Clinical Section

President Ian Burn FRCS

Meeting 11 June 1976
at Whipps Cross Hospital

Cases

Complicated Acute Pancreatitis

Gillian C Hanson MB MRCP
and M J Phillips MRCP
(*Whipps Cross Hospital, London E11 1NR*)

Woman, aged 54

This case demonstrates the respiratory and metabolic problems that may follow an attack of acute pancreatitis. The patient's progress was complicated by abscess formation and Gram-negative septicæmia and prolonged duodenal ileus which necessitated intravenous feeding for seven weeks.

The patient was admitted to the intensive therapy unit, Whipps Cross Hospital, two weeks after the diagnosis of acute pancreatitis had been made. Her deterioration could be related to severe metabolic imbalance and respiratory failure. The pancreatic inflammation had subsided, the serum amylase being 320 U/l (normal <450). The problems which required correction on admission were as follows: glucose intolerance (blood glucose 1.6 mmol/l); metabolic (K^+ 1.9 mmol/l, Mg^{+-} 0.35 mmol/l, normal 0.75–1.5; PO_4 mmol/l, normal 0.8–1.4); metabolic acidosis, pH 7.23, base deficit 10; malnutrition (no calories for two weeks, serum albumin 21 g/l); pulmonary (Po_2 4.8 kPa (36 mmHg), Pco_2 5.5 kPa (41 mmHg)).

This patient was not a known diabetic, the glucose intolerance being presumably related to the insulin antagonism secondary to high circulating corticosteroids and catecholamines, and to relative insulin resistance subsequent to stress; it is also possible that there was absolute insulin deficiency secondary to destruction of pancreatic β cells. This tendency towards hyperglycæmia necessitated frequent blood glucose monitoring and insulin titrated according to the blood levels.

The serum potassium level on admission was 1.9 mmol/l, and since there was an associated metabolic acidosis, this implied that the total body potassium depletion was extreme. The situation would have been compounded by the administration of insulin and/or sodium bicarbonate, shifting the potassium into the cells and lowering the serum potassium even further. Treatment in this patient consisted of the infusion of potassium chloride in normal saline. Bicarbonate was not used, not only because it was considered dangerous (because of the hypokalæmia), but because it was thought that volume replacement, potassium replacement and oxygen therapy would improve cellular metabolism and perfusion.

Magnesium deficiency has been reported in acute pancreatitis (Feller *et al.* 1974). Serial magnesium levels should certainly be estimated. Fluid obtained by nasogastric suction may contain up to 0.5 mmol magnesium ions per litre. Magnesium supplements should be started within 2–3 days of the onset of the illness if ileus associated with gastrointestinal fluid loss is likely to be prolonged, and should also be added if the serum calcium has fallen. Edmondson *et al.* (1952) found that in patients who died from acute pancreatitis the magnesium content of the necrotic peritoneum was increased.

Tetany generally occurs when the serum magnesium is less than 0.5 mmol/l, but presumably did not occur in this patient because the ionized fraction was relatively high because of the metabolic acidosis. Extremely low levels of potassium may also be associated with tetany. Magnesium can be replaced with either intramuscular or intravenous magnesium sulphate 50% (*see* Table 1). In severe magnesium depletion (0.5 mmol/l or less) approximately 50 mmol should be replaced over the first 24 hours and then 20–30 mmol daily until the serum magnesium has returned to normal. In tetany the dose should be infused intravenously at a rate of not more than 0.25 mmol/m^2 body surface per minute, i.e. 0.4 mmol/min in a 70 kg man. Generally, after infusion of 10–20 mmol, tetany will cease and the rest of the magnesium can be infused over 24 hours. In severe depletion in the absence of tetany, Mg^{++} can be given intra-

Table 1

Ionic solutions available for treatment of metabolic disorders and maintenance of metabolic balance during long-term intravenous therapy

Solution	*Approximate daily adult maintenance dose (mmol/kg)*	*Route*
Calcium gluconate 10%: 0.25 mmol Ca^{++}/ml	0.11 Ca^{++}	Intravenous●
or calcium chloride 10%: 0.45 mmol Ca^{++}/ml		Intravenous●
Magnesium sulphate 50%: 2.0 mmol Mg^{++}/ml	0.1–0.25 Mg^{++}	Intravenous● or intramuscular
Potassium chloride 15%: 2 mmol K^+/ml	0.7–0.9 K^+	Intravenous●
Dipotassium hydrogen phosphate (K_2HPO_4): 2 mmol K^+/ml 1 mmol PO_4^{--}/ml	0.15 PO_4^{--}	Intravenous (as an infusion)
Sodium bicarbonate 8.4%: 1 mmol HCO_3^-/ml 1 mmol Na^+/ml	1.0–1.4 Na^+ HCO_3^- may not be required according to acid-base status	Intravenous (as an infusion)

● As a bolus or as an infusion with 5% dextrose, dextrose saline, or saline

muscularly. The maintenance requirement for a patient with severe gastrointestinal loss is around 12 mmol daily (Lee 1974).

Phosphate depletion is now being increasingly recognized in critically ill patients, in particular where fluids which do not contain phosphate are being given intravenously. Lack of phosphate produces depletion of red blood cell 2–3 diphosphoglycerate, which in turn affects the oxyhæmoglobin dissociation curve, thereby increasing the tenacity of the hæmoglobin molecule for oxygen. Decreased delivery of oxygen to the cell may be offset by an increase in cardiac output or the onset of a metabolic acidosis (commonly arising because of lack of oxygen supply to the cell). Phosphate in deficiency states, can be rapidly restored with dipotassium hydrogen phosphate (Table 1), 10–20 mmol being infused in the first 24 hours. In long-term intravenous feeding phosphate should be supplied in similar amounts to calcium (approximately 0.15 mmol/kg body weight daily in adults) and can be given as phosphate in the fat solution 20% intralipid (one litre of 20% intralipid containing 15 mmol of phosphate), or Aminosol 10% (approximately 18 mmol of phosphate per litre).

When this patient was admitted the calcium level was normal (2.29 mmol: range 2.1–2.6), largely because adequate calcium supplements had been given throughout her illness. It must be remembered that glucagon may cause a fall in serum calcium.

The metabolic acidosis was probably secondary to inadequate cellular perfusion and oxygenation.

The blood gases were of considerable interest. The abdomen was distended and the diaphragm splinted; basal atelectasis was therefore present, with more extensive collapse and probably infection at the left base. Pulmonary collapse alone could not account for the severe hypoxia, which was probably increased by inadequate pulmonary perfusion due to a low initial dynamic blood volume.

Unlike the pulmonary failure generally encountered with pancreatitis and intra-abdominal sepsis, the hypoxia was rapidly corrected by volume and metabolic replacement, physiotherapy, and 40% oxygen by face mask. By these means the (Po_2 rose from 5.5 kPa (41 mmHg) to 14.2 kPa (107 mmHg) over a period of four hours. The serum potassium during this time had risen to 3.1 mmol/l, central venous pressure from 4–8 cm H_2O, blood pressure from 100/70 to 120/90; the pulse rate had fallen from 110 to 90/min. The patient was also feverish and the sputum purulent – antibiotic therapy coupled with physiotherapy had clinically improved the aeration of the left lower lobe.

This patient's further progress was complicated by the sudden onset of a gram-negative septicæmia in the presence of a palpable mass (confirmed by barium meal) in the region of the head of the pancreas. The night before elective surgery, the patient suddenly collapsed; this was associated with a rising pulse rate and temperature, and at one stage the femoral pulse was not palpable. After resuscitation, the patient was transferred to theatre for emergency treatment and 600 ml of milky pus drained through the posterior wall of the stomach. Approximately 300 stones were removed from the gall bladder and a cholecystostomy performed. Coliform organisms were grown from the blood taken at the time of collapse.

Following surgery the patient received continuous positive-pressure ventilation and appropriate antibiotic therapy. Duodenal ileus persisted, and after three weeks of intravenous feeding a gastroenterostomy was performed. Complete oral nutrition was not possible for a further four weeks, the patient being fed intravenously for a total period of seven weeks. The daily intravenous feeding regime is summarized in Table 2. Provided that the patient can tolerate the peptides and sodium concentration, a protein hydrolysate (Aminosol 10%) as opposed to a pure crystalline L-rotatory amino acid is to be preferred, since it contains phosphorus and zinc (approximately 18.4 μmol/l). Phosphate was also supplied in the phospholipids of Intralipid 20% (plasma protein

Table 2

Average daily intravenous feeding regime: extra fluid and electrolyte solutions added for maintenance of fluid and electrolyte balance

	Volume (ml)	*Calories*	*Carbo-hydrate (g)*	*Fat (g)*	*Nitrogen (g)*	*Comments*
Dextrose 40%	300	480	120			Insulin added to dextrose solution to maintain blood glucose at 5–10 mmol/l. Potassium ions also added
Aminosol 10%	500	165			6.4	Sodium content 68 mmol; phosphate content 16.5 mmol. Preferably given via Y-catheter. Observe for hyperlipæmia
Intralipid 20%	500	1000		100		
Dextrose 40%	300	480	120			Insulin added to dextrose solution to maintain blood glucose at 5–10 mmol/l. Potassium ions also added
Aminosol 10%	500	165			6.4	Sodium content 68 mmol; phosphate content 16.5 mmol. Preferably given via Y-catheter. Observe for hyperlipæmia
Intralipid 20%	500	1000		100		
	2600	3290	240	200	12.8	

Table 3

Long-term intravenous diet: additives

Substance	*Dose*	*Frequency*	*Route*
Folinic acid	6 mg	Daily	Intramuscular
Iron (Imferon)	25 mg	Weekly	Intramuscular
Parentrovite	Ampoules (high-potency) 1 and 2	Daily	Intravenous
Vitamin B_{12}	500 µg	Weekly	Intramuscular
Vitamin D	600 iu	Daily	Intramuscular
Vitamin K_1	10 mg	Daily	Intramuscular

fraction or blood, 500 ml was given weekly to replace trace metals). Calcium, magnesium and potassium requirements were assessed according to serial blood levels and amounted to approximately twice the maintenance requirements (Table 1).

The additives are listed in Table 3. Folic acid depletion is becoming increasingly recognized in long-term intravenous feeding, and may initially manifest as pancytopenia with a hæmorrhagic diathesis. Patients receiving ethanol or folate antagonists such as Epanutin or trimethoprim, or those on dialysis, are particularly liable to this complication (Wardrop *et al.* 1975).

REFERENCES

Edmondson H A, Berne C J, Homann R E & Wertman M (1952) *American Journal of Medicine* **12**, 34

Feller J H, Brown R A, Tousenit G P M & Thompson A G (1974) *American Journal of Surgery* **127**, 196

Lee H A ed (1974) Parenteral Nutrition in Acute Metabolic Illness. Academic Press, London; p 108

Wardrop C A J, Heatley R V, Tennant G B & Hughes L E (1975) *Lancet* ii, 640