# THE PANCREATIC-FUNCTION TEST — METHOD AND NORMAL VALUES

S. BANK, M.B., CH.B., M.R.C.P. (LOND.);* I. N. MARKS, B.SC., M.B., CH.B., M.R.C.P. (EDIN.);† M. G. MOSHAL, B.SC., M.B., CH.B.; G. EFRON, M.B., CH.B., M.MED.; and MISS R. SILBER

*From the Gastro-Intestinal Service, Groote Schuur Hospital, and the Departments of Medicine and Surgery, University of Cape Town*

The collection and measurement of the duodenal contents following secretin stimulation has been employed as a test of pancreatic function in specialized clinics for almost 25 years.[1-3] The secretin test of pancreatic function was modified by various workers,[4-8] and different criteria of normality were described according to the method employed.

The discovery of pancreozymin[9] prompted a further modification of the secretin test, to include pancreozymin stimulation.[10,11] The use of combined secretin-pancreozymin stimulation appeared justified because of the known stimulant effect of secretin on volume and bicarbonate response and the effect of pancreozymin on enzyme response. The secretin-pancreozymin test of pancreatic function was extended to include serial blood-enzyme determinations.[12,13] This secretin-pancreozymin provocative enzyme test soon replaced the older and rather unreliable provocative enzyme tests. The introduction of these two modifications necessitated the establishment of appropriate criteria of normality. However, values differ according to the exact procedure and biochemical methods used for the enzyme determinations.[12,14a,14b,15]

During the past 3 years the secretin-pancreozymin pancreatic-function test has been carried out on 450 subjects at the Gastro-Intestinal Service at Groote Schuur Hospital. The purpose of this paper is to describe the methods used to define the local normal values for the duodenal aspirate and serum enzymes in this series. In addition, the ancillary tests that have been used as a routine in assessing pancreatic disease will be discussed briefly and their normal values presented.

## METHOD OF THE PANCREATIC-FUNCTION TEST

The method described by Marks and Tompsett[12] was carried out in all cases. Minor modifications were introduced largely to cope with the bulk of patients referred for investigations. These were: (*a*) intubation on the morning of the test, and (*b*) venepuncture for serum enzymes 1 hour after the injection of secretin, and ½, 1 and 2 hours and often 4 hours after the injection of pancreozymin. The details of our method are as follows:

1. A No. 16 or 18 Rüsch radiopaque nasogastric tube was passed into the stomach. Under fluoroscopic control in the supine position, the tip of the tube was advanced towards the pylorus. Passage through the pylorus was facilitated by placing the patient in the right lateral position and by firm manual compression of the lower abdomen. In most subjects, entry into the duodenum was accomplished without difficulty within 5 - 15 minutes. Pylorospasm occasionally required leaving the patient in the right lateral position for ½ - 2 hours before rescreening; failure to negotiate the pylorus rarely occurred. The duodenal tube was positioned with its tip at the junction of the second and third parts of the duodenum, immediately adjacent to the right vertebral border.

2. A second tube (No. 14 or 16 Rüsch) was passed into the stomach through the other nostril and positioned to lie in the dependent part of the stomach immediately to the left of the vertebral border. Particular attention was paid to correct positioning of the gastric tube to prevent gastric contamination of the duodenal contents.

3. Continuous suction at a pressure of 5 inches of Hg was applied to both tubes, and this was supplemented by frequent manual aspiration to ensure patency. The test was started when the duodenal aspirate became alkaline, and a 10 - 20 minute basal sample was collected in most patients.

4. Secretin* (Boots)—1 unit per kg. body weight in 20 ml. of normal saline — was administered intravenously, and a 60-minute 'post-secretin' duodenal aspirate was collected in 4 samples; 2 of 10 minutes and 2 of 20 minutes. The volume and intensity of bile staining of each sample was noted, and the 2 10-minute and the 2 20-minute samples were pooled to make 20- and 40-minute collections respectively.

5. Pancreozymin* (Boots)—1·5 units per kg. body weight in 20 ml. of normal saline — was then given intravenously over a period of 3 minutes, and a further 20 minutes' 'post-pancreozymin' collection was obtained. The intensity of bile staining was again noted.

6. Blood was taken 1 hour after secretin, and ½, 1 and 2 hours after pancreozymin, for the provocative enzyme tests. A further specimen was taken 4 hours after the test in many patients.

To ensure satisfactory collections, the colour and pH of the duodenal and gastric secretions were checked at frequent intervals and the tubes were adjusted under fluoroscopic control, if necessary. Aliquots of the 2 post-secretin collections and 1 post-pancreozymin collection were immediately separated for biochemical estimations. Part of the aliquot, for amylase estimation, was thoroughly mixed with an equal volume of glycerol to increase enzyme stability,[5] and the remainder was kept under liquid paraffin for bicarbonate estimation.

Testing for secretin and pancreozymin sensitivity before the test, was carried out only in patients with a history of allergy. Severe anaphylactoid reactions were not seen in this series. An occasional patient experienced sweating and shivering at the end of the secretin period, but rigors in 1 patient necessitated stopping the test. Pancreozymin produced a transient sensation of warmth, abdominal cramps, and nausea in most patients.

### Investigations

The following investigations were carried out:

1. *Duodenal aspirate.* (*a*) The volume of each sample was measured and the total 80-minute volume determined by simple addition of the 3 amounts. (*b*) Bicarbonate concentration and output were measured — the standard bicarbonate method using the Van Slyke apparatus was carried out. The output was calculated by multiplying the concentration (in mEq./l.) by the volume. (*c*) Amylase concentration and output (and occasionally lipase and trypsin) were measured. (*d*) Biliary content of the aspirate was recorded simply as nil to 4 plus. (*e*) Microscopy of the pooled collection for cholesterol crystals, bile pigment and parasitic ova was done. (*f*) Examination for malignant cells was undertaken where indicated.

2. *Provocative-enzyme test.* Serum amylase, lipase and trypsin were determined on the 4 or 5 blood samples obtained after stimulation.

### Biochemical Methods

*Enzyme Determinations*

For the first 2 years of this study well-documented methods

*Ben May Fellow in Gastro-enterology.
†Senior Bursar, Council for Scientific and Industrial Research.

*Available from Boots Pure Drug Co. Ltd., Nottingham, UK.

for determining the pancreatic and serum enzymes were used. To cope with the increased demand for the tests, both for routine and research purposes, the department of chemical pathology was approached to try to simplify and shorten the techniques. New methods for amylase and lipase determinations were subsequently developed[14a,14b] and have been used over the latter part of this series. This has allowed a greater number of estimations to be carried out simultaneously.

*Pancreatic amylase*: This was determined initially by a modification[12] of the method of Lagerlöf.[3] The results were expressed in Lagerlöf units. Latterly Pimstone's[14a] modification of the Gomori method was used. The result was expressed as the number of mg. of starch digested by 1 ml. of pancreatic juice in ½ an hour at 37°C.

*Serum amylase*: This was determined initially by the Wohlgemuth method[15] and more recently by Pimstone's[14a] modification of Gomori's method. The result was expressed as the number of mg. of starch digested by 10 ml. of serum in ½ an hour at 37°C.

*Pancreatic and serum lipase:* This was determined initially by the method of Cherry and Crandall,[16] using olive oil as the substrate and N/20 NaOH to neutralize the fatty acids liberated. Pimstone's[14b] modification of the Gomori method, using alpha-naphthyl laurate as the substrate, and a diazonium salt (fast violet B) as the colour reagent, was later employed. This result was expressed as the number of micromoles of alpha-naphthol liberated by 1 ml. of pancreatic juice or 1 ml. of serum in 3 hours at 37°C.

*Trypsin*: This was determined by the method described by Nardi,[17] using benzoyl-I-arginine amide HCl as the substrate, and was expressed as units of tryptic activity.

*Glucose-tolerance Test*

A standard 2-hour glucose-tolerance test, using 50 G. of oral glucose, was carried out. Fingerprick blood sugars were determined by the method of Hagedorn and Jensen.[18] The glucose-tolerance test after cortisone loading[19] was carried out in a few patients.

*Faecal Fat Excretion*

This was estimated by the 5-day radio-triolein technique, followed by chemical analysis by the method of Van de Kamer *et al.*[20]

NORMAL VALUES

## Material and Method

Two groups of subjects were selected to enable the local normal values to be calculated. These comprised 37 control subjects and 36 patients with unequivocal pancreatic disease, as shown by calcification of the pancreas.

The control group consisted of 4 normal subjects, 21 patients with overtly functional complaints, and 11 patients with a variety of diseases totally unrelated to pancreatic pathology. This group did not include any patients with diabetes, peptic ulceration, carcinoma, obesity or small-bowel disease, or patients who had had abdominal operations. Particular attention was paid to alcohol consumption, and the subjects in this group were either teetotal or only occasional mild drinkers.

Of the 36 patients with chronic calcific pancreatitis, all had overt or biochemical evidence of abnormal glucose tolerance, and 16 had obvious or chemical steatorrhoea. The pancreatitis was due to alcohol in all but 3.

## Statistical Methods

The following parameters were subjected to statistical analyses in the two groups: (1) mean amylase concentration in the 80-minute collection, (2) mean bicarbonate concentration in the 80-minute collection, and (3) volume.

The following statistical methods were used in the various groups: (*a*) mean ±2 standard deviations (SD), and (*b*) estimation of the 10th and 90th percentiles. The second method[21] was included since the mathematical distribution was not always of the Gaussian type.

## Results

*Amylase Concentration in the 80-minute Duodenal Aspirate*

Fig. 1 shows the distribution curve and Table I the mean, range, and standard deviations, and the lower limits of normal and upper limits found in the control and pancreatic calcification groups respectively.

(*a*) *Lagerlöf method:* In the controls the lowest limit of normal (mean −2 SD) was 1·9 units per ml. (u/ml.). However, with the use of the percentile method a level of 3·1 u/ml. was calculated. In the pancreatic disease group, the upper limit found was 3·4 u/ml. when the mean +2 SD was calculated and a figure of 2·8 u/ml. was derived with the percentile method.

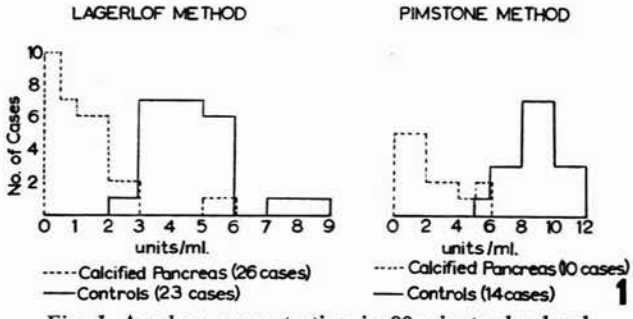


*Fig. 1.* Amylase concentration in 80-minute duodenal aspirate, by the Lagerlöf and Pimstone methods.

TABLE I. AMYLASE CONCENTRATION IN 80-MINUTE DUODENAL ASPIRATE—RANGE, MEAN AND LIMITS OF NORMAL

| | *Control group* | | *Calcific pancreatitis* | |
|---|---|---|---|---|
| | *Mean* | *Range* | *Mean* | *Range* |
| Lagerlöf (u/ml.) .. | 4·6 ±1·35 | 2·3 − 8·2 (23)* | 1·08±1·17 | 0−5·4 (26) |
| Pimstone (u/ml.) .. | 8·82±1·6 | 5·4−11·9 (14) | 2·65±1·89 | 0·3−5·7 (10) |

| | *Lower limit of normal* | | *Upper limit* | |
|---|---|---|---|---|
| | *Mean −2SD* | *10th percentile* | *Mean +2SD* | *90th percentile* |
| Lagerlöf units .. | 1·9 | 3·1 (23) | 3·4 | 2·8 (26) |
| Pimstone units .. | 5·6 | 5·4 (14) | 6·4 | 5·7 (10) |

* Numbers in brackets indicate number of subjects in each group.

Consideration of both forms of analyses suggested that an amylase concentration in the 80-minute aspirate below 1·9 u/ml. was indicative of undoubted pancreatic disease. These findings are further substantiated by reference to the distribution curve (Fig. 1), where the extent of overlap is shown. Apart from 1 patient in the pancreatic-disease group, the overlap in the 2 groups occurred only between 2 and 3 units/ml.; in most cases the separation was clear.

*We have therefore, taken a duodenal amylase concentration of less than 1·9 Lagerlöf u/ml. as diagnostic of pancreatic disease, and a concentration between 1·9 and 3·4 u/ml. as diagnostic only if 1 of the other 2 parameters of exocrine function was borderline as well,* viz. *volume or bicarbonate.*

(*b*) *Pimstone method:* With the 'new method' the statistical analysis showed that the calculated lower levels in the

control group were 5·6 and 5·4 u/ml. for mean −2 SD and 10th percentile respectively. The upper limit in the disease group was 6·4 and 5·7 u/ml. using the mean +2 SD and percentile methods respectively.

The distribution curve, however, showed that none of the controls had an amylase concentration of less than 5 u/ml. and that the extent of the overlap between the two groups occurred only in the 5 and 6 u/ml. range.

*Since the numbers are relatively small, an amylase concentration below 5 Pimstone u/ml. has been taken as diagnostic of pancreatic disease and a level between 5 and 6 u/ml. as suggestive if it occurred alone or diagnostic if either the volume or bicarbonate concentration was borderline.*

*Bicarbonate Concentration in the 80-minute Duodenal Aspirate*

Fig. 2 shows the distribution curve and Table II the mean, range, and standard deviations, and the lower limits of normal in the control group and upper limits found in patients with calcific pancreatitis.

In the 37 control subjects, the lowest limits of normal were 60 mEq./l. (mean −2 SD) to 67 mEq./l. (10th percentile). Conversely, the upper limits of bicarbonate concentration ranged from 60 mEq./l. to 65 mEq./l. when analysed in this way.

The distribution curve (Fig. 2) shows that the bulk of the overlap between the normal and diseased groups occurred in the values between 50 and 70 mEq./l., but there was in fact only 1 control patient with a value below 60 mEq./l. while 4 patients with pancreatitis had levels of 60 mEq./l. or above.

*An 80-minute bicarbonate concentration of 60 mEq./l. or less was regarded as diagnostic of pancreatic disease if it was the only abnormal parameter, and a value between 60 and 67 mEq./l. as suggestive if either the amylase or volume was in the borderline range as well.*

*Volume of the 80-minute Collection*

Fig. 3 shows the distribution curve and Table III the mean, range, and standard deviations, and the lower limits of normal in the control group and upper limits found in the calcific pancreatitis group for the 80-minute post-secretin-pancreozymin volume of the duodenal aspirate.

Table III shows that the lower limit of volume secretion in the control group varied between 108 and 155 ml., depending on the type of analysis used. In the calcific

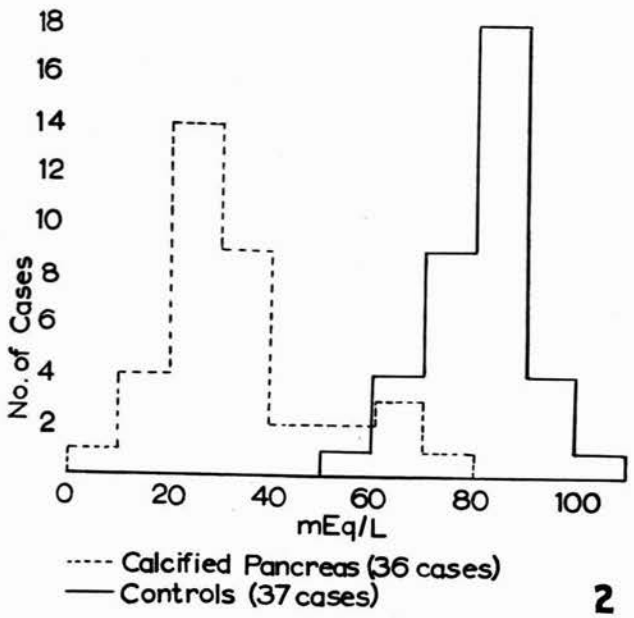


*Fig. 2.* Bicarbonate concentration in 80-minute duodenal aspirate.

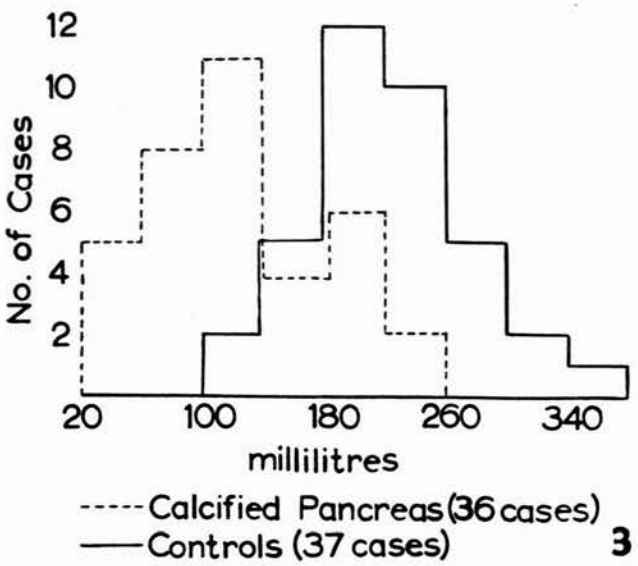


*Fig. 3.* Volume of 80-minute duodenal aspirate.

TABLE II. BICARBONATE CONCENTRATION IN 80-MINUTE DUODENAL ASPIRATE—RANGE, MEAN AND LIMITS OF NORMAL (VAN SLYKE, IN MEQ. PER LITRE)

| *Control group* | | *Calcific pancreatitis* | |
|---|---|---|---|
| *Mean* | *Range* | *Mean* | *Range* |
| 80·9±10·3 | 56—108 (37)* | 33±16 | 9—78 (36) |

| *Lower limit of normal* | | *Upper limit* | |
|---|---|---|---|
| *Mean−2 SD* | *10th percentile* | *Mean +2 SD* | *90th percentile* |
| 60 | 67 (37) | 65 | 60 (36) |

* Numbers in brackets indicate number of subjects in each group.

TABLE III. VOLUME OF 80-MINUTE DUODENAL ASPIRATE—RANGE, MEAN AND LIMITS OF NORMAL (IN ML.)

| *Control group* | | *Calcific pancreatitis* | |
|---|---|---|---|
| *Mean* | *Range* | *Mean* | *Range* |
| 221±57 | 115—390 (37)* | 122 | 23—234 (36) |

| *Lower limit of normal* | | *Upper limit* | |
|---|---|---|---|
| *Mean −2SD* | *10th percentile* | *Mean +2SD* | *90th percentile* |
| 108 | 155 (37) | —† | 204 (36) |

* Numbers in brackets indicate number of subjects in each group.
† Could not be calculated.

pancreatitis group the upper level was 204 ml. for the percentile analysis, but the individual values were too widely distributed to permit a satisfactory figure for the mean +2 SD.

The wide overlap between the control and diseased group is indicated by the distribution curve (Fig. 3).

*A level of less than 100 ml. in the 80-minute duodenal aspirate was considered diagnostic of intrinsic disease or of extrinsic pressure upon the pancreas. A volume between 100 and 140 ml. was regarded as suspect if unassociated with any other abnormality, but highly suggestive of pancreatic disorder if either the amylase or bicarbonate were borderline. Levels between 140 and 400 ml. were regarded as having no diagnostic value, irrespective of the patient's body weight. A volume greater than 400 ml. was suggestive of hepatic cirrhosis, and a volume greater than 500 ml. of haemochromatosis.*

*Provocative Serum-enzyme Test*

Table IV shows the upper limits of normal for serum amylase, lipase and trypsin accepted by our laboratory, and the established values constituting a positive result in any of the 4 blood samples taken after secretin and pancreozymin stimulation.

TABLE IV. NORMAL UPPER LIMITS FOR SERUM ENZYMES AND ACCEPTED POSITIVE VALUES FOR THE PROVOCATIVE ENZYME TEST

| | Method | Normal upper limit (serum) | Positive provocative test |
|---|---|---|---|
| | | Units | Units |
| Amylase | Wohlgemuth | 10 | > 13 |
| | Pimstone | 140 | > 180 |
| Lipase | Cherry and Crandall | 0·5 | > 0·5 |
| | Pimstone | 0·2 | > 0·25 |
| Trypsin | Nardi | 100 | > 100 |

Serum-amylase elevation was found to be the most sensitive index of the provocative tests, but isolated elevations of trypsin or lipase were sometimes noted. Wherever possible, all 3 enzyme determinations were therefore carried out on each blood sample to increase the diagnostic yield.

*Biliary Response to Secretin and Pancreozymin Stimulation*

The biliary response to stimulation was visually assessed on each sample of duodenal aspirate and graded 0 (colourless) to 4 (black), depending on the amount of bile present. The biliary response to secretin and pancreozymin stimulation in the control group was as described by Marks.[22] A moderate amount of bile was usually present following secretin, but the amount usually diminished to little or none during the latter part of the post-secretin hour; the post-pancreozymin response was characteristically very dark or black, owing to the gallbladder-contracting activity of cholecystokinin, a useful impurity in the pancreozymin preparation. A completely colourless duodenal aspirate throughout the test was virtually diagnostic of common bile duct obstruction from common duct carcinoma. A biliary response of less than 2 throughout the 80-minute collection was suggestive of impaired gallbladder function.

*Glucose Tolerance*

The following criteria were accepted as an index of impaired glucose tolerance: (*a*) transient glycosuria during an acute attack; (*b*) a fasting blood-sugar level greater than 120 mg. per 100 ml.; (*c*) abnormal glucose tolerance in which the glucose-tolerance test showed a rise in the blood-sugar level exceeding 200 mg. per 100 ml. at the 1-hour period or a level greater than 135 mg. per 100 ml. at 2 hours; (*d*) sub-clinical diabetes — fasting blood sugar normal, but 1-hour and 2-hour figures exceeding 200 and 135 mg. per 100 ml. respectively; and (*e*) overt diabetes.

*Faecal Fat*

The upper limit of daily chemical fat excretion and the radio-triolein content of the 5-day stool for this laboratory have previously been described by Bank *et al.*[23] Impaired fat digestion was indicated by a chemical faecal fat excretion greater than 5·8 G. per day and a percentage radioactivity in the 5-day stool in excess of 6·3% of the administered dose.

## DISCUSSION

*Duodenal Aspirate*

It is unfortunate that the various workers using secretin and pancreozymin stimulation as a test of pancreatic function have employed different techniques and indeed different doses of the stimuli in their respective studies. Howat[24] and Burton *et al.*[25] collected 3 10-minute post-secretin and 3 10-minute post-pancreozymin duodenal aspirates and compared the results in normal subjects with those found in various disease states. Their normal values were calculated from the mean ±2 SD, and they placed most reliance on volume and amylase output per kg. body weight and maximal bicarbonate concentration for the individual 10-minute collections. As expected, significant differences were obtained between normal subjects and patients with chronic pancreatitis or pancreatic neoplasms. Sun and Shay[26] collected a single 10-minute post-pancreozymin response followed by a 60-minute post-secretin response and expressed their results in 15 'normal' subjects in terms of volume per kg. body weight, maximal bicarbonate concentration, amylase concentration in mg. per 100 ml., and amylase output in mg. Dreiling and Janowitz[27] modified the test slightly by collecting a 20-minute post-pancreozymin response followed by a 60-minute post-secretin response.

Marks and Tompsett[12] had earlier reported on an 80-minute test in which secretin was injected at the commencement of the test followed, after 60 minutes, by the administration of pancreozymin. Their rationale for this particular routine was based on the fact that the pancreatic response to secretin stimulation persists for about 80 minutes or longer, whereas the response to pancreozymin is of much shorter duration. Although they measured volume, bicarbonate content and amylase concentration on each of 2 10-minute and 2 20-minute post-secretin samples, and on 2 10-minute post-pancreozymin samples, they showed that sufficient diagnostic information could be obtained by determination of the volume, bicarbonate content and amylase activity of the pooled 80-minute specimen of duodenal contents. Nineteen 'normal' subjects and 26 patients with pancreatic disease were tested, but the

lowest values encountered in the 'normal' subjects, rather than the calculated lower limits of normal, were used in determining the abnormal response.

The present study was undertaken to provide more acceptable criteria for defining an abnormal response in the 80-minute secretin-pancreozymin test described by Marks and Tompsett.[12] Data obtained from 37 control subjects and 36 patients with unequivocal evidence of pancreatic disease were examined. The 80-minute volume and the mean bicarbonate and amylase concentrations were calculated from data derived from 0 - 20, 20 - 60 and 60 - 80 minute collections and were subjected to statistical analysis by the mean $\pm 2$ SD and percentile methods.

Using these criteria, we have shown that a definitive diagnosis of pancreatic disease could be made by the finding of (*a*) a mean amylase concentration of less than 1·9 Lagerlöf units or 5·0 Pimstone units per ml., or (*b*) a mean bicarbonate concentration of less than 60 mEq./l., or (*c*) an 80-minute volume of less than 100 ml. It was also shown that an amylase concentration between 1·9 and 3·4 Lagerlöf units or between 5·0 and 6·0 Pimstone units per ml., a bicarbonate concentration between 60 and 67 mEq./l., or an 80-minute volume between 100 and 140 ml. were borderline values if occurring alone, but virtually diagnostic if in combination with a borderline value in one of the remaining 2 parameters. A low amylase concentration proved to be the most sensitive index of pancreatic disease, and the 80-minute volume the least reliable of the 3 parameters, in keeping with the findings of Marks and Tompsett.[12]

The volume per kg. body weight, the maximal bicarbonate concentration of the 3 collections and the amylase and bicarbonate output were also determined. These measures did not increase the diagnostic yield of the test, however. The fact that the 80-minute volume, absolute or corrected for body weight, showed the greatest overlap between the control and disease groups, afforded an explanation for the failure of bicarbonate or amylase output to add to the diagnostic value of the test.

Although bicarbonate and amylase estimations on a pooled 80-minute aliquot would have considerably reduced the laboratory load without detracting from the diagnostic value of the test,[12] estimations were carried out on 2 post-secretin aliquots and 1 post-pancreozymin aliquot to gain further information on the relative importance of the pancreozymin stimulus. Despite evidence to the contrary reported with a different technique,[25] the question whether pancreozymin adds appreciably to the diagnostic yield of the secretin component of the 80-minute pancreatic-function test must remain open. However, it would seem that addition of the pancreozymin stimulus has increased the sensitivity and specificity of the provocative enzyme test. For practical purposes, biochemical estimations need only be carried out on an aliquot of the pooled 80-minute collection to provide a measure of pancreatic function, and an index of gallbladder function can be obtained simply by noting the intensity of bile staining of each of the samples before pooling.

*Provocative Enzyme Tests*

The results of the provocative tests under conditions of secretin, morphine, or cholinergic stimulation, singly or together, led Dreiling and Richman[28] to the conclusion that these tests had no value in the diagnosis of pancreatic disorder. The positive results found in a proportion of patients with pancreatic disease were vitiated, to a large extent, by the high incidence of false positive results in normal subjects. The more recent experience with combined secretin-pancreozymin stimulation, however, suggests that more reliable results may be obtained with this combined stimulus.[13,26] Burton *et al.*[13] considered that this submaximal enzyme secretory stimulus caused little or no rise in the pancreatic enzymes in blood serum when the gland was normal, but caused a significant rise in serum enzymes when the pancreas was diseased and duct obstruction with or without inflammation was present. Obstruction impedes the outflow of pancreatic juice, and increased absorption of the enzymes into the blood stream is further facilitated by the increased permeability associated with inflammatory change. The incidence of false positive results in our series, based on operative evidence of pancreatic disease, was only 4% and offers strong support for the claims made by previous workers regarding the usefulness of the provocative enzyme test, utilizing combined secretin-pancreozymin stimulation.[13,26] Moreover, the test was most frequently positive in patients investigated after a recent attack of acute pancreatitis, some of whom showed a normal result with the pancreatic-function test. The provocative test was positive in about twice as many patients with non-calcific pancreatitis as with calcific pancreatitis.

The relatively high incidence of positive provocative enzyme results in mild to moderate pancreatic insufficiency and the frequent finding of disturbed glucose tolerance in more advanced pancreatic disorder have suggested the use of these 2 tests only for the diagnosis of pancreatic disease.[13,24] The tests are not necessarily abnormal in such patients, however, and it should be remembered that abnormal glucose tolerance or a positive provocative test may sometimes occur in patients without pancreatic disease. It is for these reasons that we have always combined these 2 tests with the more reliable but time-consuming pancreatic-function test involving duodenal intubation.

*Enzymes in the Acute Attack*

The pancreatic-function, provocative enzyme and glucose-tolerance tests are little more than confirmatory in patients in whom the levels of serum amylase, lipase and trypsin taken during an attack of abdominal pain support a clinical diagnosis of acute pancreatitis. However, the confident diagnosis of acute pancreatitis by means of the serum-amylase level alone conventionally demands a 10-fold increase over the upper limit of normal. This diagnostic level, in our experience, is unusual except in patients with acute gallstone pancreatitis.

We consider the pancreatic-function test justifiable, and indeed necessary, in patients with a *clearly significant* serum-amylase elevation, to help exclude a diagnosis of gallstone pancreatitis by means of microscopic examination of the duodenal aspirate.

The pancreas in alcoholic pancreatitis is usually compromised by recurrent mild attacks developing against a background of alcoholic insult,* and such patients not infrequently show only a mild elevation in serum enzymes

*See article by Marks and Bank on page 1039 of this issue of the *Journal*.

during an attack. We have, therefore, accepted a two-fold increase in serum enzymes as supportive evidence of a clinical diagnosis of pancreatitis, but have employed the pancreatic-function, provocative enzyme and glucose-tolerance tests in these patients to provide further confirmation of the diagnosis.[29]


## SUMMARY

The method of the 80-minute combined secretin-pancreozymin pancreatic-function test is described.

The lower limits of normal for the volume, bicarbonate concentration and amylase concentration in the 80-minute duodenal collection were analysed statistically in 37 subjects free of pancreatic or gastro-intestinal disease and were compared with the upper limits found in 36 patients with chronic calcific pancreatitis.

Normal values for serum amylase, lipase and trypsin after secretin and pancreozymin stimulation obtained in this laboratory are given and the value of the provocative enzyme test is discussed.

The ancillary tests in the investigation of pancreatic disease are briefly discussed and the normal values presented.


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