Consensus statement

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European Society of Coloproctology consensus on the surgical management of intestinal failure in adults

Abstract

Intestinal failure (IF) is a debilitating condition of inadequate nutrition due to an anatomical and/or physiological deficit of the intestine. Surgical management of patients with acute and chronic IF requires expertise to deal with technical challenges and make correct decisions. Dedicated IF units have expertise in patient selection, operative risk assessment and multidisciplinary support such as nutritional input and interventional radiology, which dramatically improve the morbidity and mortality of this complex condition and can beneficially affect the continuing dependence on parenteral nutritional support. Currently there is little guidance to bridge the gap between general surgeons and specialist IF surgeons. Fifteen European experts took part in a consensus process to develop guidance to support surgeons in the management of patients with IF. Based on a systematic literature review, statements were prepared for a modified Delphi process. The evidence for each statement was graded using Oxford Centre for Evidence-Based Medicine Levels of Evidence. The current paper contains the statements reflecting the position and practice of leading European experts in IF encompassing the general definition of IF surgery and organization of an IF unit, strategies to prevent IF, management of acute IF, management of wound, fistula and stoma, rehabilitation, intestinal and abdominal reconstruction, criteria for referral to a specialist unit and intestinal transplantation.

Introduction

Intestinal failure (IF) is a debilitating condition characterized by inability to maintain a state of adequate nutrition and/or fluid and electrolyte balance because of an anatomical and/or physiological disorder of the intestine. There are various causes of IF such as ischaemic bowel, Crohn's disease, radiation enteritis, enterocutaneous fistula caused by iatrogenic injury or enteroatmospheric fistula caused by open abdomen, malignancy and severe gastrointestinal dysmotility [1–3]. IF can be an acute or a chronic condition.

Surgical management of patients with acute and chronic IF requires significant expertise in terms of technical challenges and decision-making. Dedicated IF units have expertise in patient selection, operative risk assessment and multidisciplinary support such as nutritional input and interventional radiology, which dramatically improves the morbidity and mortality of this complex condition and can beneficially affect the continuing dependence on parenteral nutritional (PN) support.

Currently there is little guidance to bridge the gap between general surgeons and specialist IF surgeons. Clarification of the role of general surgery and IF surgery may help with decisions about interim measures and referrals to specialist units.

The primary aim of this process was to develop a consensus-based guidance by European experts to support surgeons in managing patients with IF where there is a lack of evidence-based recommendations.

Readers should also refer to other detailed guidelines regarding the management of IF:

- The European Society for Clinical Nutrition and Metabolism (ESPEN)-endorsed recommendations. Definition and classification of intestinal failure in adults [4];
- ESPEN guidelines on PN: gastroenterology [5];
- ESPEN guidelines on PN: home PN in adult patients [6];
- ESPEN guidelines on PN: central venous catheters (access, care, diagnosis and therapy of complications) [7];
- the surgical management of patients with acute intestinal failure [8];
- 'sepsis–nutrition–anatomy–plan' or 'SNAP' approach [9] (this paper summarizes some practical aspects of the management of IF).

Definition of intestinal failure

The term 'intestinal failure' was first coined by Fleming and Remington in 1981. Since then, various definitions have been used to classify IF. Most recently, the ESPEN conducted a thorough literature review on this topic to endorse some recommendations [4].

Definition

IF is defined as the reduction of gut function below the minimum necessary for the absorption of macronutrients and/or fluid and electrolytes, such that intravenous supplementation is required to maintain health and/or growth. A reduction of gut absorptive function that does not require intravenous supplementation to maintain health and/or growth can be considered as 'intestinal insufficiency' (or 'intestinal deficiency' for those languages where 'insufficiency' and 'failure' have the same meaning).

A high-output intestinal fistula is defined as one with effluent of more than 500 ml per 24 h. A high-output stoma is defined as one that produces more than 1500 ml of effluent per 24 h.

Functional classification

On the basis of onset, metabolic and expected outcome criteria, IF is classified as [9]:

- Type 1 – acute, short-term and usually self-limiting.
- Type 2 – prolonged acute condition requiring artificial nutrition for more than 28 days, often in metabolically unstable patients, requiring complex multidisciplinary care and intravenous supplementation over periods of weeks or months. This type is considered potentially reversible.
- Type 3 – chronic, in metabolically stable patients, requiring intravenous supplementation over months or years.

Pathophysiological classification of short bowel syndrome

IF can be caused by five major pathophysiological conditions, which may originate from various gastrointestinal or systemic diseases. They include short bowel, intestinal fistula, intestinal dysmotility, mechanical obstruction and extensive small bowel mucosal disease.

Anatomical classification of short bowel syndrome is also important, with three different groups for which the prognosis differs according to the surgical anatomy and the length of remaining small bowel:

- Group I: with an end-jejunostomy, chronic IF is generally observed if < 1 m of small bowel remains (Fig. 1).
- Group II: with jejuno-colonic anastomosis, chronic IF is generally observed if < 0.5 m of the small bowel remains with all the colon in place. More small bowel is required where there is less colon (Fig. 2).
- Group III: with jejuno-ileo-colonic anastomosis and preservation of the ileocaecal junction; this is the 'best case' for which only 30–50 cm of small bowel remaining is enough to avoid (chronic) IF (Fig. 3).

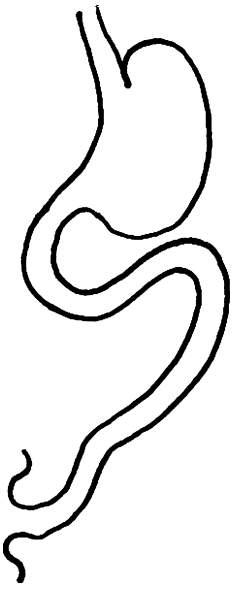

Figure 1 End-jejunostomy.

Figure 2 Jejuno-colonic anastomosis.

Method

Working process

A steering group was formed by experts who have a common interest in improving surgical management in

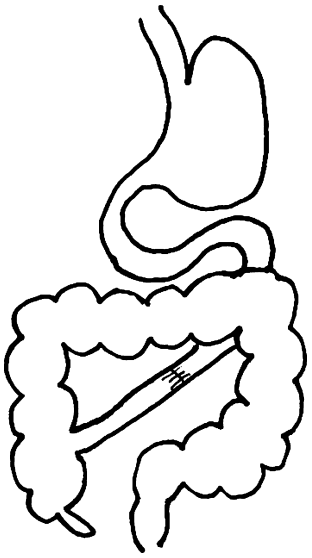

Figure 3 Jejuno-ileo-colic anastomosis.

IF: C. Vaizey (Chair), Y. Maeda, M. Boermeester, G. Carlson, Y. Panis, W. Wallace. Specialists in the working group were identified by literature review, contacting European Society of Coloproctology (ESCP) country representatives (24 countries) and recommendations of other experts. The process of identifying specialists is summarized in Fig. 4.

A literature review was conducted by the steering committee to identify areas and issues relating to surgical aspects of IF. PubMed was searched using the keywords 'intestinal failure' (title/abstract), 'enterocutaneous fistula' (title/abstract) for English-language articles published from January 1972 to June 2015. A search using each keyword was performed, with filters applied for 'publication in English' and 'adults at the age of or over 19'.

Inclusion criteria were randomized clinical trials and prospective/retrospective studies relevant to the practice of IF surgery.

Exclusion criteria were case reports, including some reports superseded by studies with larger samples or the same cohort of patients included in subsequent multicentre/international reports, letters, editorials, basic science papers, papers written in languages other than English, papers regarding a paediatric population, outdated articles, clinical treatment and management for chronic conditions but not directly treating intestinal failure per se although mentioning IF as consequence or complication of disease or surgery, and technical aspects of intestinal transplantation without specific reference to IF.

A manual search of relevant articles and references that may have been missed by the search engine strategy was added. Review articles were not included in principle but cross-checked for the completeness of the literature search. A full overview of the literature was written, and then statements were prepared for the Delphi rounds.

A consensus process was conducted by a modified Delphi method. Briefly, the specialists of the working group were asked to complete a questionnaire constructed on a web-based electronic survey system via the ESCP web site. Each specialist completed the questionnaire independently to maintain anonymity. Each question had a 5-point Lickert scale (strongly disagree, disagree, neutral, agree and strongly agree), with a possibility to abstain from the vote, asking whether the expert agreed or not with the statement. There was also

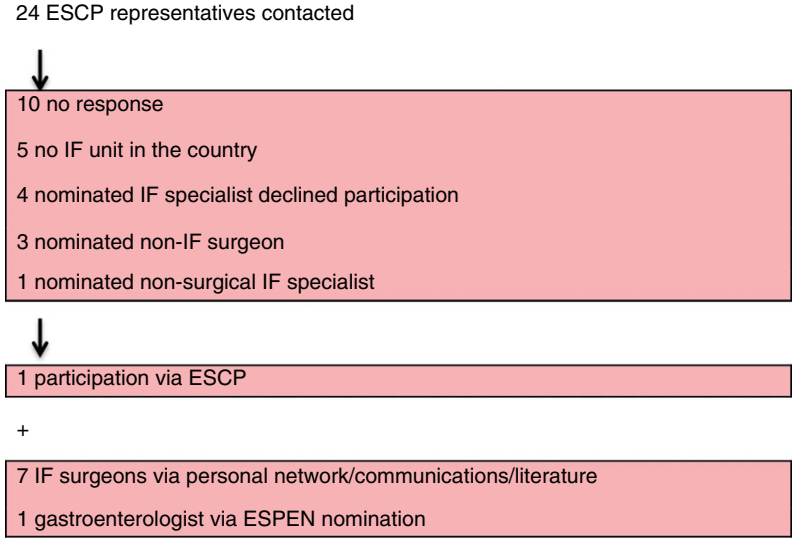

Figure 4 Recruitment of participants for the process.

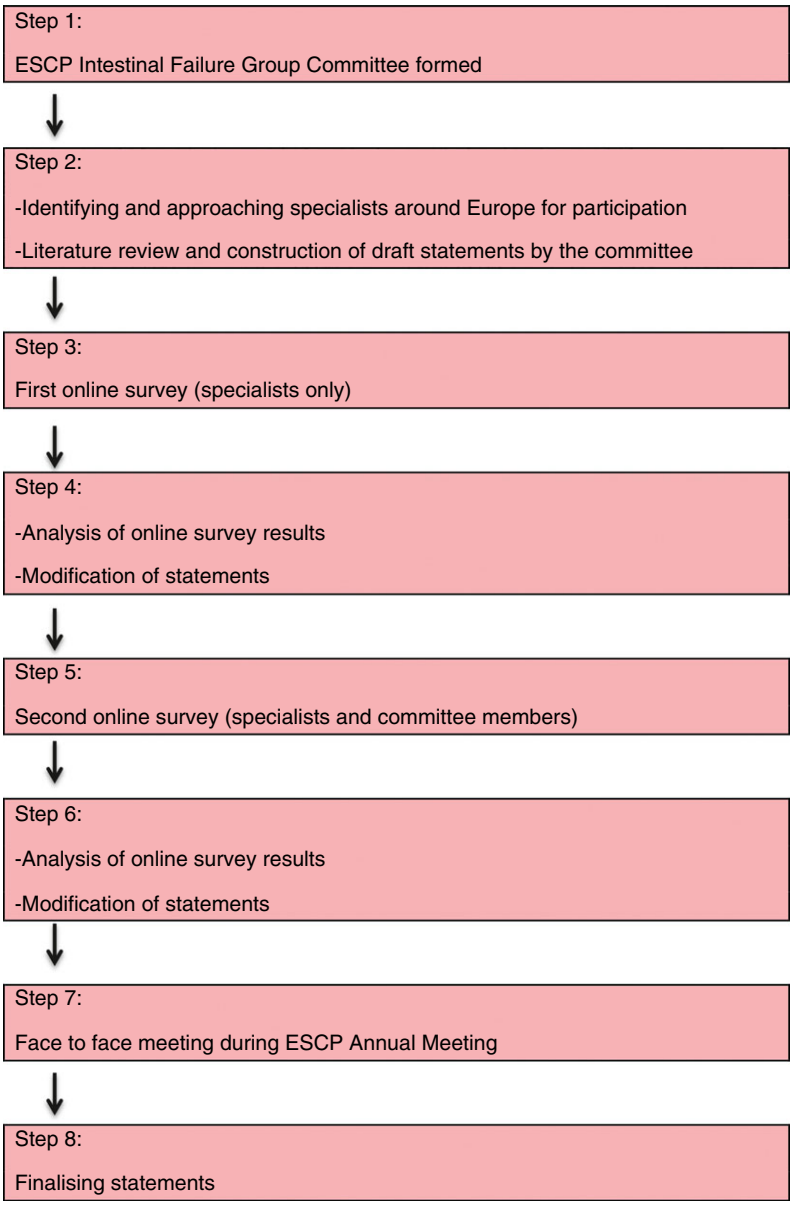

Figure 5 Flow of process.

a free space for each expert to make comments if necessary. The steering group analysed the outcome of the first round and modified the questionnaire for the second round of surveys, reflecting the opinions of the working group experts. The second round was conducted online using the same web-based survey with the percentage of agreement of the previous round presented in each statement. Both the steering committee and the working group participated in the second round survey. Following the two rounds, a face-to-face consensus meeting was held for detailed discussion for all the topics raised during the first two rounds. The steering committee compiled the final statements based on the surveys and discussion. Final comments were then requested from all members of the group and a final consensus reached. The flow of process is summarized as Fig. 5. The evidence for each statement was graded using Oxford Centre for Evidence-Based Medicine Levels of Evidence (http://www.cebm.net/wp-content/uploads/2014/06/CEBM-Levels-of-Evidence-2.1.pdf).

Results

The search strategies found 637 articles. Excluding five duplicates, the titles of 632 articles were screened.

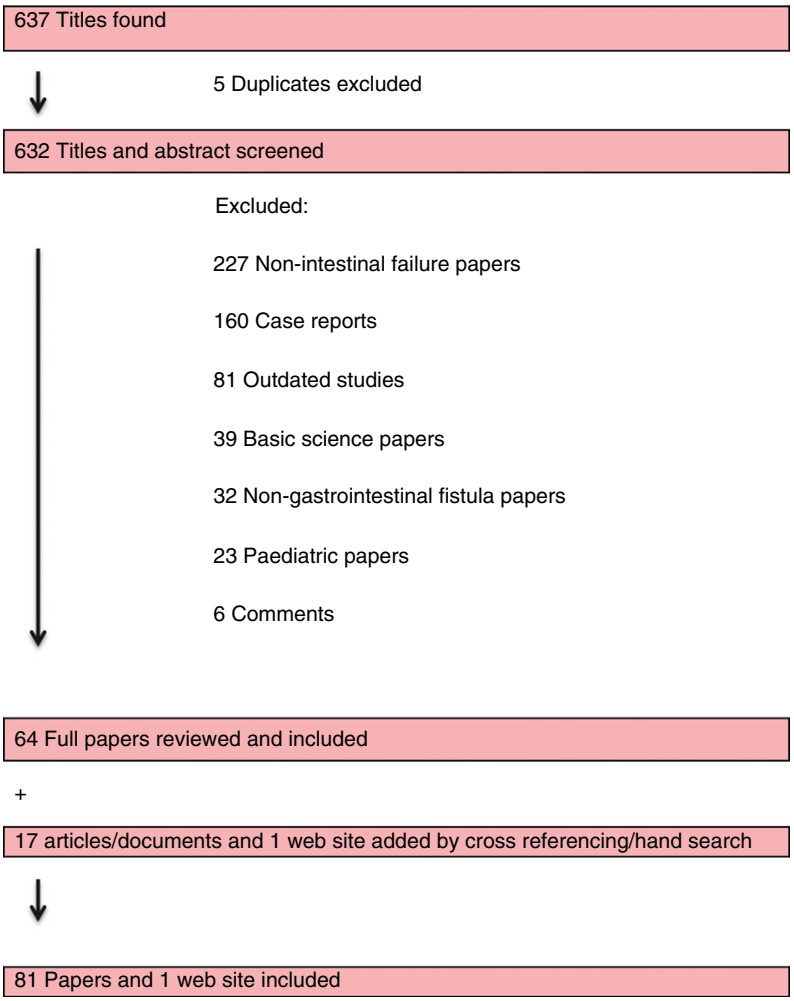

Figure 6 Flow of literature review.

Five hundred and sixty-eight articles were excluded for the following reasons: papers reporting treatment of hernia and underlying diseases that may cause enterocutaneous fistula but no direct description with regard to managing IF (227), case reports (160), papers outdated by more recent reports (81), basic science papers (39), reports on nongastrointestinal fistula (32), papers regarding paediatric patients (23), comments (6). This left 64 papers from the search to be included. A further 18 articles/documents and one web site were added from a hand search, so in total 82 papers/web links have been included in this guideline. The flow of the literature search is summarized in Fig. 6.

General

IF is not currently recognized as a subspeciality of abdominal surgery. There are no clear international guidelines regarding the surgical treatment of IF or the establishment and administration of IF units. In order to establish a surgical standard and pathways for referral, offer appropriate management and develop training in IF surgery, the group suggests that:

- IF surgery should be a recognized subspeciality in gastrointestinal surgery (Level of Evidence 5).
- Type 2 IF (> 28 days) should be treated in a multidisciplinary IF unit [10] (Level of Evidence 4).
- Surgery on patients with Type 3 IF, or in patients where a short gut and Type 3 failure is an anticipated outcome of the surgery, should be performed in a specialized centre with multidisciplinary expertise in IF, except in the emergency setting (Level of Evidence 5).

Organization of an intestinal failure unit

The importance of having a team of dedicated and trained personnel in managing IF has been recognized

for many years [11]. A successful outcome for this challenging condition can be achieved with input from multidisciplinary specialist experts and appropriate use of resources [10–15]. The closure rate of enterocutaneous fistula, with or without surgery, reaches over 95% at a specialist centre [3,16]. The specialist centre should have the capacity to offer multidisciplinary input for the patients, not only in the short-term but also long-term support in a seamless fashion including support for home-based treatment [17]:

- There should be two whole time equivalents of the core members of staff at a specialized unit. These core members are:
  - consultant gastroenterologist/physician with specialist training in nutrition;
  - consultant surgeon with experience/training in IF/complex abdominal surgery;
  - consultant interventional radiologist;
  - consultant anaesthetist with expertise in complex abdominal surgery;
  - stoma/wound care nurse with expertise in enterocutaneous fistula;
  - specialist dietician with expertise in intestinal failure (e.g. high-output stoma/fistula);
  - nurse specialist with expertise in the administration of parental nutrition;
  - specialist pharmacist with expertise in PN.
- The centre should also have support from:
  - consultant pain specialist with expertise in chronic abdominal pain;
  - consultant plastic surgeon with expertise in abdominal wall reconstruction;
  - specialist physiotherapist with expertise in chronically debilitated patients;
  - psychiatrist or psychologist with expertise in depression related to chronic disease and/or intestinal failure;
  - urologist;
  - vascular surgeon (Level of Evidence 5).
- The specialist service should also have the following:
  - access to an emergency operating theatre on site, 24 h a day, with a fully staffed recovery room;
  - an operating theatre with nursing (and/or technical) staff with a specific interest in gastrointestinal surgery;
  - critical care facilities, including intensive care beds;
  - an imaging department with facilities and expertise for X-ray screening, CT scan, MRI scan and interventional radiology, and radiologists trained in interventional radiological techniques (notably percutaneous drainage and tunnelled line insertion);
  - clinicians with expertise in venous access techniques;
  - stoma therapy and tissue viability services;
  - other surgical specialities (hepatobiliary; gynaecology);
  - other support specialties (notably microbiology);
  - other allied health professionals (occupational therapy, social work, clinical psychologists);
  - pharmacy facilities which permit a PN compounding service to tailor the PN to the patients' needs within 48 h;
  - facilities for clinical audit (including, but not limited to, clerical support, IT facilities);
  - easy access to dental assessment and treatment;
  - there should be a dedicated ward, or at least a dedicated area on the ward, for admission of IF patients (Level of Evidence 5).

The number of lumens of central venous catheters (CVC) and peripherally inserted central catheters (PICCs) is associated with catheter-related bloodstream infection [7,18]:

- Long term (more than 6 months) PN should be administered through a single lumen tunnelled dedicated catheter [19] (Level of Evidence 4).
- Catheter-related bloodstream infections (CRBSI) should be audited once a year and reported as episodes of CRBSI infection per 1000 catheter days (Level of Evidence 5).
- Any abdominal surgery for patients with IF who have Ehlers–Danlos Type IV disease, Behçet's disease, desmoid disease, systemic sclerosis, radiation enteritis or Gardner's syndrome require significant expertise and liaison with disease-specific specialists [20–23]. These patients should be referred to hospitals with experience in management of these disorders (Level of Evidence 4).
- Patients with IF who are awaiting surgery and have portal hypertension should be assessed in a specialist liver unit prior to operation (Level of Evidence 5).
- Patients with IF due to intestinal ischaemia and those with severe cardiovascular comorbidity should be assessed by CT angiography for compromised mesenteric arterial supply to the gut. Those with a compromised mesenteric arterial supply to the gut should be assessed for revascularization surgery or endovascular intervention in a specialist vascular unit prior to reoperation. This may require a staged approach (Level of Evidence 5).

Prevention of intestinal failure

Although IF may be the direct consequence of a primary disease process such as extensive mesenteric ischaemia or Crohn's disease, important (and potentially preventable) causes of IF are adverse sequelae of

abdominal surgery such as anastomotic failure or development of postoperative enterocutaneous fistula. Up to two-thirds of enterocutaneous fistulae are caused by iatrogenic injury [24,25]. This may be due to failure to recognize an injury at the time of the index surgery, or catastrophic results of reoperation in a hostile abdomen with inflammatory adhesions, as may occur shortly after abdominal surgery, or simply too many reoperations [26]. Immediate reoperative surgery for enterocutaneous fistula is potentially detrimental, especially as spontaneous closure with conservative management is possible [27–29]. It is also essential that all treatment modalities are considered in consultation with other specialities. It has been reported that up to one-third of patients with enterocutaneous fistula due to Crohn's disease can achieve closure when administered anti-tumour necrosis factor therapy and those undergoing surgery within 3 months of infliximab administration do not suffer from increased complications and morbidity [30,31]:

- Formation of an anastomosis in the malnourished patient, adjacent to sepsis, or in the haemodynamically unstable patient, or where there is any question of ischaemic bowel should be avoided or the anastomosis defunctioned proximally. The distal limb of a resected bowel segment should be exteriorized whenever possible to allow access for subsequent radiological contrast study and distal feeding (Level of Evidence 5).
- In cases of significant resection/fistula formation, accurate intra-operative measurement of the length of the remaining bowel should be attempted to aid subsequent planning (Level of Evidence 5).

Recurrence of enterocutaneous fistula is reported to be 28% when definitive surgery is done within 12–24 weeks from time of onset of fistula [32]:

- IF surgery should be discouraged within 12 weeks, and preferably postponed until at least 24 weeks, after previous surgery. A patient with an open abdomen should not have planned reconstructive surgery until the abdomen has softened and re-epithelialized, which usually take at least 6 months. The decision to undertake a repeat laparotomy in this window should be taken with the involvement of a second specialized consultant not involved with the case at the time of the index operation (Level of Evidence 4).
- Reoperative surgery in this window should be performed by a specialized consultant (Level of Evidence 5).

A review suggested that oxidized regenerated cellulose and hyaluronate carboxymethyl cellulose reduce the formation of adhesions in non-IF patients [33], but a randomized controlled trial has shown that the use of anti-adhesive products may increase anastomotic leakage [34]. Some manufacturers clearly state that the use of their product is contraindicated for gastrointestinal surgery with anastomosis [Adept®, Baxter (http://www.baxterbiosurgery.com/us/resources/pdfs/adept/ADEPT_Instructions_For_Use.pdf); Seprafilm®, Genzyme (http://products.sanofi.co.uk/Seprafilm_IFU.pdf)] and some of these products have already been withdrawn in some parts of Europe:

- The use of an anti-adhesion device or medication is not recommended in IF surgery (Level of Evidence 3).
- Use of negative-pressure wound therapy has not been shown to increase mortality or intestinal fistulation in the open abdomen and may facilitate nursing care [35,36]. The use of topical negative pressure (TNP) in the open abdomen is, however, discouraged after the initial phase, where potential closure is less likely and the fistulation rate is unacceptably high [37]. TNP should be used with extreme care in the septic open abdomen, unless fistulation has already occurred prior to its use (Level of Evidence 2).
- Consideration of the possibility of distal feeding should be made. The distal bowel should be brought to the surface whenever possible [38,39] (Level of Evidence 4).
- The incidence of postoperative fistula and hernia are reduced by primary abdominal closure, which should be achieved whenever possible (Level of Evidence 5).

Management of acute intestinal failure

Sepsis control is an important management strategy in the acute phase. Percutaneous drainage is a safe and effective intervention with an extremely low mortality [40]:

- Resuscitation according to the sepsis bundle and source control of sepsis (ideally by percutaneous means) are the immediate priorities. Contrast-enhanced CT scanning is usually the initial choice of investigation (Level of Evidence 5).
- Patients should be allowed to take liquids and diet as early as possible and as tolerated unless the surgeon feels that withholding oral intake may reduce peritoneal contamination and provide the best chance of spontaneous closure immediately after fistula formation (Level of Evidence 5).
- PN should be commenced as soon as it is anticipated that enteral nutrition will be unable to meet the patient's nutritional and metabolic needs (Level of Evidence 5).
- The content of PN should be tailored to the patient's needs and reviewed on at least a twice-weekly basis until stable (Level of Evidence 5).

- If a patient has an adequate length of healthy gut but is unable to consume and absorb adequate calories, enteral tube feeding (including fistuloclysis [39]) may be required (Level of Evidence 4).
- Functional bowel length (i.e. the length proximal and distal to a fistula or enterostomy) should be measured radiologically when precise measurement was not performed or possible during prior surgery, to judge the potential absorption capacity of enteral intake; metabolic balance studies may also be required [41] (Level of Evidence 4).
- When the distal end is exteriorized as an enterostomy/mucus fistula, distal feeding (even in the form of bolus feeding) may maintain the health and calibre of the distal bowel in anticipation of a future anastomosis, provided this does not interfere with wound management [42] (Level of Evidence 5).
- Although surgery is contraindicated in the early stages, there are some exceptional circumstances where this is necessary, for example to gain control of sepsis, to remove ischaemic bowel or to control a high-volume enterovaginal fistula (i.e. formation of proximal stoma) (Level of Evidence 5).
- Reconstructive surgery should not be undertaken for 6–12 months and until nutrition has been optimized, and preferably after the patient has had a period of time at home. A few indicators of optimization are rising albumin level (preferably > 32 g/l), resolution of sepsis, good fluid and electrolyte balance and stable or increasing weight. Evidence of stoma prolapse or softening of the abdomen may indicate maturation of adhesions and a less hostile abdomen, allowing decisions to be made regarding timing of surgery. If there is severe, active and uncontrollable disease preventing adequate nutrition, definitive surgery should be avoided and a staged approach with resection but without primary anastomosis is recommended [43,44] (Level of Evidence 5).
- Absorbable mesh can be used as a temporary closure measure, although subsequent hernia repair may be required [45] (Level of Evidence 5).
- Specific nutrient deficiencies need to be monitored with regular measurements of magnesium, zinc, selenium, iron, vitamins D, K or B_{12} in those requiring prolonged nutritional support, particularly if there are difficulties with oral magnesium and phosphate supplementation with a high-output stoma/fistula [46] (Level of Evidence 4).
- Laparoscopy is acceptable in very highly selected cases but in general is not an appropriate option in patients with ECF [47] (Level of Evidence 5).

Wound, fistula and stoma

- Ward nursing staff should have the nursing skills needed to care for wounds, stomas and fistulae when specialized stoma nurses are not immediately available (Level of Evidence 5).
- Secondary drainage bags should be used where needed to ensure that the weight of the effluent does not pull the stoma/wound manager bag off (Level of Evidence 5).
- Sodium losses are most effectively monitored by urinary volume and sodium concentration, provided renal function is satisfactory (Level of Evidence 5).
- The addition of regular high-dose loperamide, codeine phosphate and proton pump inhibitors (PPIs) reduce fistula/stoma output. In case of high-output fistula or stoma, daily measurement of the pH of effluent should be used to guide PPI dose. The minimum acceptable pH of a proximal small bowel fistula should be more than 6 (Level of Evidence 5).

The expected effect on fistula closure rate with somatostatins is small, and the effect on output is not well established [48]. The only study that has shown an effect on closure rate with lanreotide included 70% non-small bowel fistula [49]:

- There is little evidence to support the routine use of somatostatin analogues or cholestyramine in the management of high-output stoma or intestinal fistula [50] (Level of Evidence 4).
- Oral hypo-osmolar fluids should be limited to 1000 ml per 24 h in patients with high stoma or fistula outputs. Oral fluid intake in the form of a potassium-free isotonic electrolyte solution should be given, also at up to 1000 ml per 24 h (Level of Evidence 5).

Jaundice

- Jaundice is multifactorial in these patients but sepsis should be excluded and treated as a priority in IF patients who develop jaundice (Level of Evidence 5).
- Medication should be viewed as a potential cause of jaundice and agents such as octreotide discontinued. Gallstone obstruction should also be excluded (Level of Evidence 5).
- The lipid content of PN should be reviewed in patients who develop jaundice and are on PN, in the absence of another obvious causes (Level of Evidence 5).
- Patients with deteriorating liver function tests may need an urgent referral to a specialist unit within 28 days of the onset of IF (Level of Evidence 5).

Rehabilitation

- There should be a delay to restorative surgery in Type 2 IF patients, and when possible they should be discharged home prior to surgery. For this to be possible the following may need to be addressed:
  - home PN;
  - venous access care and aseptic connection of PN;
  - complex wound care;
  - distal feeding;
  - education on optimal oral intake;
  - resolution of dental issues [51];
  - psychological problems [52];
  - robust arrangements for outpatient monitoring with a 24-h support line;
  - supervision of home care by a specialized IF centre;
  - correction/control of underlying disease (e.g. inflammatory bowel disease) (Level of Evidence 5).

Definitive radiological assessment

Initial radiological assessment in acute IF focuses on excluding and treating abdominal sepsis.

- Prior to surgery assessment of the following should be undertaken:
  - imaging and definition of anatomy by oral contrast, enema, fistulogram or per stoma contrast for exclusion of distal obstruction;
  - patients with intestinal failure due to prior intestinal ischaemia and those with severe cardiovascular comorbidity should be assessed by CT angiography more specifically for compromised mesenteric arterial supply to the gut;
  - assessment of the need to stent the ureters at the time of reconstructive surgery;
  - assessment of any abdominal wall defect by CT or MRI;
  - assessment of bowel quality and length to give the patient as much prognostic information as possible preoperatively;
  - exclusion of gallstones and renal stones;
  - definition of the anatomy of an ileal conduit with a conduitogram (Level of Evidence 5).

Intestinal reconstruction

Simultaneous reconstruction of the intestinal tract and abdominal wall is associated with a high complication rate, justifying the management of such patients in specialized units. The advantages of bringing distal bowel back into continuity have to be weighed against the risks of surgery. Surgery is generally lifestyle changing rather than life saving in the short term. Long term it can increase life expectancy by getting patients off PN:

- Prior to surgery there should be confirmation of satisfactory nutritional and metabolic status and exclusion of ongoing sepsis (Level of Evidence 5).
- Careful assessment of whether the patient is likely to be able to cope with the diarrhoea which may result from full restoration of gastrointestinal continuity is required. This may include taking a history about previous problems with continence, clinical assessment and specialized investigations of the distal gastrointestinal tract and sphincters. Consideration of colostomy should be given if function is likely to be poor due to loose stools (Level of Evidence 5).
- Adequate time should be set aside so that surgery is not rushed. In cases that are expected to take more than 4 h a second surgeon with expertise in IF may be considered. Dissection should be gentle and unhurried, in order to avoid enterotomy (Level of Evidence 5).
- Complex cases are technically very challenging and should only be undertaken in specialized centres where there is appropriate expertise and support (Level of Evidence 5).
- Most patients should be booked into a high-dependency unit for their postoperative care (Level of Evidence 5).
- Avoidance of enteric injury is paramount. It is mandatory to mark and repair every serosal tear (Level of Evidence 5).
- Anastomotic technique should be meticulous and anastomoses should be kept away from old abscess cavities or laparotomy incisions. Handsewn anastomosis may reduce the rate of recurrence of enterocutaneous fistula compared with stapled anastomosis [53]. Stapled anastomoses should be reinforced with sutures (Level of Evidence 5).
- Defunctioned small intestine distal to a fistula may have a narrow lumen and be atrophic and extremely friable. If multiple anastomoses are constructed, a defunctioning proximal loop stoma should be considered, rather than leaving high-risk anastomoses in continuity (Level of Evidence 5).
- Simultaneous cholecystectomy should be considered in patients with a short bowel and proven/high risk of gallstones, to avoid the need for re-entry into the abdomen (Level of Evidence 5).

Abdominal wall reconstruction

Reconstruction of the abdominal wall is an important component of these operations and failure to do so adequately may result in an increased risk of refistula-

tion, formation of a large incisional hernia and inadequate cosmesis. Evidence for the safety and efficacy of nonabsorbable mesh in the open abdomen with enteric fistulation is equivocal, with possible increased rates of infection [54–56]. Simultaneous reconstruction of the abdominal wall with prosthetic mesh is associated with a particularly high incidence of recurrent postoperative fistulation and should be avoided if possible. In a study from an IF unit refistulation occurred in 7 (11.1%) cases but was more common when the abdominal wall was reconstructed with prosthetic mesh (7 of 29, 24.1%) than with sutures (0 of 34, 0%). A cross-linked biological mesh was associated with a particularly high rate of refistulation (5 of 12, 41.7%) [57]:

- When bowel is anastomosed every attempt should be made to close the abdominal wall to reduce the risk of anastomotic leakage (Level of Evidence 5).
- Nonabsorbable synthetic meshes and cross-linked biological implants should not be placed in the peritoneal cavity in IF due to the reported high rate of complications [58–60] (Level of Evidence 4).
- Techniques which employ autologous tissue, such as component separation and suture repair, are appropriate [61–63] (Level of Evidence 4).
- Larger defects may require plastic surgical reconstruction using autologous sliding/pedicled flaps [64]. Free flaps are occasionally necessary when there is a defect extending very high up on the abdominal wall which cannot be repaired with a biological mesh and native tissue, and cannot be reached with a pedicled flap (Level of Evidence 5).
- The use of nonabsorbable synthetic meshes should ideally be limited to onlay and they should never be placed within the peritoneal cavity. They should be avoided whenever possible in a contaminated (or a potentially contaminated) environment (Level of Evidence 4).
- If a mesh is required to repair large contaminated abdominal wall defects, a noncross-linked biological mesh should be used [57,65,66] (Level of Evidence 5).
- Biological mesh outside the abdominal cavity leads to seroma formation [67]. Drains should be left in until dry or according to the manufacturers' recommendations (Level of Evidence 5).

Surgical outcome measurements in IF

- Surgical outcome should be measured using the following:
  - 30-day and in-hospital mortality;
  - unplanned return to theatre (reoperation) after surgery for Type 2 IF;
  - recurrent fistulation rate after surgery for enterocutaneous fistula;
  - unplanned hospital readmission;
  - percentage of patients who are able to discontinue parenteral support 2 years after reconstruction surgery (Level of Evidence 5).

Criteria for referral to a specialist centre

- Criteria for referral to a specialist IF unit should be as follows [8]:
  - any patient with IF beyond the expertise of the referring hospital;
  - recurrent intestinal fistulation after failed surgical treatment of Type 2 IF;
  - persistent IF requiring PN for more than 28 days, complicated by venous access problems due to catheter sepsis or thrombosis;
  - patients with fistulae to the open abdomen [68];
  - total or near total enterectomy leaving < 50 cm of small bowel to colon or < 100 cm small bowel to a stoma;
  - persistent abdominal sepsis;
  - persistent nutritional or metabolic problems associated with a high stoma or fistula output or with PN;
  - concomitant vascular comorbidity (Level of Evidence 5).

Surgery for Type 3 intestinal failure

- Surgical procedures to augment the length of remaining bowel (e.g. the STEP procedure) [69] may have a role in highly selected stable adult patients with Type 3 IF, but such procedures should be undertaken only in specialized centres and subjected to audit (Level of Evidence 5).

Intestinal transplantation

The outcome of intestinal transplantation is less successful than with transplantation of other abdominal organs, with reported graft failure of 15–27% and 5-year patient survival of around 50% [70–74]. The indications for intestinal transplantation and multivisceral transplantation can be divided into complications of PN, including line complications, access difficulties and deterioration in liver function, and high-risk conditions requiring extensive evisceration [75,76]. A simulation study has shown that intestinal transplantation marginally

improved survival for patients on PN with a life expectancy of < 12 months when compared to home PN [77], but the rate of patients maintaining renal function is < 50% in transplanted patients compared with those on home PN [78]:

- Intestinal transplantation needs to be discussed at an IF network meeting with both the intestinal transplant team and a dedicated IF unit involved [70,71] (Level of Evidence 5).
- Home PN should continue to be the primary therapeutic option for IF due to better or comparable long-term survival compared with intestinal transplantation [79,80] (Level of Evidence 5).
- Intestinal transplantation has a role as a potential lifesaving intervention, particularly in patients with difficult venous access or abnormal liver function [81] (Level of Evidence 5).

Acknowledgement

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Conflicts of interest

The committee members and the working group members were carefully screened and declare the following conflict of interests: C. J. Vaizey (Acelity/Lifecell: consultancy), Y. Maeda, E. Barbosa, F. Bozzetti, J. Calvo, Ø. Irtun, P. B. Jeppesen, M. Panisic-Sekeljic, I. Papaconstantinou, A. Pascher, Y. Panis and W. D. Wallace (no conflict of interest), S. Klek (honoraria from Baxter, B Braun, Fresenius-Kabi, Nutricia, Nestlé), G. Carlson (honoraria from Acelity, Baxter and Cook Ltd for teaching and lecturing), M. Boermeester (Ipsen: grant, Acelity/LifeCell: consultancy and grant, Baxter: grant).

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References

1 Paine P, McLaughlin J, Lal S. Review article: the assessment and management of chronic severe gastrointestinal dysmotility in adults. *Aliment Pharmacol Ther* 2013; **38:** 1209–29.
2 Kalaiselvan R, Theis VS, Dibb M *et al.* Radiation enteritis leading to intestinal failure: 1994 patient-years of experience in a national referral centre. *Eur J Clin Nutr* 2014; **68:** 166–70.
3 Gyorki DE, Brooks CE, Gett R *et al.* Enterocutaneous fistula: a single-centre experience. *ANZ J Surg* 2010; **80:** 178–81.
4 Pironi L, Arends J, Baxter J *et al.* ESPEN endorsed recommendations. Definition and classification of intestinal failure in adults. *Clin Nutr* 2015; **34:** 171–80.
5 Van Gossum A, Cabre E, Hebuterne X *et al.* ESPEN guidelines on parenteral nutrition: gastroenterology. *Clin Nutr* 2009; **28:** 415–27.
6 Staun M, Pironi L, Bozzetti F *et al.* ESPEN guidelines on parenteral nutrition: home parenteral nutrition (HPN) in adult patients. *Clin Nutr* 2009; **28:** 467–79.
7 Pittiruti M, Hamilton H, Biffi R *et al.* ESPEN guidelines on parenteral nutrition: central venous catheters (access, care, diagnosis and therapy of complications). *Clin Nutr* 2009; **28:** 365–77.
8 Carlson G, Gardiner K, McKee R, MacFie J, Vaizey C. *The surgical management of patients with acute intestinal failure.* Associations of Surgeons of Great Britain and Ireland, 2010.
9 Lal S, Teubner A, Shaffer JL. Review article: intestinal failure. *Aliment Pharmacol Ther* 2006; **24:** 19–31.
10 Datta V, Engledow A, Chan S *et al.* The management of enterocutaneous fistula in a regional unit in the United kingdom: a prospective study. *Dis Colon Rectum* 2010; **53:** 192–9.
11 Geels W, Bagley K, Vader L. The enterocutaneous fistula: supplanting surgery with meticulous nursing care. *Nursing* 1978; **8:** 52–5.

12 Corcos O, Castier Y, Sibert A *et al.* Effects of a multimodal management strategy for acute mesenteric ischemia on survival and intestinal failure. *Clin Gastroenterol Hepatol* 2013; **11:** 158–65.e2.
13 Irving M, White R, Tresadern J. Three years' experience with an intestinal failure unit. *Ann R Coll Surg Engl* 1985; **67:** 2–5.
14 McIntyre PB, Ritchie JK, Hawley PR *et al.* Management of enterocutaneous fistulas: a review of 132 cases. *Br J Surg* 1984; **71:** 293–6.
15 Saalwachter AR, Evans HL, Willcutts KF *et al.* A nutrition support team led by general surgeons decreases inappropriate use of total parenteral nutrition on a surgical service. *Am Surg* 2004; **70:** 1107–11.
16 Rahbour G, Gabe SM, Ullah MR *et al.* Seven-year experience of enterocutaneous fistula with univariate and multivariate analysis of factors associated with healing: development of a validated scoring system. *Colorectal Dis* 2013; **15:** 1162–70.
17 Matarese LE, Jeppesen PB, O'Keefe SJ. Short bowel syndrome in adults: the need for an interdisciplinary approach and coordinated care. *JPEN J Parenter Enteral Nutr* 2014; **38(1 Suppl):** 60S–4S.
18 Chopra V, Ratz D, Kuhn L *et al.* PICC-associated bloodstream infections: prevalence, patterns, and predictors. *Am J Med* 2014; **127:** 319–28.
19 Dreesen M, Foulon V, Spriet I *et al.* Epidemiology of catheter-related infections in adult patients receiving home parenteral nutrition: a systematic review. *Clin Nutr* 2013; **32:** 16–26.
20 Brown M, Teubner A, Shaffer J *et al.* Home parenteral nutrition–an effective and safe long-term therapy for systemic sclerosis-related intestinal failure. *Rheumatology (Oxford)* 2008; **47:** 176–9.
21 Chung HJ, Goo BC, Lee JH *et al.* Behcet's disease combined with various types of fistula. *Yonsei Med J* 2005; **46:** 625–8.
22 Shatnawei A, Habib M, Hamilton C *et al.* The association between home parenteral nutrition and patients with FAP-associated intra-abdominal desmoids: a retrospective study. *JPEN J Parenter Enteral Nutr* 2013; **37:** 683–8.
23 Xhaja X, Church J. Enterocutaneous fistulae in familial adenomatous polyposis patients with abdominal desmoid disease. *Colorectal Dis* 2013; **15:** 1238–42.
24 Owen RM, Love TP, Perez SD *et al.* Definitive surgical treatment of enterocutaneous fistula: outcomes of a 23-year experience. *JAMA Surg* 2013; **148:** 118–26.
25 Ravindran P, Ansari N, Young CJ *et al.* Definitive surgical closure of enterocutaneous fistula: outcome and factors predictive of increased postoperative morbidity. *Colorectal Dis* 2014; **16:** 209–18.
26 Bradley MJ, Dubose JJ, Scalea TM *et al.* Independent predictors of enteric fistula and abdominal sepsis after damage control laparotomy: results from the prospective AAST Open Abdomen registry. *JAMA Surg* 2013; **148:** 947–54.
27 Fischer PE, Fabian TC, Magnotti LJ *et al.* A ten-year review of enterocutaneous fistulas after laparotomy for trauma. *J Trauma* 2009; **67:** 924–8.
28 Glass RE, Ritchie JK, Lennard-Jones JE *et al.* Internal fistulas in Crohn's disease. *Dis Colon Rectum* 1985; **28:** 557–61.
29 Harju E, Pessi T, Koikkalainen T *et al.* The treatment of high enterocutaneous fistula with surgical drainage and total parenteral nutrition. *Int Surg* 1985; **70:** 33–8.
30 Amiot A, Setakhr V, Seksik P *et al.* Long-term outcome of enterocutaneous fistula in patients with Crohn's disease treated with anti-TNF therapy: a cohort study from the GETAID. *Am J Gastroenterol* 2014; **109:** 1443–9.
31 Kasparek MS, Bruckmeier A, Beigel F *et al.* Infliximab does not affect postoperative complication rates in Crohn's patients undergoing abdominal surgery. *Inflamm Bowel Dis* 2012; **18:** 1207–13.
32 Lynch AC, Delaney CP, Senagore AJ *et al.* Clinical outcome and factors predictive of recurrence after enterocutaneous fistula surgery. *Ann Surg* 2004; **240:** 825–31.
33 ten Broek RP, Stommel MW, Strik C *et al.* Benefits and harms of adhesion barriers for abdominal surgery: a systematic review and meta-analysis. *Lancet* 2014; **383:** 48–59.
34 Tang CL, Jayne DG, Seow-Choen F *et al.* A randomized controlled trial of 0.5% ferric hyaluronate gel (Intergel) in the prevention of adhesions following abdominal surgery. *Ann Surg* 2006; **243:** 449–55.
35 Carlson GL, Patrick H, Amin AI *et al.* Management of the open abdomen: a national study of clinical outcome and safety of negative pressure wound therapy. *Ann Surg* 2013; **257:** 1154–9.
36 Acosta S, Bjarnason T, Petersson U *et al.* Multicentre prospective study of fascial closure rate after open abdomen with vacuum and mesh-mediated fascial traction. *Br J Surg* 2011; **98:** 735–43.
37 Schmelzle M, Alldinger I, Matthaei H *et al.* Long-term vacuum-assisted closure in open abdomen due to secondary peritonitis: a retrospective evaluation of a selected group of patients. *Dig Surg* 2010; **27:** 272–8.
38 Levy E, Frileux P, Sandrucci S *et al.* Continuous enteral nutrition during the early adaptive stage of the short bowel syndrome. *Br J Surg* 1988; **75:** 549–53.
39 Teubner A, Morrison K, Ravishankar HR *et al.* Fistuloclysis can successfully replace parenteral feeding in the nutritional support of patients with enterocutaneous fistula. *Br J Surg* 2004; **91:** 625–31.
40 Greenstein AJ, Sachar DB, Greenstein RJ *et al.* Intraabdominal abscess in Crohn's (ileo) colitis. *Am J Surg* 1982; **143:** 727–30.
41 Jeppesen PB, Mortensen PB. Intestinal failure defined by measurements of intestinal energy and wet weight absorption. *Gut* 2000; **46:** 701–6.
42 Coetzee E, Rahim Z, Boutall A *et al.* Refeeding enteroclysis as an alternative to parenteral nutrition for enteric fistula. *Colorectal Dis* 2014; **16:** 823–30.

43 Visschers RG, van Gemert WG, Winkens B *et al.* Guided treatment improves outcome of patients with enterocutaneous fistulas. *World J Surg* 2012; **36:** 2341–8.

44 Runstrom B, Hallbook O, Nystrom PO *et al.* Outcome of 132 consecutive reconstructive operations for intestinal fistula–staged operation without primary anastomosis improved outcome in retrospective analysis. *Scand J Surg* 2013; **102:** 152–7.

45 Atema JJ, Gans SL, Boermeester MA. Systematic review and meta-analysis of the open abdomen and temporary abdominal closure techniques in non-trauma patients. *World J Surg* 2015; **39:** 912–25.

46 Ellegard L, Kurlberg G, Bosaeus I. High prevalence of vitamin D deficiency and osteoporosis in out-patients with intestinal failure. *Clin Nutr* 2013; **32:** 983–7.

47 Melton GB, Stocchi L, Wick EC *et al.* Contemporary surgical management for ileosigmoid fistulas in Crohn's disease. *J Gastrointest Surg* 2009; **13:** 839–45.

48 Rahbour G, Siddiqui MR, Ullah MR *et al.* A meta-analysis of outcomes following use of somatostatin and its analogues for the management of enterocutaneous fistulas. *Ann Surg* 2012; **256:** 946–54.

49 Gayral F, Campion JP, Regimbeau JM *et al.* Randomized, placebo-controlled, double-blind study of the efficacy of lanreotide 30 mg PR in the treatment of pancreatic and enterocutaneous fistulae. *Ann Surg* 2009; **250:** 872–7.

50 Sancho JJ, di Costanzo J, Nubiola P *et al.* Randomized double-blind placebo-controlled trial of early octreotide in patients with postoperative enterocutaneous fistula. *Br J Surg* 1995; **82:** 638–41.

51 Lee AM, Gabe SM, Nightingale JM *et al.* Intestinal failure and home parenteral nutrition: implications for oral health and dental care. *Clin Nutr* 2013; **32:** 77–82.

52 Stern JM, Jacyna N, Lloyd DA. Review article: psychological aspects of home parenteral nutrition, abnormal illness behaviour and risk of self-harm in patients with central venous catheters. *Aliment Pharmacol Ther* 2008; **27:** 910–8.

53 Brenner M, Clayton JL, Tillou A *et al.* Risk factors for recurrence after repair of enterocutaneous fistula. *Arch Surg* 2009; **144:** 500–5.

54 Kurmann A, Barnetta C, Candinas D *et al.* Implantation of prophylactic nonabsorbable intraperitoneal mesh in patients with peritonitis is safe and feasible. *World J Surg* 2013; **37:** 1656–60.

55 Carbonell AM, Criss CN, Cobb WS *et al.* Outcomes of synthetic mesh in contaminated ventral hernia repairs. *J Am Coll Surg* 2013; **217:** 991–8.

56 Slater NJ, Bokkerink WJ, Konijn V *et al.* Safety and durability of one-stage repair of abdominal wall defects with enteric fistulas. *Ann Surg* 2015; **261:** 553–7.

57 Connolly PT, Teubner A, Lees NP *et al.* Outcome of reconstructive surgery for intestinal fistula in the open abdomen. *Ann Surg* 2008; **247:** 440–4.

58 Anderson O, Putnis A, Bhardwaj R *et al.* Short- and long-term outcome of laparostomy following intra-abdominal sepsis. *Colorectal Dis* 2011; **13:** e20–32.

59 Shah BC, Tiwari MM, Goede MR *et al.* Not all biologics are equal!. *Hernia* 2011; **15:** 165–71.

60 Scholtes M, Kurmann A, Seiler CA *et al.* Intraperitoneal mesh implantation for fascial dehiscence and open abdomen. *World J Surg* 2012; **36:** 1557–61.

61 Ewart CJ, Lankford AB, Gamboa MG. Successful closure of abdominal wall hernias using the components separation technique. *Ann Plast Surg* 2003; **50:** 269–73; discussion 273–4.

62 Petro CC, Como JJ, Yee S *et al.* Posterior component separation and transversus abdominis muscle release for complex incisional hernia repair in patients with a history of an open abdomen. *J Trauma Acute Care Surg* 2015; **78:** 422–9.

63 Wind J, van Koperen PJ, Slors JF *et al.* Single-stage closure of enterocutaneous fistula and stomas in the presence of large abdominal wall defects using the components separation technique. *Am J Surg* 2009; **197:** 24–9.

64 Szczerba SR, Dumanian GA. Definitive surgical treatment of infected or exposed ventral hernia mesh. *Ann Surg* 2003; **237:** 437–41.

65 Mangus RS, Kubal CA, Tector AJ *et al.* Closure of the abdominal wall with acellular dermal allograft in intestinal transplantation. *Am J Transplant* 2012; **12(Suppl 4):** S55–9.

66 Rosen MJ, Krpata DM, Ermlich B *et al.* A 5-year clinical experience with single-staged repairs of infected and contaminated abdominal wall defects utilizing biologic mesh. *Ann Surg* 2013; **257:** 991–6.

67 Taner T, Cima RR, Larson DW *et al.* Surgical treatment of complex enterocutaneous fistulas in IBD patients using human acellular dermal matrix. *Inflamm Bowel Dis* 2009; **15:** 1208–12.

68 Mawdsley JE, Hollington P, Bassett P *et al.* An analysis of predictive factors for healing and mortality in patients with enterocutaneous fistulas. *Aliment Pharmacol Ther* 2008; **28:** 1111–21.

69 Yannam GR, Sudan DL, Grant W *et al.* Intestinal lengthening in adult patients with short bowel syndrome. *J Gastrointest Surg* 2010; **14:** 1931–6.

70 Grant D, Abu-Elmagd K, Mazariegos G *et al.* Intestinal transplant registry report: global activity and trends. *Am J Transplant* 2015; **15:** 210–9.

71 Fishbein TM. Intestinal transplantation. *N Engl J Med* 2009; **361:** 998–1008.

72 Desai CS, Gruessner AC, Khan KM *et al.* Isolated intestinal transplants vs. liver-intestinal transplants in adult patients in the United States: 22 yr of OPTN data. *Clin Transplant* 2012; **26:** 622–8.

73 Mangus RS, Tector AJ, Kubal CA *et al.* Multivisceral transplantation: expanding indications and improving outcomes. *J Gastrointest Surg* 2013; **17:** 179–86; discussion 186–7.

74 Smith JM, Skeans MA, Horslen SP *et al.* OPTN/SRTR 2012 annual data report: intestine. *Am J Transplant* 2014; **14(Suppl 1):** 97–111.
75 Pironi L, Joly F, Forbes A *et al.* Long-term follow-up of patients on home parenteral nutrition in Europe: implications for intestinal transplantation. *Gut* 2011; **60:** 17–25.
76 Gotthardt DN, Gauss A, Zech U *et al.* Indications for intestinal transplantation: recognizing the scope and limits of total parenteral nutrition. *Clin Transplant* 2013; **27 (Suppl 25):** 49–55.
77 Roskott AM, Groen H, Rings EH *et al.* Cost-effectiveness of intestinal transplantation for adult patients with intestinal failure: a simulation study. *Am J Clin Nutr* 2015; **101:** 79–86.
78 Pironi L, Lauro A, Soverini V *et al.* Renal function in patients on long-term home parenteral nutrition and in intestinal transplant recipients. *Nutrition* 2014; **30:** 1011–4.
79 Messing B, Lemann M, Landais P *et al.* Prognosis of patients with nonmalignant chronic intestinal failure receiving long-term home parenteral nutrition. *Gastroenterology* 1995; **108:** 1005–10.
80 Lloyd DA, Vega R, Bassett P *et al.* Survival and dependence on home parenteral nutrition: experience over a 25-year period in a UK referral centre. *Aliment Pharmacol Ther* 2006; **24:** 1231–40.
81 Pironi L, Forbes A, Joly F *et al.* Survival of patients identified as candidates for intestinal transplantation: a 3-year prospective follow-up. *Gastroenterology* 2008; **135:** 61–71.