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Original Articles

Severe Chronic Intra-Abdominal Sepsis

A Report of 3 Cases and a Review of Patient Management

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Abstract. The management of three cases (one fatal) with extensive intraabdominal sepsis, is described.

Management included metabolic and fluid control, intravenous nutrition (where feeding by the oral route is impossible because of multiple intestinal fistuli), maintenance and support of vital organ function, and infection control.

Appropriate and timely surgical intervention may be life saving

Key words: Intra-abdominal sepsis, Metabolic and fluid control Nutrition. Vital organ function, Infection control, Surgery.

Introduction

The use of elemental diets and supplemental nutrition in the conservative management of intestinal fistuli is well documented [15,20]. The majority of these patients have been fit enough to be treated in the surgical ward. The occasional patient with this condition is so desperately ill that more intensive treatment is required. Such patients require long term intravenous therapy, delicate metabolic control, maintenance and support of vital organ function, control of infection and timely, frequently heroic surgery. 15 such patients have been admitted to the Intensive Therapy Unit at Whipps Cross Hospital over the last 4 years – all these patients at some stage of their illness required ventilation, five patients died after a protracted and severe illness.

The article is a summary of our experience with particular emphasis on management

Case History 1 (Table 1)

Mrs. L.F. aged 19 presented when 36 weeks pregnant with signs of peritonitis. At laparotomy, the abdomen was found to be full of pus following rupture of an ovarian cyst. A week later, she went into premature labour and was delivered of a live infant by Caesarean section. Four weeks after the Caesarean section, faeces were draining from the abdominal wound, the vagina, and from a stab drainage wound in the right iliac fossa. She was toxic and ill, was suffering from rigors, had lost weight rapidly and the skin was flaking. She was trnasferred to an intensive therapy unit.

The day after transfer, an infected uterus was removed and pelvic and paracaecal abscesses drained; an opening in the caecal wall was converted into a caesostomy. Postoperatively she developed disseminated intravascular coagulation. Seventeen units of whole blood plus platelets, fresh frozen plasma, and plasma protein fraction were infused over a 12 h period. Heparin was given. Intravenous feeding was restarted, together with vitamin supplements and essential ion replacement. Because of inadequate spontaneous ventilation, she required a tracheostomy and intermittent positive pressure ventilation for three weeks.

Two weeks after the hysterectomy, her conditon began again to deteriorate. Pus poured from the abdominal wall and vagina. A gastrografin follow-through showed a leak at the jejuno-ileal junction in the right iliac fossa (Fig. 1).

At operation a widespread purulent peritonitis was found, with perforations in the caecum and terminal ileum; there was a large abscess in the left paracolic gutter. A right hemicolectomy was performed, and the terminal 35 cms of ileum removed. The patient subsequently steadily improved. Oral feeding could not be commenced for 4 weeks because of persistent ileus. The patient was discharged home one month after starting oral feeding.

Discussion

The development of a haemorrhagic diathesis was probably related to several factors, haematinic depletion due to malnutrition, extensive sepsis, and the presence of an infected raw area around the vaginal vault following hyster-

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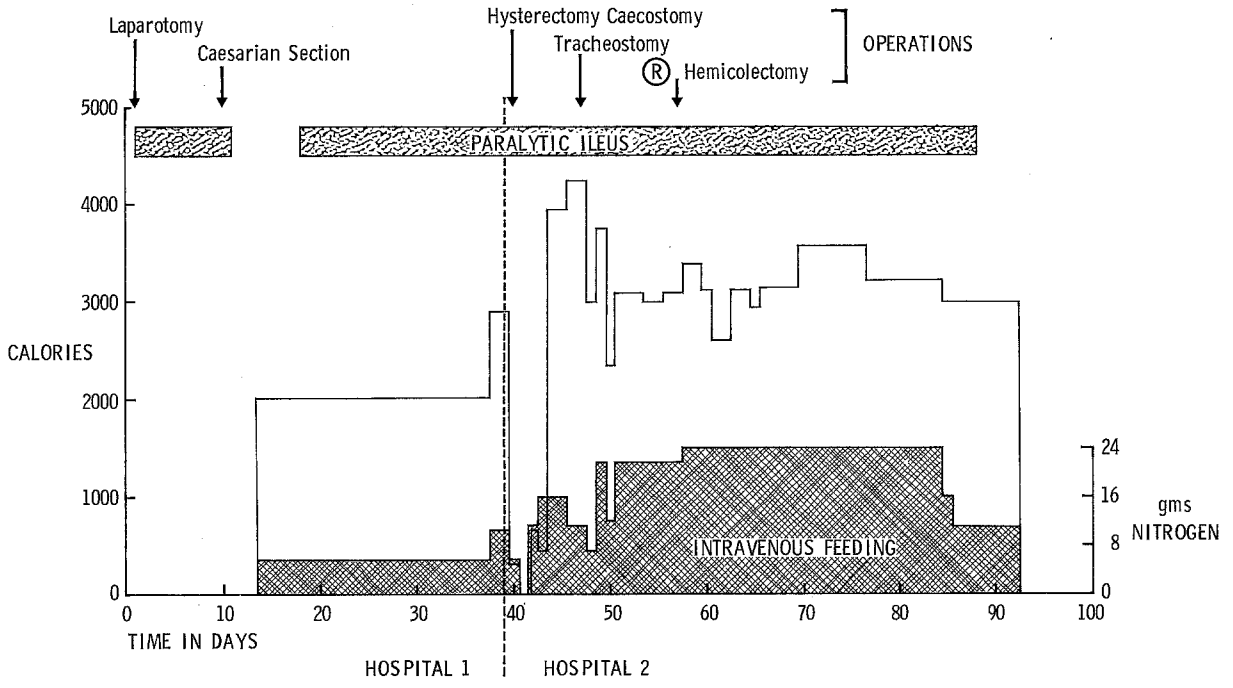
Table 1. Case 1. Progress chart showing intravenous feeding in relation to events



ectomy. The flaking erythematous skin was consistent with nicotinic acid deficiency.

The average daily intravenous feeding regime provided 3225 calories with 24 g of nitrogen and was continued for eleven weeks (Table 1).

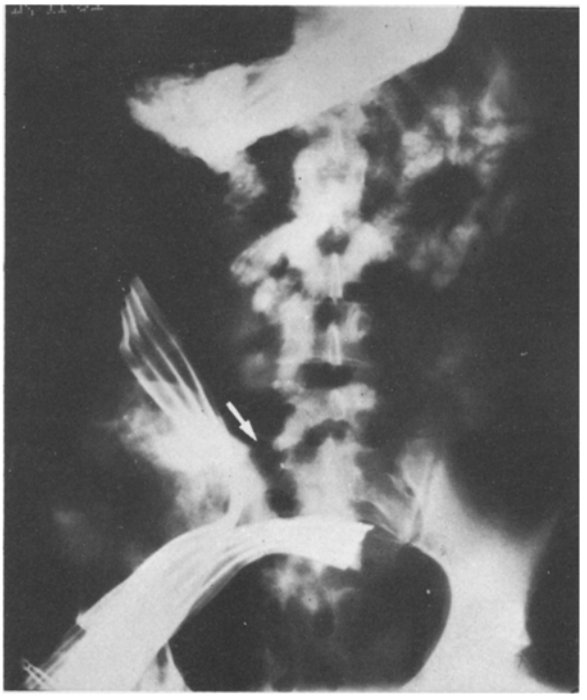


Fig. 1. Case 1. Gastrografin follow through showing an intestinal leak at the jejeuno-ileal junction (arrowed)

Case History 2 (Table 2)

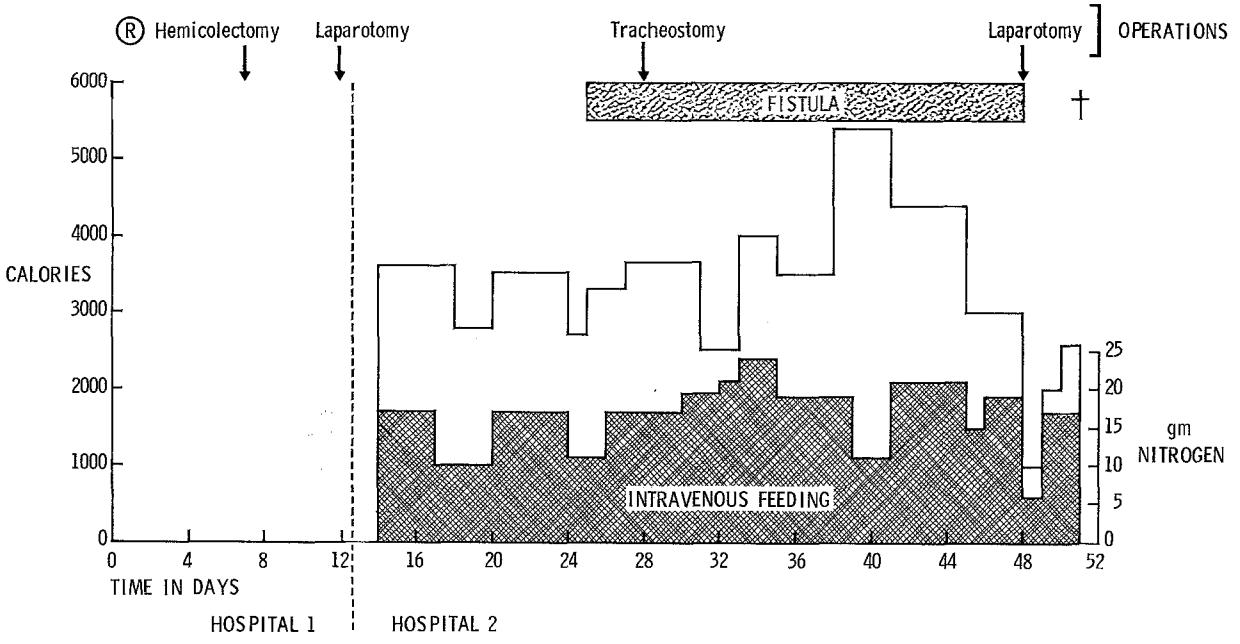
Mr. A.G., a 43 year old Indian, presented with acute lower abdominal pain and a palpable mass in the right iliac fossa. Six months later the appendix mass was resected; histology showed non-caseating granulomata suggestive of regional ileitis. One month later he became unwell with colicky lower abdominal pain and the mass was again palpable. He underwent a right hemicolectomy. Five days later he was extremely ill with pyrexia, dehydration and signs of peritonitis. At laparotomy the whole small bowel except for the proximal 35 cm was gangrenous due to thrombosis of the superior mesenteric artery. An end to side anastomosis between the jejunum and transverse colon was fashioned and he was transferred for intensive therapy.

He remained extremely toxic with a tachycardia and swinging pyrexia. Faeculent fluid from the drain sites grew E. Coli. Blood cultures were sterile. He was commenced on intravenous cotrimoxazole, cephalothin and lincomycin. A gastrografin meal failed to demonstrate a leak at the anastomosis and peritoneal lavage with noxytiolin 2.5% was commenced.

Two weeks after the laparotomy his condition had again deteriorated with rigors and pyrexia. Faeculent fluid started to drain from the abdominal wound. A gastrografin meal demonstrated a fistula from the anastomosis (Fig. 2). It was decided to treat this conservatively.

Two weeks later he remained toxic and ill, despite intensive antibiotic therapy and intravenous feeding. At laparotomy the anastomosis was found to be intact but a fistula from the closed proximal end of the transverse

Table 2. Case 2. Progress chart showing intravenous feeding in relation to events



colon to skin was found and closed; a large subphrenic abscess was drained.

Two days post-operatively he suffered an asystolic cardiac arrest and died. Autopsy confirmed generalised peritonitis and a subphrenic abscess.

Discussion

There is at present a move towards the conservative management of small bowel fistuli – the patient being fed intravenously until the fistula has almost closed when nutrition is maintained with an elemental intestinal diet and intravenous supplemental feeding. Laparotomy in this case should have been performed earlier. The terminal asystolic cardiac arrest was probably secondary to a prolonged high cardiac output state related to extensive sepsis.

Average daily nutrition was composed of 3,600 calories with 20 g of nitrogen and 200 mmol potassium ions (Table 2).

Case History 3 (Table 3)

Mr. T.R. a 54 year old teacher, presented with acute colicky lower abdominal pain, absolute constipation and vomiting of 48 h duration. At laparotomy the small bowel was found to be dilated, with pus in the lower abdomen. There was a mass of diverticular disease in the rectovesical pouch. A defunctioning transverse colostomy was fashioned.

Seven weeks after admission, operation was performed for colostomy closure, multiple small abscess cavities and a mass of adhesions between friable small bowel and colon

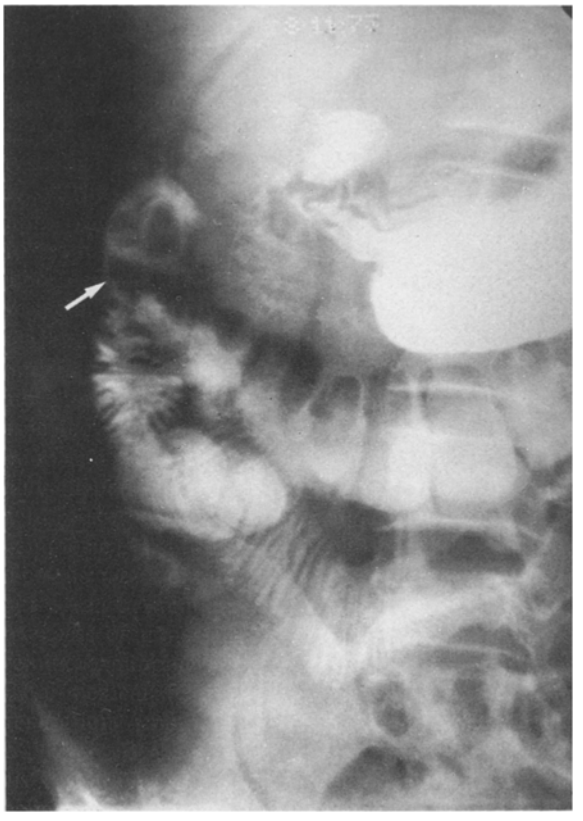
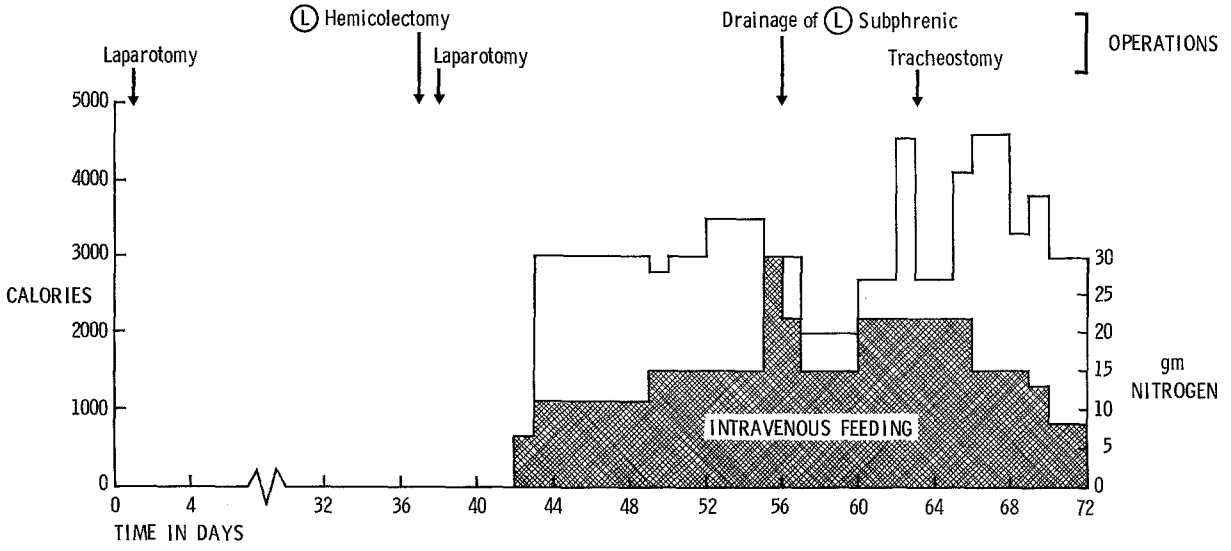


Fig. 2. Case 2. Gastrografin follow through showing a leak at the anastomotic site between the jejeunum and transverse colon

Table 3. Case 3 Progress chart showing intravenous feeding inrelation to events



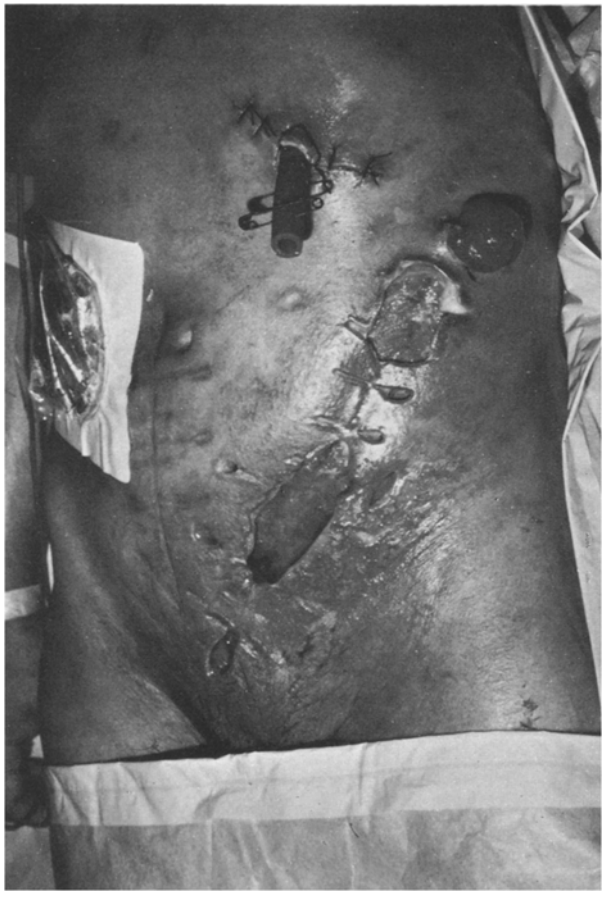


Fig. 3. Case 3. Appearance of the anterior abdominal wall 56 days after admission for drainage of a left subphrenic abscess

were found. Left hemicolectomy was performed with closure of the rectal stump and two short lenghts of small bowel were resected. The transverse colon was brought out as a mucous fistula. 12 h post-operatively the sustained a cardiorespiratory arrest from a massive intraperitoneal haemorrhage. At laparotomy a bleeding point was found at the base of the mesentery.

Post-operatively his condition remained critical. Klebsiella sp. was isolated from the blood and was a dominant growth from the abdominal wounds. He was treated initially with co-trimoxazole intravenously which was replaced by gentamicin and lincomycin with blood level control. He was fed intravenously.

After an initial improvement he developed rigors and pyrexia, his abdomen became distended and drained faeculent fluid (Fig. 3); he developed bilateral sterile pleural effusions.

Nineteen days post-operatively he suffered a respiratory arrest. Intermittent positive pressure ventilation was established and following resuscitation a left subphrenic collection of pus was drained. Klebsiella sp. were still present in his blood and gentamicin was restarted.

Over the following four weeks his general conditon gradually improved. He was weaned off the ventilator and oral feeding replaced intravenous feeding.

It was a further four weeks, during which his abdominal fistulae closed, before he was fit enough to go home with a transverse colostomy.

His daily intravenous feeding regime provided an average of 3000 calories daily with 16 gm Nitrogen as aminosol 10% (Table 3).

Discussion

The cardiac arrest following left hemicolectomy was attributed to intra-abdominal bleeding. It was thought that septicaemia was the most probable cause for the patient's

continued critical conditon. Blood cultures subsequently grew Klebsiella sp. and it was not until the subphrenic abscess was drained that blood cultures became negative. This highlights the need for repeated surgical intervention to drain collections of pus – antibiotics are not sufficient on their own.

The three cases described illustrate the problems that may arise in the management of patients with chronic intra-abdominal sepsis. Management can be summarised under the following headings:

Metabolic and Fluid control
Nutrition
Maintenance and support of vital organ function
Control of Infection
Surgery

Metabolic and Fluid Control

Patients with intra-abdominal sepsis readily become fluid depleted, either secondary to ileus and large volumes of gastric aspirate being inadequately replaced with intravenous fluid, or subsequent to chronic loss from diarrhoea or fistula sites.

In the absence of careful fluid balance control, such patients may become sufficiently fluid depleted to present with shock. Once these patients become shocked, large volumes of appropriate fluid may be required to restore blood volume; severe volume depletion if undetected may be complicated by acute renal failure – especially in the elderly. Rapid volume replacement should be controlled by serial measurements of the right atrial pressure. During rapid volume replacement, potassium monitoring and adequate potassium replacement is essential E.C.G. monitoring is also important since cardiac dysrhythmias are common, and T-wave changes with or without a conduction defect may signify alterations in the intracellular/extracellular potassium ratio.

Volume replacement in a patient who has been in negative nitrogen balance for a week or more should include albumin containing solutions such as blood, plasma, purified protein fraction or salt free albumin. Serum albumin levels in such patients are generally less than 25 g/L and it is known that the interstitial space accumulates large quantities of oedema fluid when the plasma albumin falls below this level [5].

A metabolic alkalosis commonly complicates loss of fluid from the stomach, is associated with depletion of total body potassium and a rapid fall in intravascular volume. These patients are especially predisposed to renal failure and cardiac dysrhythmias. A severe metabolic alkalosis is complicated by respiratory depression which in the presence of pre-existing hypoxia (commonly found in patients with sepsis), may lead to hypercapnoea and further hypoxia. Patients with a severe metabolic alkalosis present a serious operative risk; the metabolic abnormalities should therefore be corrected prior to operation.

Patients with chronic intra-abnominal sepsis are rarely able to absorb food orally – fluid volume replacement and control can be most accurately gauged by serial weighing and monitoring of the central venous pressure.

Fluid and metabolic abnormalities should be corrected over the first 2 - 3 days following admission, intravenous feeding being left until all abnormalities have been corrected.

Carbohydrate solution should not be given until total body potassium has been restored and serum phosphate levels are normal. Protein solutions should not be administered until a metabolic acidosis has been corrected since cationic amino-acids may accentuate it [14]. Fructose solutions should not be used during the acute stress phase since these patients are markedly predisposed to a lactic acid acidosis [28]. Protein should not be given as a protein hydrolysate in children 12 years or less or if there is evidence of hepatic or renal failure. Following a period of stress, there is a tendency towards sodium retention and potassium excretion [18] and therefore unless there is evidence of sodium depletion, solutions containing high concentrations of sodium ions should be avoided until renal sodium clearance is adequate.

Patients with chronic fistula losses or diarrhoea rapidly become magnesium and phosphate depleted, calcium levels rarely fall because of the high body calcium reserves. Magnesium ions can be given intramuscularly or intravenously as magnesium sulphate; and inorganic phosphate as dipotassium hydrogen phosphate (K_2HPO_4) or Electrolyte Solution B.[1]

Once deficiencies have been corrected, the average electrolyte and fluid requirements for maintenance are shown in Table 4. These requirements do not account for the extra losses via the gastrointestinal tract, in the sweat or via the respiratory tract through hyperventilation. Patients who are hypercatabolic and septic with heavy gastrointestinal losses may require at least 5 l of fluid daily in order to maintain normal fluid balance. In patients where basic fluid balance and electrolyte control is difficult, daily electrolyte analysis of the urine and gastrointestinal fluids is essential.

Adequate quantities of phosphate can generally be obtained from the protein hydrolysate Aminosol 10% (18 mmol of inorganic phosphate per l) and this may be supplemented by that present in the phospholipid of Intralipid (15 mmol phosphate/l 20%). We have not seen phosphate depletion in patients receiving at least a litre of each of these solutions. There is some controversy whether the phosphate is readily available from phospholipid in critically ill patients and therefore serial estimations are essential. Should phosphate depletion develop in spite of these measures or because the use of Aminosol 10% is contraindicated, phosphate may be administered as dipotassium hydrogen phosphate or as electrolyte solution B.[2]

The potassium requirements are high once I.V. feeding is commenced and allowances should be made not only for high losses in the urine secondary to stress, but also

[1] Travenol Laboratories on personal request

[2] Travenol Laboratories on personal request

Table 4. Daily mineral requirements per kg B.W. in adults. Allowance will cover resting metabolism and minimal physical activity (modified from [30])

Mineral	mmol
Sodium	1.0 - 1.4
Chlorine	1.3 - 1.9
Potassium	0.7 - 0.9
Calcium	0.11
Magnesium	0.1 - 0.25
Phosphorous	0.15
Iron	1 μmol

Table 5. Mineral Content per litre of Aminosol 10%

Sodium	136 mmol
Chlorine	118 mmol
Calcium	0.68 mmol
Magnesium	0.4 mmol
Phosphorous	18 mmol
Copper	0.45 μmol
Zinc	18.4 μmol

the increased uptake by the cell during glucose and protein feeding.

The requirements for trace metals in long term nutrition in adults is uncertain. It is probable that the trace metal supply is of particular importance during the intravenous feeding of infants and young children and may also be of importance when intravenous feeding is continued for more than two weeks in adults.

Wretlind [29] uses the "Addamel Electrolyte Solution" to replace trace metals (on clinical trial Kabivitrum) but other workers [26] have successfully used plasma for this purpose. 500 ml of plasma or fresh blood infused weekly should supply an adequate quantity of trace metals in adults on intravenous nutrition. Aminosol 10% also contains trace metals (Table 5).

Nutrition

One of the most important aspects of management in patients with severe intra-abdominal sepsis, is to provide sufficient nitrogen and calories to maintain a positive nitrogen balance. Nitrogen losses can be estimated at the bedside as recommended by [19]. Nitrogen intake can then be matched against losses. This technique is not reliable when there is severe gastrointestinal loss. Accurate estimation of gastrointestinal nitrogen loss may be difficult because of inability to collect losses from multiple fistula sites. Should nitrogen balance not be possible, and the patient too sick to be lifted on to a pair of weighing scales – weighing of the bed plus patient should be performed two to three times weekly. This system (provided it is performed accurately) gives an excellent sequential guide to fluid balance and nutritional status.

The majority of patients with multiple bowel fistuli and extensive intra-abdominal sepsis have to be fed intravenously; the precise dietary requirements cannot be standardised but certain criteria have to be maintained in order to ensure optimum utilisation (Table 6). The nitrogen requirement for these patients is approximately 16 - 30 g daily and the calorific requirement 3000 - 4500 K cal daily. Intravenous feeding should be started as soon as metabolic and fluid control is established, and renal and cardiac function has been assessed. Many intravenous solutions are hypertonic, viscous and acidic, and since central venous pressure monitoring is important in mangement of patients with large fluid losses, the usual route is via a central venous line.

Table 6. Guidelines for establishing an intravenous feeding regime in an adult

1. Provide appropriate quantity of protein.
2. Provide 150 calories/g of nitrogen infused.
   (In an adult on a low protein diet provide at least 3000 calories)
3. Provide 30 per cent of calories as carbohydrate.
4. Intralipid 2 - 4 g/kg body weight/24 hrs.
   (If intralipid omitted because of contraindications to its use, ensure adequate replacement of phosphate).
5. Provide approximately 5 mmol K^+/g Nitrogen infused.
6. Ensure all electrolyte requirements are met.
7. Ensure fluid balance and acid base balance is correct.
8. Supply vitamins and haematinics.
9. Reassess requirements daily.

Intravenous Feeding Regime

There is now available a wide variety of nitrogen containing solutions – which may be divided into synthetic crystalline amino-acid preparations and protein hydrolysates. The synthetic L-amino-acid solutions show no improvement in nitrogen balance from the protein hydrolysate solution Aminosol 10% [25] but should be used where peptides and ammonia are contraindicated, e.g. in the feeding of infants and in patients with hepatic or renal failure. Aminosol 10% has also the disadvantage in containing a high concentration of sodium ions and therefore should not be used where sodium ion retention is suspected, or where renal clearance is inadequate. The two amino-acid solutions of optimum value in feeding the critically ill patient intravenously are probably the protein hydrolysate Aminosol 10% and the pure crystalline L-amino-acid solution Vamin N [25]; other amino-acid solutions may contain fructose or sorbitiol as a calorific source (e.g. Aminoplex 5. Trophysan), or may contain an excess of nonessential amino-acids such as lysine and arginine (Aminoplex 14), or glycine (Trophysan).

Calories can be added to these solutions by using the preparation Aminosol glucose or Vamin glucose. At least 150 cal should be provided per g of nitrogen infused and this should be made up as carbohydrate (30% of the total energy supply) and fats.

Glucose is the carbohydrate source of choice – being the normal physiological substrate – can be metabolised

by all body tissues, and is a prerequisite for protein anabolism. In the acute phase of stress, which may last up to 72 h (depending upon the severity), there is failure of insulin response to a glucose load associated with glucose intolerance. Subsequent to this there is continuing glucose intolerance associated with high insulin levels suggesting resistance to the action of endogenous insulin [2]. It is therefore important during glucose feeding, to give the solution at a rate not exceeding 0.5 g/kg BW/h and to give insulin should the blood glucose rise above 10 mmol/l. Soluble insulin is preferably given with the carbohydrate solution commencing at 1 unit of insulin per 4 g glucose infused and steadily increasing until the blood glucose is controlled. During the first few days of I.V. feeding it is wise to start with approximately 150 g carbohydrate daily in an adult and steadily increasing to a total of 250 - 400 g daily. 2-hourly blood glucose monitoring is essential during the glucose/insulin regime. Once intravenous carbohydrate solution are used, potassium demands increase and generally 100 - 160 mmol are required daily to maintain a normal serum potassium in the absence of excessive potassium losses.

Glucose infusions should be stopped if the serum potassium falls below 3.3 mmol/l until the level has been restored. Serum phosphate levels must be carefully observed. Fructose offers no advantage, it is more expensive, and when administered rapidly may induce lactic acid acidosis[3], a condition which may already be present in the critically ill. Since sorbitol goes through the fructose pathway during metabolism it is equally likely to produce a rise in serum lactate.

Current evidence shows that the soya bean oil emulsion (Intralipid) is a particularly safe fat solution and has the advantage over other calorific sources in being of neutral pH, isoosmolar and containing a high number of calories (2000 cal/l 20% Intralipid). Fat solutions should preferably be avoided when blood samples are being taken and should not be repeated until the plasma is free of fat.

A typical intravenous feeding regime adopted in patients with severe intra-abdominal sepsis is shown in Table 7. To this must be added routinely the sodium and potassium requirements. Other additives which require to be given are shown in Table 8.

The details of electrolyte requirements in adults was shown in Table 4. Patients with intra-abdominal sepsis quickly become hypomagnesaemic and the usual maintenance dose is 8 - 12 mmol daily.

The vitamins and haematinics to be given during intravenoaus feeding are shown in Table 9. Folic acid, vitamin B_{12} and iron should be started after one week of parenteral nutrition, and folic acid should be started immediatley in patients on dialysis, patients who have received or are receiving folate antagonists and in patients receiving ethanol as a calorific source [27]. The preparation Vitlipid (Table 10) is valuable as a source of fat soluble vitamins. The investigations required in these patients to ensure correct metabolic balance is shown in Table 11. It is essential to observe for a gradually increasing alkalosis (which may indicate a falling total body potassium) and increasing acidosis, hypophosphataemia, and an increasing serum osmolality.

Routine administration of magnesium trisilicate mixture via the Ryles tube in the patient who is unable to absorb orally appears to reduce the incidence of gastric haemorrhage. Once the gastric aspirate is 500 mls or less daily and bowel sounds are present – oral feeding can be

Table 7. Typical intravenous feeding regime for an adult Patient with intraabdominal sepsis (renal and hepatic function normal and sodium clearance adequate)

Solution	Volume	Content					Comments
		K cal	N g	Na mmol	K mmol	Po_4 mmol	
Dextrose 20%	500	400					Add electrolytes and vitamins. May require insulin. Rate not $>$ 0.5 Gdextose/kg BW/hour
Aminosol 10%	500	115	6.4	68	0.08	Approx. 9	Give via Y connection. No additives. Note high Na^+ content
Intralipid 20%	500	1000	0	0	0	7.5	Contains P as phospholipid approx. 15 mmol/l
Dextrose 20 %	500	400					
Aminosol 10%	500	115	6.4	68	0.08	Approx. 9	
Intralipid 20%	500	1000	0	0	0	7.5	
Vamin glucose	1000	650	9.4	50	20	0	
total	4000	3680	22.2	186	20.16	33	

Table 8. Additives which may be required during intravenous feeding in adults

	Dose and Frequency	Route
Magnesium Sulphate 50% 2.0 mmol Mg^{++}/ml	According to serum magnesium Maintenance requirement approx. 0.1 - 0.25 mmol/kg B.W. daily	I.M.
Calcium gluconate 10% 0.2 mmol Ca^{++}/ml	According to serum calcium and maintenance requirement in the presence of a normal serum calcium (see table 1)	I.V. in carbohydrate solution
Sodium bicarbonate 8.4% 1 mmol HCO_3-/ml 1 mmol a/ml	According to acid base balance urine and plasma sodium levels.	I.V.
Potassium phosphate (K_2HPO_4) 2 mmol K^+/ml 1 mmol HPO_4-/ml	According to serum phosphate and maintenance requirements (see table 1). Allow for phosphate given in intralipid and/or aminosol.	I.V. in carbohydrate solution.
Potassium chloride 15% 2 mmol K^+/ml	According to serum potassium. According to acid base status and potassium losses.	I.V. in carbohydrate solution

Table 9. Vitamins and haematinics required during intravenous feeding in adults

Substance	Dose	Frequency,	Route
Vitamin K_1	5 - 10 mgm.	Daily	IM
Vitamin B_{12}	100 uG	weekly	IM
Vitamin D	Not required for the feeding thenrequired	first 2-3 wks ina dosage of	of intravenous 600 units daily IV.
Parenterovite	Ampoules 1 and 2 High Potency	daily	IV
Iron (Imferon)	50 mgm.	weekly	IM
Folinic Acid or Folic Acid	5 - 10 mgm.	daily	IM

started. Oral feeding should be started very gradually – since a hypertonic load may precipitate diarrhoea. It is wise to start with Caloreen (glucose polymer).

50 g diluted in 500 mls of water and the dose gradually increased to 200 g daily simultaneously reducing the carbohydrate in the intravenous feed. One gram of carbohydrate should be diluted in 5 - 10 mls with water. Once this regime is being adequately absorbed, albumaid (hydrolysate of bovine serum protein) can be added to the carbohydrate solution, the intravenous protein being steadily decreased. The intravenous feeding solution to be finally stopped (after 7 - 10 d of starting oral nutrition) is the intralipid. Electrolyte solutions and intralipid can be safely given via a peripheral vein. Once protein and carbohydrate are being absorbed orally, a light diet can generally be taken and intravenous feeding stopped. During this transition period, it is wise to continue a peripheral vein infusion, since with inadequate absorption and associated diarrhoea, electrolyte and fluid control should be supplemented intravenously.

Maintenance of Vital Organ Function

Pulmonary insufficiency has been recognised for many years as a serious complication arising in patients with extensive nonthoracic sepsis. The severity of this insufficiency has only recently been realised [6]. The characteristic physiologic findings in these patients is severe shunting, loss of compliance and increased work of breathing. These patients, therefore, at the height of intraabdominal sepsis generally require artificial ventilation, and since in our experience, extensive intra-abdominal sepsis is associated with a protracted course, such patients should be tracheostomised if respiratory assistance is required for more than one week.

Pulmonary shunting does not subside until the intra-abdominal infection is under control and frequently ventilation has to be continued for many weeks in order to maintain an adequate paO_2. We feel that a pulmonary end-expiratory pressure (PEEP) should be routinely applied in patients who require mechanical ventilation since focal

Table 10. Vitamin and haematinic content of vitalipid and soluvit (preparations available on clinical trial) (Kab i Vitrum Ltd)

Vitilipid for Adult (added to the Intralipid solution)	
Vitamin a (as Retinol acetate)	0.75 mg Retinol
Vitamin D (as Calciferol)	3 ug
Vitamin K_1	0.15 mg
Soybean oil	1,000 mg
Egg-yolk phosphatides	120 mg
Glycerol	250 mg
Aq. steril. ad	10 ml

Solivito lyophilized (disolved in 10ml 5% Dextrose and added to the glucose infusion)			
		to the glucose infusion)	
Thiamine	1.2 mg as monoitrate	1.236	mg
Riboflavine	1.8 mg as Na-riboflavine phosphate	2.466	mg
Nicotinamide	10 mg as Nicotinamide	10	mg
Pyridoxine	2 mg as Pyridoxine chloride	2.431	mg
Folic acid	0.2 mg as Folic acid	0.2	mg
Vitamin B_{12}	2 ug as Cyanocobalmine	2	ug
Pantothenic acid	10 mg as Sodium pantothenate	11.0	mg
Biotion	0.3 mg as Biotin	0.3	mg
Ascorbic acid	30 mg as Sodium ascorbate	34	mg
	Amino-acetic acid (as body)	100	mg

Table 11. Investigations required to ensure adequate metabolic control in adult patients on intravenous feeding

Essential Daily	Fluid balance B.U. Electrolytes. Blood glucose Acid base status Hb. P.C.V.
Advisable daily	Body weight Clinical Nitrogen Balance (Lee 1974 c) Urine and plasma osmolality Serum creatinine Electrolyte analysis of urine and gastrointestinal loss (if excessive)
3x weekly or more frequently when indicated	Serum calcium Serum magnesium Serum inorganic phosphate Serum preteins

atelactasis is an invariable feature. An attempt should be made to maintain paO_2 at 80 - 100 mm. Hg. (10.7 - 13.3 kPa) the inspiratory oxygen percentage (fiO_2) should not be increased above 60%, or above 50% for long term ventilation since there is a danger of oxygen toxicity above this level [23]. High levels of PEEP increase the incidence of pneumothorax and therefore should be maintained at a level sufficient to achieve a paO_2 of 70 mm (9.3 kPa) on a fiO_2 of 50%. Patients who have been ventilated for a long time should be weaned off slowly once the paO_2 is maintained at 70 mm (9.3 kPa) or more on an fiO_2 of 35% or less on 2 cms PEEP. They should be allowed to breathe spontaneously against an expiratory resistance of 2 cms. H_2O [8].

Patients with severe sepsis characteristically have a high cardiac output [7], and it has been our experience that one of the major features of clinical deterioration is the onset of right heart or biventricular failure. It is probable that a high pulmonary vascular resistance is one of the major features causing right heart failure in sepsis [6]. It has been found that pulmonary shunting can be reduced by improving cardiac output and on occasions right ventricular output monitoring (thermodilution technique) may be indicated in order to obtain optimum ventilatory parameters with adequate cardiac output. Glucose potassium and insulin may not only provide calories but may also improve cardiac output [21].

Organic phosphate 2-3 diphosphoglycerate (D.P.G.) affects the position of the oxyhaemoglobin dissociation curve by decreasing the affinity of haemoglobin for oxygen. A deficiency can be compensated for by an increase in cardiac output – this however may precipitate cardiac failure when the cardiac output is already high secondary to sepsis. Sepsis itself has no effect on oxygen dissociation but decreased levels may be found in hypophosphataemia and transfusion of old blood [7]. It is essential in these patients to optimise the oxyhaemoglobin dissociation curve by maintaining a normal red cell D.P.G. A normal serum phosphate should therefore be ensured and when transfusion is required, the blood infused if A.C.D. preserved, should be less than 3 d old.

A sustained tachycardia of 100 - 120/min is common in these patients. The incidence of dysrhythmias is high and may be related to digoxin toxicity (which may be precipitated by renal failure or hypokalaemia), potassium imbalance, a metabolic acidosis, hypoxia, ventricular failure, hypovoaemia or severe sepsis related to intraperitoneal accumulation of pus. A supraventricular tachycardia of over 140/min in the absence of any correctable factor may be reduced by the use of verapamil hydrochloride or a partial β blocker such as practolol. Total β blockade is dangerous in these patients since it may be complicated by a prolonged period of bradycardia or asystole. Ventricular extrasystoles are best treated with intravenous lignocaine and a ventricular tachycardia is most rapidly and effectively treated by D.C. cardioversion.

It is not proposed to discuss details in management of acute renal failure but to stress that patients with intra-abdominal sepsis frequently have creatinine clearances of less than 50 per cent normal during periods of severe stress. Renal function should be observed carefully and factors such as hypovolaemia, cardiac failure, potassium imbalance, hyperosmolality or hypoxia, likely to precipitate deterioration, should be avoided. Repeated operative procedures are likely to produce deterioration in the creatinine clearance post-operatively; volume control pre and postoperatively is therefore essential. Mannitol should be used routinely postoperatively once fluid volume deficits have been corrected.

Monitoring antibiotic levels when using a potentially nephrotoxic antibiotic is essential. Diuretic therapy during the use of a nephrotoxic antibiotic may precipitate renal failure [10].

Control of Infection

It is essential, before using antibiotics, to take swabs for culture from the relevant sites and to take blood cultures routinely. Antibiotics should be used for short periods only and have no part to play in the management of intra-abdominal abscess formation, which requires good surgical drainage.

Peritoneal dialysis has proved to be valuable in the immediate postoperative management of extensive nonlocalised peritonitis and this is combined with instillation of 200 ml 2.5 per cent noxytiolin solution twice daily for the first three days after operation. The noxytiolin should be left in the peritoneal cavity for one h before draining out [22]. Extensive skin sloughing over fistula sites requires frequent changing of dressings which may be associated with extreme distress to the patient, pain may be relieved by the inhalation of entonox (50% oxygen with nitrous oxide) for 5 min prior to, and during the dressing procedure. Irrigation of the fistule site with hydrogen peroxide followed by 0.5% sodium hypochlorite packs where application of a colostomy or ileostomy bag has not been possible, has been found to give maximum success.

Antibiotics should always be used where there has been a positive blood culture. They should be given in high doses either intravenously or intramuscularly, and should be stopped once two sets of blood cultures on consecutive days have been negative. Gentamicin should be used where no other antibiotic is considered suitable, should preferably be combined with carbenicillin (to cover the streptococcus and prevent the possible emergence of resistant strains of pseudomonas pyocyaneus) and the dose should be regulated according to peak and trough blood levels. The average dose required for a 70 kg adult is 140 mg initially followed by 120 to 140 mgm IM 8-hourly. A positive blood culture for the bacteroides species may take several days and when septicaemia is suspected, the initial antibiotic therapy for a patient suffering from intra-abdominal sepsis should always include intravenous clindamycin or metronidazole.

A low grade pyrexia 39°C or less with a pulse rate of 100 - 110/min is common and does not necessarily require antibiotic therapy.

Surgery

Chronic intra-abdominal sepsis remains a key factor in postoperative morbidity and mortality and is well demonstrated by the case histories presented in this report. At varying time intervals after surgery some patients may exhibit signs of increasing toxicity and gradual or sudden clinical deterioration. Such a relapse, typically occurring after a short period of apparent improvement, must raise the possibility of persistent or residual intra-peritoneal suppuration. The new focus of sepsis may have spread from the original site as a primary event or the surgical procedure may itself have contributed to dissemination of infection and abscess formation. Occult collections of intraperitoneal pus are often the underlying reason for the final demise of a patient from metabolic, nutritional and multiple organ system failure.

In order to prevent progression to septicaemia and septic shock, it is necessary to maintain an aggressive surgical attitude, coupled with interdisciplinary co-operation. A marked reduction in mortality, recently reported by Ledingham [17] underlines the 'team' approach.

Details of the pathological condition and surgical procedures undertaken are valuable indicators to the probable site of intra-abdominal sepsis. The final site of abcess development is influenced by a combination of factors, including the anatomy of the subdivisions of the peritoneal cavity, gravity, peritoneal exudate, surgical manoeuvres, intra-abdominal pressure and diaphragmatic movement.

The pelvis and the various subphrenic spaces are common sites for abscess collection and must therefore be regarded with a high index of suspicion in a toxic patient. Intra-hepatic pyogenic abscesses should also be considered in the search for occult inflammation. Repeated clinical examination is mandatory, including regular rectal examinations to detect a pelvic abscess.

Erect, supine and lateral plain x-ray films may localise subphrenic accummulations of pus. The diagnostic yield can be increased by the addition of ultrasound [9] and radio-isotope scanning [4]. It has not been our policy to perform needle aspirations in an attempt to diagnose subphrenic abscess in view of unreliable results and possible contamination of the pleural cavity [13].

Despite the advent of sophisticated diagnostic aids, intra-abdominal sepsis can still remain latent and undetected, prolonged intestinal ileus being the only manifestation of undisclosed pus.

Operative Management

Surgical intervention is clearly indicated in those patients who have an intra-abdominal focus of sepsis diagnosed and localised. Consideration must also be given to exploring a second group of postoperative patients displaying prolonged ileus, increasing toxicity, rising white cell count accompanied by fluctuating pyrexia, and progressive clinical deterioration. It is in this group of cases with signs of probable occult intra-abdominal sepsis that large, often multifocal collections of pus are discovered with a resultant clinical improvement following drainage. Early surgery is therefore essential in an attempt to decrease the morbidity and mortality of this condition.

The abdomen should be entered through the original incision as this will usually connect directly with the abscess cavity. Recent experience with similar cases has led us [12] to adopt a policy of a formal exploratory laparotomy if major intraperitoneal sepsis is suspected. This approach not only discloses the main collection of pus but often reveals other loculations and also allows detection of intrahepatic abscesses by on-table needling. A priority at the time of operation is the collection of sufficient material for accurate bacteriological investigation. A syringe containing some of the pus is preferable to the

more commonly used absorbent cotton-wool swab. Early gram staining gives a helpful lead to antibiotic therapy.

After isolating the abscess area from the rest of the peritoneal cavity with moist packs, loculations are broken down digitally and free pus and fluid aspirated. Massive peritoneal contamination, if present, is managed by liberal saline lavage with up to four litres of warm normal saline being used.

Noxytiolin may be added to the final washout in a 2.0% solution and some of this left behind in the peritoneal cavity. Recent experimental evidence [16] has cast some doubt on the validity of noxytiolin but we still use the solution in major peritonitis with free faecal contamination. Multiple soft polythene drainage tubes are inserted through separate stab incisions. The opportunity may be taken to site a peritoneal dialysis catheter in anticipation of the need for postoperative peritoneal lavage.

Drainage subphrenic absecesses is performed via either anterior or posterior extranerous routes depending upon the position of the accumulation. Complete evacuation of the cavity is carried out and a tube drain introduced through which post-drainage sinograms are done. Withdrawal of the tube depends on progressive decrease in the cavity size and reduction in drainage volume. Multiple subphrenic and co-existent intra-hepatic abscesses do occur and these possibilities should be entertained in patients failing to respond to repeated surgery. Pelvic abscesses are drained through the rectum provided they are mature. More usually, active surgery is pre-empted by the collection discharging spontaneously. Exploratory needle aspiration prior to drainage should obviate accidental perforation of small bowel loops adherent to the rectum.

A lesser sac abscess can be difficult to diagnose but is fortunately less common than subphrenic and pelvic collections. More often related to acute pancreatitis than perforated gastric ulcers, these abscesses can present as duodenal obstruction with vomiting and failure to absorb oral or nasogastric tube feeds. Direct drainage with the insertion of a soft rubber of polythene drain tube and radiological assessment of the decrease in cavity size is the method of choice.

Surgeons are becoming increasingly aware of liver abscesses as a cause of prolonged toxicity and often mortality in some cases. Although ultrasound scanning will effectively detect single large cavities, widespread multifocal deposits may be more difficult to demonstrate. Once within the abdomen, the surface of the liver is palpated and any suspect areas are aspirated with a wide-bore needle. The abscess is drained and a soft tube left in situ to be removed as soon as the discharge decreases.

Enterocutaneous fistulae are often associated with intra-abdominal sepsis and residual abscess formation is a well-documented cause of persistent fistula discharge [1]. Basic surgical principles in the management of intestinal fistulae include radiological visualisation of the fistulous track and early complete drainage of intra-abdominal abscesses.

Major anastomotic leakage following previous bowel resections may result in widespread peritoneal contamination and secondary peritonitis. After drainage and peritoneal toilet, the proximal and distal ends of the bowel are best exteriorised as an end colostomy and a mucous fistula. This is a lifesaving manoeuvre in a septicaemic critically ill patient. Primary intestinal anastomosis in the presence of massive sepsis is hazardous although it is possible in situations such as right hemicolectomy. Should resection in the left colon be required, a Hartman's procedure is recommended and continuity can be restored at a later date.

In view of the high risk of wound infections and breakdown, it is suggested that the policy of delayed primary wound closure be adopted. The peritoneum and rectus sheath layers are sutured with interrupted figure-of-eight monofilament nylon or wire sutures. The remainder of the incision is left open and packed with a moist saline pack. Skin sutures are inserted but left untied for 48 - 72 h, allowing free drainage of a potentially infected area. Povidone-iodine dry powder spray (Disadine-BP) has been shown to decrease the rate of wound infection following abdominal surgery, especially in intestinal surgery and peritonitis [11] and we routinely use it now in wound closure.

Conclusion

The management of three seriously ill patients suffering from extensive intra-abdominal sepsis associated with multiple intestinal fistulae and organ failure are described. The mortality in such patients is high unless attention is paid to all aspects of management. Recognition of organ failure, maintenance of nutritional metabolic and fluid balance, timely antibiotic therapy, local care of the fistula sites and early diagnosis and drainage of intra-peritoneal pus collection, are keystones to success.

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