Prediction of gall-stone pancreatitis by computer

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Summary and conclusions

The clinical features at presentation of 53 patients admitted with primary acute pancreatitis due to gall stones were compared with those of 31 patients in whom the disease was due to other causes. Between these two groups 10 significant differences existed. By listing the frequency of symptoms and signs for each group a computer data base was prepared and incorporated into a program used in the differential diagnosis of acute abdominal pain. A program written to predict the presence of gall stones in patients with acute pancreatitis was accurate in 92% of the patients studied. A predictive index devised from the presence of three of the significantly differing clinical features correctly identified 82% of patients with gall-stone pancreatitis.

Predicting the presence of gall stones on admission by analysing the presenting symptoms and signs with a computer had an accuracy comparable to that of ultrasonography or radiology and may be of value in the management of patients with acute pancreatitis.

Introduction

Acute pancreatitis presents a major diagnostic and therapeutic challenge. Not only is the treatment controversial and unsatisfactory but the disease has a high mortality rate.[1] While under 2% of all patients admitted to surgical units with acute abdominal pain have acute pancreatitis,[2 3] the disease caused 665 deaths in England and Wales during 1976.[4] The mortality rate is related to the severity of the attack when assessed by objective clinical criteria.[5 6] Although an overall mortality rate of 6-11% is reported nationally, nearly one-third of severely ill patients succumb to the disease.[7 8] To reduce this figure appropriate energetic management is needed, which demands early accurate diagnosis. The condition may be unsuspected or misdiagnosed owing to the variability of presentation, and less than half the patients with acute pancreatitis are correctly diagnosed on admission.[9 10] Analysis of patients' clinical details by computer has shown that computer-aided diagnosis is consistently more accurate than a senior clinician[11] and that mild and severe forms of the same disease may be differentiated.[12]

Recent reports have questioned the timing of biliary surgery after acute gall-stone pancreatitis[13 14] and emphasised the reduction in morbidity (without increased mortality) when early cholecystectomy is performed. We undertook this study to see whether clinical differences existed at presentation between patients with gall-stone pancreatitis and those in whom the disease was due to other causes and, if they did exist, to assess whether computer analysis would accurately predict the existence of gall stones.

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Patients and methods

The surgical unit of this hospital admits annually 1100 patients with acute abdominal pain from a regional population of 140 000. The history, physical findings, investigation results, and provisional and final diagnoses are recorded on a multiple-copy admission proforma (fig 1). Patients were included in the study when primary acute pancreatitis was suspected on clinical grounds and confirmed by the finding of serum amylase activity above 2000 IU/l or by characteristic laparotomy findings.[1] The presence of gall stones was confirmed by oral cholecystography or intravenous cholangiography, or both, plus the findings at operation. In addition, after the acute attack of the illness all patients were investigated by upper gastrointestinal endoscopy or barium-meal examination, or both. No patient with recurrent or postoperative pancreatitis (or hyperamylasaemia due to other causes) was included in the study.

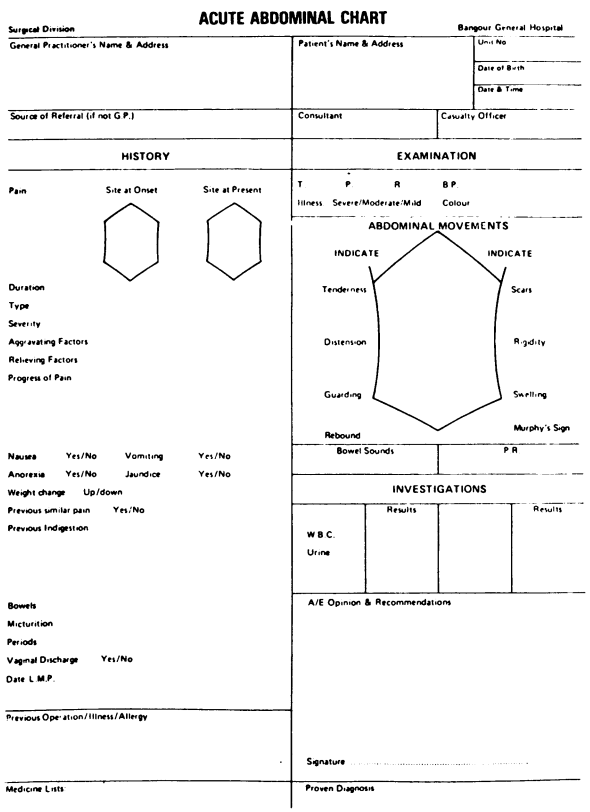

FIG 1—Chart for acute abdominal pain used for documentation and computer analysis.

Between April 1973 and July 1977, 104 patients aged 11-85 years were admitted with a diagnosis of acute pancreatitis, of whom 84 fulfilled these criteria. For each patient a total of 38 individual clinical features were collected from the proforma (table I) and stored in a Digital PDP11/10 computer, which delivered a printout listing the frequency of each symptom and sign according to the aetiological group (fig 2). Statistical analysis of the data was performed using Fisher's exact test.

Details of computer and program—The memory of the computer contained a data base for each of the following nine diseases: appendicitis, diverticulitis, perforated duodenal ulcer, non-specific abdominal pain, acute cholecystitis, intestinal obstruction, acute pancreatitis, ureteric colic, and dyspepsia. The new data bases

TABLE I—*Clinical details analysed*

- General details:
  - Age and sex
- Pain:
  - Site at onset
  - Site at present
  - Aggravating and relieving factors
  - Progress
  - Duration
  - Type at onset
  - Type at present
- Other symptoms:
  - Nausea
  - Vomiting
  - Anorexia
  - Indigestion
  - Jaundice
  - Bowel habit
  - Bladder function
- History:
  - Previous similar pain
  - Previous abdominal surgery
  - Drugs
- General examination:
  - Colour
  - Temperature
  - Pulse rate
- Abdominal inspection:
  - Movements
  - Scars
  - Distension
- Abdominal palpation:
  - Site of tenderness
  - Rebound tenderness
  - Guarding
  - Rigidity
  - Swellings
  - Murphy's sign
- Other findings:
  - Abdominal auscultation
  - Rectal examination
- Laboratory investigations*:
  - Total white cell count
  - Differential white cell count
  - Serum amylase activity
  - Serum bilirubin concentration

*Not included in data base.

created were incorporated in the memory and a program written to analyse the data using Bayes's theorem to predict the probability of the presence of gall stones in patients with acute pancreatitis. The operator performed the analysis by typing on a teletype keyboard the symptoms and signs of each patient in numerical code form (fig 3). The results of the analysis listed the percentage probability for each of the nine diseases followed by a prediction of the likelihood of gall stones being present in patients with acute pancreatitis (fig 4). The

CODE	SYMPTOM	NS P	S
50	PROGRESS PAIN GETTING BETTER	2	11
51	PROGRESS NO CHANGE IN PAIN	15	16
52	PROGRESS PAIN GETTING WORSE	14	26
53	DURATION UNDER 12 HRS	13	23
54	DURATION 12-24 HRS	11	17
55	DURATION 24-48 HRS	2	2
56	DURATION OVER 48 HRS	5	11
57	PAIN AT ONSET STEADY	20	35
58	PAIN AT ONSET INTERMITTENT	2	3
59	PAIN AT ONSET COLICKY	6	12
60	PAIN AT ONSET SHARP	3	3
61	PAIN MODERATE	9	21

FIG 2—Example of computer data base listing showing frequency of symptoms in patients with gall stones (S) and without stones (no stones; NS).

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SEX MALE
? 6
AGE 30-39
? 23
SITE ONSET EPIGASTRIC
? 36
SITE PRESENT EPIGASTRIC
? 43
AGGRAVATED BY NIL
? 49
RELIEVED BY NIL
? 52
PROGRESS PAIN GETTING WORSE
? 54
DURATION 12-24 HRS
? 59
PAIN AT ONSET COLICKY
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FIG 3—Example of clinical details fed into computer in numerical code form.

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RESULTS

APPEND DIVERT PERFOU NONSAP CHOLE  SMBOBT PANC  R.COLIC DYSPEP
 0.00   0.00   0.06   0.05   0.46   0.00  93.34   0.00   6.08
PANC : NO STONES / STONES  98.21  /  1.79
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FIG 4—Example of computer analysis in patient without gall stones.

program was tested by analysing data from 145 patients with acute pancreatitis. Since the results were expressed in percentage terms a prediction was considered to be unequivocal when the percentage likelihood was over 75%.

Results

Differences between patients with and without gall stones—Ten significant clinical differences existed between the two groups of patients ($P < 0.05$) (table II). In general, patients with gall-stone pancreatitis experienced pain and tenderness in the right upper quadrant and reacted to Murphy's test. Over half the patients were clinically jaundiced or had passed dark urine, while a further 18% gave a history of a recent attack of jaundice. In contrast, patients without gall stones complained of generalised abdominal pain and when examined had generalised tenderness associated with generalised rebound tenderness and a negative Murphy's sign.

TABLE II—*Significance of differences between the two groups of patients with acute pancreatitis*

Symptom	Patients without gall stones (n = 31)	Patients with gall stones (n = 53)	P*
Pain:			
Onset, general	6	2	<0·05
Present in right upper quadrant	1	12	<0·02
Present, generalised	8	1	<0·01
Jaundice:			
History of jaundice	–	10	<0·01
Dark urine	1	13	<0·01
Clinically jaundiced	1	15	<0·01
Tenderness:			
Right upper quadrant	4	24	<0·01
Generalised	12	4	<0·001
Rebound	22	24	<0·05
Murphy's test positive	1	42	<0·001

*Fisher's exact test.

Results of computer analysis—The computer program to predict gall stones in acute pancreatitis was tested in 145 patients. Initially, blind retrospective analysis of the details of the 84 patients included in the study was performed; a further 61 patients were prospectively analysed. Ninety-three patients were shown subsequently to have gall stones, and the computer accurately predicted this in 85 (91%). Of the remaining 52 patients, in whom radiological examinations failed to show calculous biliary disease as a cause for acute pancreatitis, the absence of gall stones was correctly predicted in 49 patients (94%), leading to an overall computer accuracy of 92%.

Evaluation of predictive index—We found that some discrimination between the two groups was possible if each patient studied scored one point for each of the 10 significantly different clinical features present. The most discriminant features were overt jaundice (or a recent history of jaundice), in association with tenderness of the right upper quadrant and a positive Murphy's sign. Empirical observation showed that patients who had one or more of these features were likely to have gall stones, and on testing, this predictive index correctly identified 80 out of the 93 patients with gall stones. Of the 52 patients with a normal biliary tree, the index correctly identified 32 by the absence of these signs, resulting in a predictive accuracy of 82%.

Effects of drug ingestion and alcohol consumption—The proportions of women taking oral contraceptives and of patients taking steroid drugs and a wide range of other medications were similar between the two groups. When patients had been given narcotic analgesics before referral, however, we found that the masking of abdominal signs led to computer inaccuracy. There were significant differences in alcohol intake between the two groups. Of the patients with gall-stone pancreatitis, 40 (75%) consumed no alcohol and 2 (4%) consumed more than 100 g of alcohol daily, while of the patients without gall stones, 17 (55%) were teetotal and 10 (32%) were heavy drinkers ($P < 0.001$). Coexistent duodenal ulceration was found in 7 (23%) of patients without but in only 3 (6%) of patients with gall stones ($P < 0.05$).

Surgery—In the 53 patients with gall-stone pancreatitis biliary surgery was performed within the first five days after admission provided calculi were shown radiologically. Sixteen patients were treated by early cholecystectomy (table III), and a further 28 patients underwent elective biliary exploration after recovering from the initial

TABLE III—*Operations performed on the 53 patients with gall-stone pancreatitis*

Early cholecystectomy	5
plus choledochotomy	11
Late cholecystectomy	20
plus choledochotomy	8
Awaiting operation	9
Total	53

attack of pancreatitis or during the same hospital admission. Biliary surgery was performed on the first available elective list, and operative cholangiography was performed in every case. No operative deaths occurred, and pancreatitis did not recur after exploration of the common duct. Of the 21 patients discharged for convalescence after an attack of acute pancreatitis, seven were readmitted on one or more occasions with recurrent acute pancreatitis while awaiting interval cholecystectomy. In patients who underwent simple cholecystectomy the gall-bladder bile was infected by coliform organisms and *Streptococcus faecalis* in 41%, despite the use of peroperative antibiotics. When choledochotomy was performed the incidence of biliary infection rose to 66%.

Of the 31 patients without gall stones, nine underwent surgery. Four emergency laparotomies were performed because of diagnostic uncertainty. In one patient, an 11-year-old child, the history and physical findings suggested acute appendicitis. At laparotomy widespread fat necrosis was observed and the peritoneal fluid amylase activity was raised. In the remaining three patients the serum amylase activity was below 1000 IU/l but widespread fat necrosis was again observed. Five patients underwent delayed operation for complications of acute pancreatitis—namely, pseudocyst formation and pancreatic abscess. Twenty-two patients without gall stones were not subjected to surgery. One patient in this group later suffered another attack of acute pancreatitis due to alcohol abuse.

Discussion

Gall stones are aetiologically important in over half the patients presenting with acute pancreatitis.[15 16] Although urgent surgery may be indicated to decompress the biliary tree, most patients in the UK are treated conservatively. Early biliary surgery for acute cholecystitis is associated with no greater morbidity or mortality than interval cholecystectomy. Although the incidence of choledochotomy is higher, the total period of hospital admission and convalescence is shorter, resulting in earlier return to full employment.[17 18] Evidence suggests that patients with acute pancreatitis due to gall stones may similarly benefit from early surgery.[13] Instrumentation of the lower common bile duct has been considered to be dangerous, but in this series 70% of the patients undergoing early biliary surgery also underwent exploration of the common duct without increased morbidity or mortality, supporting the findings of Acosta *et al.*[13]

The traditional conservative management of patients with gall stones results in an appreciable proportion (17%) who fail to return for elective biliary surgery.[19] These patients may develop septicaemic complications[20] or recurrent attacks of acute pancreatitis. While subsequent attacks of pancreatitis tend to be milder than the initial attack, deaths may occur.[6]

In the UK few surgeons will accept clinical suspicion alone as an indication for exploring the biliary tree.[21] Gall stones may be retrieved from the faeces,[13 22] but confirmation usually depends on the results of contrast radiological studies. A patient with acute pancreatitis may have impaired liver function, rendering cholecystography or intravenous cholangiography useless. Grey-scale ultrasonography may be of value in detecting gall stones in patients with acute pancreatitis.[23] This non-invasive examination may be performed early in the disease, but the need for specialised equipment and skilled operators has restricted its widespread use.

This study has shown that significant clinical differences exist between patients with gall-stone pancreatitis and those in whom the disease is due to other causes. The presence or absence of these 10 features may permit prediction of the likelihood of the presence of gall stones. A data base prepared from 38 clinical features has allowed a program to be written that accurately identifies those patients with gall-stone pancreatitis. Since evidence is accumulating to show that undue delay in operating increases the risk of further attacks and complications, early biliary surgery is recommended in patients with acute gall-stone pancreatitis. A computer-assisted diagnostic program informs the clinician of the probability of the presence of gall stones and encourages more vigorous early investigation and surgical intervention to eradicate the cause of acute pancreatitis.

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ONE HUNDRED YEARS AGO We read, in the *Journal de Médecine*, the following curious case. A woman of highly nervous temperament was bitten by a dog in the right thigh. From that moment she became melancholy and sleepless, and was tortured by the thought that she had not been cauterised; later on, she had violent paroxysms, attempted to commit suicide several times, and was extremely emaciated and feeble. The sight of dogs filled her with horror, she could not swallow liquids, had violent pain in the throat, and tried to strangle herself. The treatment had to be adapted to her mental state. The wound was cauterised, and she herself fed by the bowels, having chloral administered three times daily after each meal. It proved highly successful. We see by this case how difficult it often is to ascertain the exact duration of the stage of incubation in hydrophobia. Here the outbreak of the disease seemed to follow close upon the bite. It may also tend to show how easily any particular method of treatment, which may have been hit upon by chance, may obtain unmerited reputation and success. A medical practitioner, Dr Anderson, has been led, by this case of mania, to add a third class of rabies—viz, rabies ending in mania—to the two previously known classes of rabies vera and rabies falsa. According to his theory, hydrophobia is a proteiform neurosis, which does not manifest itself with equal force in all cases; it has more affinity with tetanus and eclampsia than with virulent diseases, and is caused by excitement of the peripheral nerves. (*British Medical Journal*, 1879.)