose in physiologic salt solution, may be injected intravenously; not more than 1,000 c.c. should be given at one time, and at least half an hour should be taken for the injection. Fluids should not be given by mouth until the morning of the third day, preferably not until later, if the patient does not complain of too great thirst. The quantity of fluid given by mouth should not exceed half an
ounce (15 c.c.) every hour for the first half day, the quantity being gradually increased as tolerated. The majority of patients are allowed to get up on the eighth or ninth day.

**Palliation:** Obstruction of high grade may demand relief, even if a patient has metastasis. If gastro-enterostomy can be done, not infrequently the new stoma will function until death ensues and the patient is spared the distress of mechanical obstruction. The high mortality rate following gastro-enterostomy for cancer of the stomach is partly explained by the fact that it is often employed in cases in which only palliation can be expected, and partly because it is occasionally the first stage of a resection in the presence of an unusually bad risk.

A method has been presented of carrying out operations for carcinoma of the stomach in two stages. The first stage consists of excluding the growth by dividing the stomach above it and closing the distal segment of stomach. Gastro-intestinal continuity can be restored by either posterior or anterior end-to-side gastrojejunostomy. If palliation is all that can be hoped for, only the first stage may be carried out, but if conditions warrant, a second operation may be performed, in which the distal segment of stomach containing the cancer is resected and the duodenal stump closed in the usual manner.

**Mortality**

If cases are not selected on the basis of operative risk, the mortality of partial gastrectomy for cancer should be close to 10 per cent. A study of the records in The Mayo Clinic for a period of ten years, 1921 to 1930 inclusive, reveals that in three of these years the mortality rate was less than 10 per cent, whereas in the remaining years it was slightly higher. During this period, partial gastrectomy for malignant disease
of the stomach was performed on 1,080 persons, of whom 141 died, a mortality of 13.05 per cent. It is of interest that 119 of 824 men (14.5 per cent) in this group died, whereas only 22 of 256 women (8.5 per cent) died. Pulmonary complications were the major causes of death. This lends further emphasis to the fact that the utmost care must be exercised in adherence to detail in order to avoid the development of postoperative pulmonary complications.

PATHOLOGY

Boyd has divided cancer of the stomach into three main types: the massive or proliferating type, the sessile ulcerated type, and the diffuse infiltrating type. As will be shown, the prognosis in individual instances depends, to a large extent, on the nature of the growth.

The massive type (Fig. 12) may occur in any portion of the stomach, but is observed most frequently in the antrum and body, and involves chiefly the posterior wall and lesser curvature. It may become huge without causing marked symptoms, and may protrude into the lumen of the stomach as a polypoid, cauliflower-like growth. Usually there is slight ulceration, if any. The growth rarely perforates and does not have a tendency to diffuse extension. Microscopically, this type of tumor is an adenocarcinoma and is characterized by a tendency to formation of glands which may permeate all coats of the stomach. The nuclei of the malignant cells are large and are hyperchromatic. The ratio of nucleus to nucleolus is greater in benign than in malignant cells, for in malignant cells the increase in size of the nucleolus is relatively greater than the increase in size of the nucleus.
In our experience the ulcerated type (Fig. 13) of cancer of the stomach occurs with a frequency almost equal to that of the massive form. The situation of ulcerated lesions corresponds rather definitely to the usual situation of benign gastric ulcers; that is, in the antrum, on or near the lesser curvature. Undoubtedly the malignant lesions that have developed on, or are associated with, benign gastric ulcers belong in this category. Boyd has noted that in the simple ulcer which has become malignant, the malignant change is found in the edge of the ulcerated area, whereas in the cancer that has ulcerated, the malignant cells are found in the base as well as in the edge. Involvement of the serosa by perforation and extension is common, and adds to the gravity of the prognosis, as shown by Verbruggen. On microscopic examination the tendency to formation of glands is less marked, and usually there are diffuse clumps of malignant epithelial cells irregularly dispersed throughout the stroma. The stroma may be extremely dense, and produces a marked degree of induration. There may be degeneration of thin, colloid material in either of these types.

In the diffuse infiltrating type (Fig. 14), usually termed "linitis plastica" or "leather-bottle stomach," there is ordinarily no definite tumor. The walls of the stomach are thickened and edematous, particularly in the region of the pylorus, and the stomach often is moderately dilated. The process may extend toward the cardia for a variable distance, where in certain instances a rather sharp line of demarcation can be noted. Occasionally the entire stomach may be involved. This type of growth is most suitable for total gastrectomy, for there is the least tendency to involvement of lymph nodes. On microscopic examination the dense areas of fibrous tissue immediately attract attention; dispersed sparsely through this stroma are cords or clumps of malignant cells.
A fourth type, which may form a subgroup of the proliferating type, is the malignant polyp. Polyposis of the stomach is relatively rare, but if a case is encountered, the possibility of malignant change in one or more of the polyps must be considered. Such an instance has been reported recently.

Metastasis: The most common sites of metastatic lesions from cancer of the stomach are in the neighboring lymph nodes, principally the nodes of the subpyloric group, the liver, the rectal shelf, and the umbilicus. Besides these areas, the supraclavicular lymph nodes may become involved, and the ovaries, lungs, brain, spinal cord, kidneys, and bones. Direct extension to any of the neighboring tissues may occur.

**Fig. 15. Adenocarcinoma of the Stomach,** **Fig. 16. Adenocarcinoma of the Stomach,**

**Grade 1** (X 110) **Grade 2** (X 110)

**Prognosis and End-results**

*Historical:* Attempts were made long ago to offer a practical method for determining the prognosis in the presence of malignant lesions. We are concerned here only with cancer of the stomach.

MacCarty and Mahle published a report of 200 cases of gastric cancer in which the relation of differentiation of cells and lymphocytic infiltration were studied in relation to postoperative longevity. They found that patients with metastatic involvement of lymph nodes did not live more than eight years, whereas patients without lymph node metastasis had a much greater average length of postoperative life. Regardless of lymph node metastasis, the postoperative course was 23 percent longer in the presence than in the absence of lymphocytic infiltration. Extensive lymphocytic infiltration was found more frequently in association with lymph node metastasis than without it. The occurrence of hyalinization and fibrosis was not recorded.
In 1922 Broders, whose system of grading cancer is applicable to gastric as well as to other growths, made a slight modification in his scale of grading, after study of epitheliomas of the genito-urinary organs. Tumors in which 75 to 100 per cent of the cells were differentiated were graded 1 (Fig. 15). Those in which the differentiated cells constituted 50 to 75 per cent of the total were graded 2 (Fig. 16), whereas if 25 to 50 per cent were differentiated, the tumor was graded 3 (Fig. 17). The most malignant tumor was that in which less than 25 per cent of the cells were differentiated; these were graded 4 (Fig. 18).

In 1924, MacCarty considered the prognostic factors which seemingly, if not definitely, influenced the relation of new growth to longevity. These factors included the size of the growth, its cellular nature, the age of the host, the duration of the lesion, the nutrition of the patient, the proximity of the growth to vital structures, the involvement of regional and distant lymph nodes, metastasis to distant organs, the multiplicity of the lesions, the character of previous treatment, and the morale of the patient. In addition to these factors, were the four previously mentioned: lymphocytic infiltration, fibrosis, hyalinization, and cellular differentiation.

In a recent study (Gray) it has been found that the evidence of involvement of lymphatic structures associated with cancer of the stomach increases in direct proportion to the grade of malignancy. Of 100 patients who died within one year following resection for cancer of the stomach, 76 per cent showed definite involvement of the regional lymph nodes, whereas in only 30.2 per cent of 273 persons who had lived more
than five years following similar operative procedures was it possible to find involved lymph nodes.

Other interesting information has been contributed relative to the prognosis of malignant lesions. Hartman and Friedenwald have shown that achlorhydria is present in approximately half the cases of cancer of the stomach. The former, in a study of the prognostic value of gastric acidity in cases of resectable cancer, found that 78 per cent of 41 patients with free hydrochloric acid prior to operation had died within five years. The average postoperative life in this group was twelve and six-tenths months. Of thirty-nine patients with anacidity, who were traced five years, 56.7 per cent were dead. The average postoperative life was fifteen and four-tenths months. From this, Hartman deduced that a patient with resectable cancer and anacidity had a 44 per cent chance of at least five years of postoperative life, and twice the chance of a similar patient with free hydrochloric acid.

Verbrugghen observed, in a study of intramural extension of gastric cancer, that when the serosa was involved, nodal metastasis was present. Involvement of the serosa was considered, therefore, to be of the utmost prognostic importance.

Clinical and Pathologic Factors Influencing Ultimate Prognosis: In a study made by one of us (Gray), of a series of 373 patients who had undergone resection for cancer of the stomach in the clinic, the large group was subdivided into three smaller groups. The first group contained 100 persons who had died from the malignant process within a year following resection; the second consisted of 145 patients who had lived five years or longer, and the third consisted of 128 persons who had lived ten years or longer. A clinical and pathologic study was made in order to determine, if possible, what factors accounted for this difference in ultimate results. An analysis of the findings suggested certain definite positive and negative conclusions.

From a clinical prognostic standpoint, sex, age, family history of malignancy, and the general condition of the patient as evidenced by loss of weight and measurements of the total quantity of gastric content were inconclusive.

Features of positive clinical prognostic importance were found to be, in the first place, the duration of symptoms. A short history in the age group included in this study was of grave prognostic omen. This factor suggested a rapidly progressing process. This impression is strengthened by the fact that the average value for hemoglobin was seen to be higher in these cases than in the group in which a relatively chronic disease was in progress. The presence of anacidity was considered with some apprehension.

From a pathologic standpoint, no prognostic factors could be elicited from the situation of the lesion, with the obvious exception that resection must be technically possible with average operative risk.

The fact that in the group in which prognosis was less favorable the average size of the lesion was less than in the groups in which postoperative life was of more than five years' duration, is further evi-
idence that a short course is of serious significance. An ulcerating growth tends to render the prognosis less grave, whereas a perforating growth adds to the seriousness of the situation.

The three factors which are most important in decreasing the possibility of a long postoperative life are involvement of lymphatic structures, serosal involvement, and malignancy of high grade. Because the incidence of involvement of lymph nodes increased in direct proportion to the increase in severity of the malignant process as indicated by the grade of malignancy, the last-named feature should be considered the most important single factor.

End-results: One thousand consecutive cases of cancer of the stomach in which operation was performed at the clinic have been reported (Balfour and Hargis). It was found that in cases without metastatic involvement of the lymph nodes, 52 per cent of the patients were alive at the end of three years; with lymph node involvement, only 19 per cent survived that long. In 1918 W. J. Mayo reported 651 resections for cancer of the stomach; 427 of the patients had been operated on more than three years before and 311 were traced. One hundred twenty (38.6 per cent of 311) were alive three years or more after operation. Three hundred and thirteen had been operated on more than five years before, and of these 239 were traced; 62 (26 per cent of 239) were alive five years after operation. It should be noted that in some instances the operation was performed only for its palliative effect, and that these figures include all cases, regardless of the extent of the disease.

Appendix

Roentgenologic Diagnosis

Among the earliest successful applications of roentgen rays to the diagnosis of gastro-intestinal disease was the demonstration of gastric carcinoma. At that time, and for several years thereafter, the discovery of carcinoma was confined principally to cases in which the lesion was advanced, and diagnostic interpretations were based partly on clinical signs and symptoms, partly on gross roentgenologic manifestations. Today, chief reliance is placed on roentgen rays for the discovery of carcinoma, especially in its early stages, and in most cases a confident diagnosis can be made without consideration of the clinical history. In addition, the roentgenologic method will determine the situation, extent, and probable histologic character of the new growth and thus furnish valuable information as to its resectability.

This appraisal does not imply that roentgenologic examination is exceedingly simple, nor that one or two roentgenograms of the barium-filled stomach will infallibly and automatically reveal or exclude the presence of carcinoma. It is unfortunately true that, at the time of discovery, a majority of carcinomas are well advanced and distortion of the gastric shadow is pronounced; similar distortion, however, may result from other causes, which can be excluded only by thorough ex-
amination. In the first place, to disclose or exclude small, early carcinomas, the technic of inspection must be appropriate and exhaustive. For this reason the examination should be roentgenoscopic, in order to permit observation at various angles and to carry out those manipulations which are virtually indispensable. Second, care should be taken to ascertain that the patient’s stomach is entirely empty; hence preliminary evacuation with the tube is desirable. A third important requirement is that the patient’s abdomen be completely relaxed, so that the necessary palpatory investigation may be fruitful. Lastly, the finer details of mucosal relief are highly significant in searching for evidence of smaller carcinomas. Accordingly, the patient should at first take but one or two swallows of the barium suspension, which should be distributed over the mucosa by manipulation, and the stomach should not be filled until the internal relief has been carefully inspected. Obviously, there are many other important features of an effective technic, but these four are worthy of special emphasis.

Inasmuch as roentgenologic signs of gastric carcinoma reflect primarily its morbid anatomy, it may be well to remember that, both grossly and microscopically, there are several varieties of carcinoma, and that manifestations of this lesion are likely to differ accordingly. If anyone harbors the conception that carcinoma invariably is a definite tumor of the gastric wall, he should banish the thought. Hyperplasia, with consequent tumefaction, is indeed a primary characteristic of the disease, and a majority of the advanced lesions are frank tumors. Gastric carcinoma, however, is also characterized by ulceration, and this factor is scarcely less common than tumefaction. Consequently, most carcinomas are ulcerating tumors. Ulceration often is so marked that little tumefaction remains. Occasionally, ulceration is so dominant that the element of tumefaction cannot be discerned macroscopically, even on close scrutiny of the excised specimen, and morphologically the lesion must be considered an ulcer. Thus carcinomas range, with intermediate gradations, from tumors to ulcers.

Histologic variations also affect the roentgenologic picture. Soft medullary carcinomas, the adenocarcinomas, tend to protrude prominently into the lumen, are likely to be lobulated and to ulcerate deeply. Small adenocarcinomas are often sessile, simple or compound, polypoid tumors. Scirrhous carcinoma infiltrates and thickens the gastric wall, but with less striking tumefaction than the medullary variety. Ulceration is likely to be extensive, but it is shallow and often consists of mere erosions which are widespread and irregular.

The situation of the lesion has some bearing on its roentgenologic manifestations and on the readiness with which it can be disclosed and identified. More often carcinoma arises in the prepyloric segment of the stomach, in the lesser curvature, and in the posterior wall, in perhaps that order; it may, however, have its origin in the cardia, on the greater curvature, or in any other portion of the stomach. The size of a carcinoma, of course, affects the emphasis with which its signs are manifested, and hence its demonstrability and specific recognition.
**Signs of Carcinoma:** The basic roentgenologic sign of carcinoma is local deformity of the gastric lumen, which appears as a defect and is produced by intrusion of the neoplasm, the profile or surface configuration of which is thus depicted. In most instances the defect is marginal, at certain angles of view, although, occasionally, when the growth is small and confined to the posterior or anterior wall, the defect appears as a centrally lying, transradiant area, and its elicitation may require manual pressure to displace the concealing barium mixture. As a rule, the defect, whether marginal or central, presents irregularities which are caused by deep or shallow ulceration. Small ulcerating carcinomas with little tumefaction and carcinomatous ulcers will be described separately. Almost as significant as the gross defect, and highly important in the disclosure of early carcinoma, are the less obvious alterations of gastric internal relief. Practically without exception gastric rugae are either smoothed out and effaced by the underlying tumefaction or destroyed by ulceration.

Extensive carcinoma of the median portion of the stomach sometimes produces hour-glass deformity. Usually the canal between the two loculi lies centrally and is rather irregular. A small carcinoma on or near the lesser curvature may give rise to a spastic contraction of the greater curvature opposite the growth. The contraction, or incisura, is usually broad and shallow.

When carcinoma affects the antral or middle segments of the stomach, both of which are accessible to palpation, a mass corresponding to the visible defect can be felt unless the neoplasm is exceedingly small. Palpability of a gastric tumor is strongly suggestive of malignancy. Occasionally, in early scirrhous carcinoma, a mass cannot be felt definitely, although the affected segment is stiffened and slips away under finger pressure. Such loss of flexibility is strongly suggestive of malignant infiltration. By extension of carcinoma to contiguous structures, or by the production of adhesions, the stomach may become fixed, or less than normally mobile, and the loss of mobility is determinable by manipulation.

With rare exceptions, peristalsis is absent from the carcinomatous region, and such absence is of confirmatory and differential value. Moderately obstructive carcinoma of the prepyloric segment may give rise to hyperperistalsis or antiperistalsis of the uninvaded portion of the stomach, but either manifestation is uncommon. Ordinarily, in non-obstructive carcinoma, peristalsis is less marked than in normal stomachs.

Gastric motility is notably altered in most cases and virtually without exception in those which are advanced. In the absence of obstruction, the pylorus commonly is gaping, the barium suspension flows through it almost continuously, and the stomach is evacuated in much less than normal time. This hypermotility is sometimes attributable in part to stiffening of the pyloric muscle by carcinomatous infiltration, but the concomitant achylia is doubtless the principal causative factor. Obstruction occurs in from 50 to 60 per cent of cases and is evidenced
by a residue from the six-hour meal or by scant evacuation during examination.

*Advanced Carcinoma:* In most instances the roentgenologic appearance of advanced carcinoma is striking and, to the experienced examiner, virtually pathognomonic. Scirrhous carcinoma more often begins in the antral segment, encircles it, and progresses upward. The lumen of the affected portion of the stomach is rather symmetrically narrowed and funnel-like. Its internal borders are relatively smooth, as a rule, although small irregularities are seldom absent and occasionally the channel is definitely tortuous. In extreme cases, in which almost all the stomach is affected, the barium shadow may assume a grotesque outline resembling that of a leg of mutton. One variety of scirrhous carcinoma, often included under the designation "fibromatosis," may convert the entire stomach into a smooth, rather slender tube. In fact, diminution of the stomach is a notable feature of extensive scirrhous carcinoma, and this results not only from projection of the tumor into the lumen, but also from its shrinking and shortening effect.

Moderately advanced scirrhous carcinoma, when confined to the lesser curvature, is likely to be deceptive, and the inexperienced examiner may overlook it completely. On casual observation the general form of the stomach appears to be normal, the lesser curvature seems to be smooth, and the lumen is not noticeably narrowed, or if slight narrowing is apparent it resembles that produced by external pressure. On closer inspection, however, it will be seen that the curvature is abnormally smooth, for the angular incisure is lacking, peristaltic indentations are almost invariably absent, and the rugae along the curvature are smoothed out, or the normal markings are replaced by granular shadows representing multiple, small, shallow erosions.

Advanced medullary carcinoma protrudes prominently into the lumen and, accordingly, is represented by a gross defect in the barium shadow. Usually the form and size of the stomach are not notably altered, and its capacity is lessened only to the extent that the tumor intrudes. Exceptionally, the medullary growths are not ulcerated, or at least not deeply, and they have the form of relatively smooth or smoothly lobulated, broadly sessile polyps which produce corresponding defects in the barium shadow. As a rule, the medullary tumors present deep ulcerous excavations, which appear as pseudo-niches or produce gross irregularities of the surface or profile of the masses. Not rarely the tumor is largely destroyed by ulceration.

Regardless of histologic variety, carcinoma of the cardiac segment is often difficult to discern, even when the growth is fairly advanced, and sometimes the lesion escapes recognition. To discover it, the examiner must give close attention to this region, observe the barium as it flows out of the esophagus, and take note of the appearance of the gas bubble. It is desirable, also, to force the barium mixture high into the cardia by pressure over the stomach, and frequently it is necessary to examine the patient on the fluoroscopic table. In some cases
the neoplasm obstructs the esophagus, with resulting dilatation. In others, the barium enters freely but impinges on the growth and is divided into two or more streams. If care is taken to give but one or two swallows of barium at first, the surface of a tumor on the posterior or anterior wall may be depicted by faint irregular shadows. Sometimes the shadow of the growth is faintly visible in the transradiant gas bubble. Normally, the contour of the gas bubble is regular and symmetrical, and irregularity of any part of its border, especially of its mesial aspect, is most often due to carcinoma. This sign is often present and should habitually be sought.

**Differential Diagnosis of Advanced Carcinoma:** The first task of the examiner is to determine that the shadow defects and deformities observed are really due to gastric disease, for they may have many other causes, such as food or foreign bodies in the stomach, pressure by the spine, extensive masses, ascitic fluid, gas, or feces in the colon, strong retraction of the abdominal wall, and spasm. These simulants are so well known and have been described so often that detailed discussion here should be unnecessary. Unless the examiner is familiar with their characteristics, he should scarcely attempt the examination. It will be sufficient to say that the shadow defect or deformity produced by carcinoma or other intrinsic lesion is persistent as to site and shape, is not altered by manipulation, withstands antispasmodic drugs, and is visible without change at successive examinations. Simulants of organic disease are not likely to have all of these qualities.

When it is certain that an organic lesion is present, carcinoma may require distinction from benign neoplasms, syphilis, or from diaphragmatic hernia. Benign new growths are likely to be relatively small, multiple, and pedunculated; they usually produce ovoid central defects, can be shifted to some extent by manipulation, and seldom inhibit peristaltic contraction at their sites of attachment. Benign tumors, however, are subject to malignant change, and they should be regarded as at least potentially carcinomatous. Syphilis of the pyloric or median segment of the stomach may have the appearance of scirrhous carcinoma, and extensive syphilis closely resembles fibromatosis; gastric syphilis, however, seldom if ever produces a definitely palpable tumor such as that caused by carcinoma. Further, gastric syphilis is so rare that, unless clinical and laboratory evidence of the disease is strongly positive, diagnostic preference should be given to carcinoma. Hernia of the stomach through the diaphragm is sometimes confounded with carcinoma, but the former is distinguishable by the fact that a portion of the stomach lies above the line of the diaphragm.

**Early Carcinoma:** The diagnosis of small, and presumably early, carcinomas is less simple than that of the advanced lesions. Three varieties may be considered: (1) carcinomatous tumors without extensive ulceration, (2) ulcerating carcinomas, and (3) carcinomatous ulcers.

1. Small, pedunculated or sessile adenocarcinomas, without marked ulceration, are encountered occasionally by the roentgenologist. Be-
cause they are small and often pedicled, they are likely to be mistaken for benign growths. Early, infiltrating, scirrhous carcinomas, affecting a limited area on the lesser curvature or elsewhere, are exceedingly hard to disclose, for they seldom produce an evident shadow defect. Absence of peristalsis in the affected portion may be suggestive, but peristalsis of normal stomachs is often sluggish or imperceptible for periods during the examination. Moreover, peristalsis occurs sometimes, although rarely, in carcinomatous walls. A more convincing sign is local effacement of the rugae markings, for which is substituted the granular appearance indicative of multiple, shallow ulcers. Small, prepyloric scirrhous carcinomas, encircling the antrum, produce a tubular or funnel-shaped canal. Similar deformity may be caused by early syphilis, prepyloric ulcer, hypertrophic rugae, or by hypertrophy of the pyloric muscle. Pyloric hypertrophy usually causes a slight rounded invagination of the bulbar base and is also marked by a crevice at the middle of the greater curvature border of the narrowed canal; both marks are wanting in carcinoma. Hypertrophic rugae can be identified by their pronounced parallel markings. Carcinoma may be palpable; syphilis and prepyloric ulcer are not evidenced by palpation.

2. Superficially, the small ulcerating carcinoma without obvious tumefaction resembles simple ulcer, but on closer observation the former presents characteristics that permit of its distinction from benign ulcer, and these characteristics practically are pathognomonic. Most important is the fact that, with these malignant lesions, tumefaction persists in a degree sufficient to form a slightly elevated border about the ulcerous excavation. If the new growth is on the lesser curvature, the ridge appears, under pressure, as a semicircular clear stripe separating the shadow of the barium-filled crater from that of the stomach. If the lesion is on the posterior wall, the ridge is seen, under pressure, as a transradiant halo about the dense crater. Further, the crater, being excavated in neoplastic tissue, does not project beyond the normal confines of the gastric lumen; it is not tender to pressure, and gastrospasm is conspicuously absent.

3. Remaining for consideration are carcinomatous ulcers, the lesions that morphologically are merely ulcers without macroscopic or roentgenologic evidence of tumefaction. If the niche of what otherwise seems to be a simple ulcer is unduly large, with a diameter of more than 2.5 cm., it will prove usually, but not invariably, to be malignant. When the niche is not excessively large, other marks may suggest malignancy; they include irregularity of the border or base of the niche, effacement of normal arrangement of adjoining rugae, absence of gastrospasm, and absence of localized tenderness. But a small percentage of what seem both roentgenologically and clinically to be typical benign ulcers prove on microscopic examination to be malignant. In this connection it may be pointed out that, although some of the early carcinomas of any type will escape diagnosis, the percentage of failures can be held to a minimum by active coöperation of the roentgenologist and the clinician, for either may discover a single suggestive circumstance that
will impel the other to a more exhaustive reexamination and thus lead to a correct final diagnosis.

Resectability: Manifestly, the resectability of gastric carcinoma in a given instance depends on the skill of the surgeon, the situation of the lesion, its extent, and the presence or absence of metastasis. Roentgenologic examination can furnish more or less explicit information concerning most of these features.

For reasons that are obvious, carcinoma in the upper portion of the cardia is almost never resectable, whereas a malignant lesion of the middle third of the stomach or one of the pyloric segment is usually operable unless other elements forbid intervention. It is usually true that carcinoma of the distal half of the stomach is resectable if the growth does not extend well above the angular incisura, but if the invasion extends much above this point operation is seldom feasible.

In estimating the probable extent of invasion, it is to be remembered that the shadow defect depicting a medullary carcinoma represents rather closely the actual limits of disease, whereas scirrhous carcinoma infiltrates the gastric wall beyond the limits of the shadow-defect and a liberal allowance must be made for undepicted invasion. Fixing the limit of resectability at the angular incisure is of course arbitrary, for expert surgeons can, if necessary, perform total gastrectomy. Incidentally, it may be mentioned that a long subdiaphragmatic portion of the esophagus facilitates total gastrectomy, although such elongation is not often encountered. Another circumstance which makes any operation on the stomach easier to perform is a wide epigastric angle, and the converse is true of a narrow angle.

But these are not all the factors that enter into the problem of operation. Fixation of the stomach by adhesions of the diseased segment to adjoining structures may make resection difficult or impossible. If metastasis has occurred, operation will be largely or completely futile. Metastasis to the lungs, which rarely ensues from gastric carcinoma, or to the bones, is demonstrable on roentgenologic examination, but this will not disclose metastasis to abdominal lymphatic structures nor to other abdominal organs. On the whole, many carcinomas which appear roentgenologically to be resectable are found on exploration to be inoperable; the reverse, however, seldom occurs.

It is evident that if greater hope is to be held out to patients with gastric carcinoma, the disease must be found more often at an early stage when surgical intervention offers better prospects of success. Unfortunately, symptoms of early carcinoma usually are few and trivial, or completely lacking, and roentgenologic examination is practically the sole means of disclosing the disease. If the clinician will require roentgenologic inspection of the stomach as a standard feature of examination, especially of persons beyond thirty years of age, and more especially of those who have symptoms of dyspepsia however slight, a greater proportion of early carcinomas will be discovered. Further, when roentgenologic examination reveals gastric disease the nature of which is at all doubtful, the diagnosis should always include
carcinoma as a possible alternative, for approximately three-fourths of the gastric lesions exposed on the operating table are malignant.

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