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TOPIC HIGHLIGHT

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Nutritional status and nutritional therapy in inflammatory bowel diseases

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Abstract

Underweight and specific nutrient deficiencies are frequent in adult patients with inflammatory bowel disease (IBD). In addition, a significant number of children with IBD, especially Crohn's disease (CD) have impaired linear growth. Nutrition has an important role in the management of IBD. In adults with CD, enteral nutrition (EN) is effective in inducing clinical remission of IBD, although it is less efficient than corticosteroids. Exclusive EN is an established primary therapy for pediatric CD. Limited data suggests that EN is as efficient as corticosteroids for induction of remission. Additional advantages of nutritional therapy are control of inflammation, mucosal healing, positive benefits to growth and overall nutritional status with minimal adverse effects. The available evidence suggests that supplementary EN may be effective also for maintenance of remission in CD. More studies are needed to confirm these findings. However, EN supplementation could be considered as an alternative or as an adjunct to maintenance drug therapy in CD. EN does not have a primary therapeutic role in ulcerative colitis. Specific compositions of enteral diets-elemental diets or diets containing specific components-were not shown to have any advantage over standard polymeric diets and their place in the treatment of CD or UC need further evaluation. Recent theories suggest that diet may be implicated in the etiology of IBD, however there are no proven dietary approaches to reduce the risk of developing IBD.

INTRODUCTION

Inflammatory bowel disease (IBD), Crohn's disease (CD), ulcerative colitis (UC) and indeterminate colitis are chronic inflammatory disorders of the gastrointestinal tract. The relationship between nutrition and IBD is complex and involves several aspects. These include: (1) nutritional support for malnourished patients, (2) primary therapy for active disease and maintenance of remission and (3) nutrients as risk factors involved in the etiology of IBD.

Nutritional care is important in the treatment of patients with IBD and includes prevention or treatment of malnutrition and micronutrient deficiencies, prevention of osteoporosis, and, in children, promotion of optimal growth and development. Enteral nutrition (EN) is considered the modality of choice for the treatment of active CD in children and for some adults too.

NUTRITIONAL STATUS OF ADULT PATIENTS WITH IBD

Malnutrition is common in patients with IBD, especially in active CD. Several studies have documented weight loss in 70%-80% of hospitalized IBD patients and in 20%-40% of outpatients with CD[1,2]. The prevalence of malnutrition is lower in patients with UC, but nutritional deficiencies can develop fast in these patients during periods of active disease[3].

Table 1 Pathophysiology of malnutrition

Main mechanism	Effect
Decreased food intake	Anorexia
	Abdominal pain, nausea, vomiting
	Restricted diets
	Drugs
Nutrients malabsorption	Reduced absorptive surface due to inflammation, resection, bypass and fistulae
Increased intestinal loss	Exudative enteropathy (protein loss)
	Occult/overt blood loss (iron deficiency)
	Diarrhea (increased loss of Zn^{2+}, K^{+}, Mg^{2+})
	Steatorrhea (fat and fat soluble vitamin malabsorption, and divalent cations' loss: Zn^{2+}, Mg^{2+}, Ca^{2+}, Cu^{2+})
Hypermetabolic state	Alterations of resting energy expenditure
Drugs' interaction	Anorexia, nausea, test alteration, proteolysis, interaction with nutrients absorption/utilization

Pathophysiology of malnutrition

The main mechanisms responsible for malnutrition in CD are presented in Table 1. These may cause malnutrition either alone or in combination. Factors which have a major role in one nutritional deficiency may play a minor role in the appearance of a different deficiency in the same patient. The most important causes of malnutrition are probably reduced food intake[4,5], presence of active inflammation[6] and enteric loss of nutrients during periods of disease activity but also during remission[7]. Anorexia secondary to increased levels of proinflammatory cytokines [tumor necrosis factor-α, interleukin (IL)-1 and IL-6][8], white adipose tissue adipokines (leptin, adiponectin, resistin)[9] and suspected alterations in hypothalamic serotonin levels[10] are considered the main causes of reduced food intake.

Studies on energy metabolism in patients with CD have been contradictory. Energy expenditure has been reported to be increased, normal, or even reduced in IBD patients compared with healthy individuals[11,12]. This may be partly because patients with different disease extension, inflammatory activity, and nutritional status were grouped together. However, when adjusted for body composition, increased resting energy expenditure (REE) has generally been disclosed. Furthermore, despite being malnourished, children with CD fail to adapt their REE per unit of lean body mass, an additional factor contributing to malnutrition[13,14].

NUTRITIONAL ASSESSMENT OF PATIENTS WITH IBD

A variety of nutritional and functional deficiencies have been observed in patients with active or inactive CD. The prevalence of malnutrition had decreased as awareness rose, and recent studies showed that most patients in remission are in a good nutritional status and some are even overweight, but still have significant abnormalities in body composition. Sousa Guerreiro *et al*[15] reported that the BMI of CD patients overall was lower than of controls

Table 2 Nutritional assessment in patients with IBD

Assessment	Parameters	Percentage of CD patients with deficient intake or parameters
Dietary history	Energy intake, low	40%[5,15]
	Protein intake, high	150% RDA[5]
	Carbohydrates, excess	39.2%[17]
	Fat, and saturated fat, excess	27%, and 59.5%[17]
	Iron intake, low	50%, 13%[18]
	Calcium and phosphor intake, low	23%[18]
	Folate intake, low	19%[18]
	Vitamin A intake, low	13%-21%, 26%[18,19]
	Vitamin B intake, low	18%-37%[19]
	Vitamin C intake, low	21%-34%, 11%[18,19]
	Vitamin D	36%[18]
	Vitamin E	63%[18]
Anthropometry	IBW < 90%	40%[5]
	BMI > 25 kg/m^2	32%[15]
Body composition	Fat body mass, SFT < 15%	30%[5]
	Fat free mass, MAC < 15%	59%[5]
	DXA (dual-energy X-ray absorptiometry)	30% osteopenic, 60% sarcopenic[20]
	Nitrogen balance, negative	[21]

RDA: Recommended daily allowance; IBW: Ideal body weight; BMI: Body mass index; SFT: Skinfold thickness triceps; MAC: Mid arm circumference.

($P = 0.006$). Thirty two percent of patients with CD had BMI > 25 kg/m^2, but still had lower fat free mass and significantly lower adjusted mean daily intakes of carbohydrates, monounsaturated fat, fiber, calcium, and vitamins C, D, E, and K ($P < 0.05$). Muscle mass depletion was detected in more than half of CD and UC patients even in the absence of malnutrition. BMI, arm muscle area and triceps plus subscapular skin fold thickness values were significantly lower, but only in the active phase of CD[3]. Valentini *et al*[16] evaluated in a prospective, controlled, multicenter study, the nutritional status, body composition, muscle strength, and quality of life in patients with IBD in clinical remission. They showed that, despite most being well nourished (74%), both CD and UC patients have decreased body cell mass and handgrip strength (as a functional measure of nutritional status) when compared to controls. This shows that the most prevalent form of malnutrition in CD patients has changed to one of excess body weight, coupled with inadequate dietary intake of micronutrients, secondary to dietary exclusion of certain foods. Moreover, in spite of appropriate intakes of energy and macronutrients, CD patients in remission have significantly lower plasma concentrations of several vitamins and minerals (Tables 2 and 3)[17-21].

NUTRITIONAL STATUS AND GROWTH IN CHILDREN WITH IBD

Growth failure and malnutrition are one of the major complications affecting children with IBD. Weight loss is present at diagnosis in up to 90% of children[22]. Recent studies have shown that, similar to adults, a significant proportion of children with CD are overweight. In a

Table 3 Nutritional deficiencies in patients with IBD

Macro- and micro-nutrient deficiencies	Nutrients	Percentage of CD patients with deficiencies
Hypoproteinemia and hypoalbuminemia		17.6[18]
Anemia	Iron deficiency	39.2[18]
	B12 deficiency	18.4[18]
	Folic acid deficiency	19[18]
Electrolytes and trace elements	Zinc	15.2, 65[18,19]
	Copper	84[19]
	Selenium	82[19]
Vitamins' deficiency (low serum levels)	B12 deficiency	18.4[18]
	Vitamin A	23.4[18]
	Vitamin B	29[18]
	Vitamin C	84[19]
	Vitamin D	17.6[18]
	Vitamin E	16[15]

Table 4 Pathophysiology of growth failure in children with IBD

Ethiopathogenesis	Mechanism
Energy and nutrient deficiencies[30]	Deficits of energy, macronutrients and micronutrients
Inflammation/proinflammatory cytokines[31]	Anorexigenic effect
	GH-IGF1 axis effects
	Bone metabolism disturbance
	Hypermetabolic/catabolic effects
Disease severity and disease location[32,33]	Severe disease
	Jejunal localization
Abnormal bone metabolism[34]	Effect of pro-inflammatory cytokines
	GH-IGF1 axis dysfunction
	Calcium and vitamin D deficiency
	Delayed sexual maturation
	Corticosteroids
Delayed onset of sexual maturation[35]	Hypogonadism
Abnormal IGF1 axis[36]	Low IGF1 and IGF1-BP
	Proinflammatory cytokines
Drugs[28]	Corticosteroids

cohort of 783 patients with newly diagnosed IBD, low BMI (< 5%) was seen in 22%-24% of children with CD and 7%-9% of children with UC. Ten percent of children with CD and 20%-30% of children with UC had a BMI consistent with overweight or risk for overweight[23]. Despite their preserved fat mass, children with CD frequently have low lean body mass[24]. Growth retardation at diagnosis has been reported in 23%-88% of children with CD and may precede the gastrointestinal manifestations by years[25]. Growth failure is less common in UC compared to CD although growth impairment is seen in both groups[26]. The variability in reported prevalence of growth failure in children with CD can be explained by differences in the definition of growth impairment, the population under study and disease phenotype (colon *vs* small bowel). About 30%-40% of children continue to have severe linear growth retardation during their disease course and several studies found that the final height is affected in CD patients with early onset symptoms[27,28]. The etiology of growth failure is multi factorial and not completely understood, but poor nutritional state, systemic consequences of gut inflammation, disturbances of the growth hormone/insulin-like growth factor axis, genetic influences and corticosteroid use contribute in different ways (Table 4)[29-36].

INTERVENTION FOR GROWTH IN CHILDREN WITH CD

Newby *et al*[37] examined the results of different interventions for growth failure in children with CD. Three randomized, controlled trials (RCT) were identified. One study looked at the use of 6-mercaptopurine (6-MP) as a steroid sparing agent[38]. No difference in linear growth was observed between the intervention and placebo groups, although the total steroid dose received over the 18 mo follow-up period was reduced in the group receiving 6-MP. Two other trials compared EN to corticosteroids for induction of remission. In both studies, height velocity standard deviation scores were significantly increased in the EN group compared with the corticosteroid group[39,40]. The judicious use of surgical interventions was also shown to improve growth in pre-pubertal children with refractory disease[41-43]. In a large prospective trial of infliximab in children and adolescents with moderate to severe CD, improvement of height velocity and height percentiles was seen in children treated with the drug prior to or early during puberty[44]. The role of growth hormone for the treatment of growth failure associated with CD is unclear. The few studies that investigated the effect of growth hormone on growth velocity showed contradictory results and the effect of such treatment on final adult height is yet to be determined[45,46].

NUTRITION AS PRIMARY THERAPY FOR ADULTS WITH CD

Parenteral nutrition (PN)

Dudrick *et al*[47] were the first to suggest that PN was safe and possibly beneficial to patients with IBD. Use of PN for the management of adults with CD during the eighties succeeded in achieving clinical remission and avoiding surgery[47,48]. However, the remission was often short lived and the number of patients remaining in remission 3 mo later varied between 20% and 79% depending on the population of patients, length of PN administration, definitions of remission or recurrence and simultaneous use of medications[49]. PN therapy also achieved fistula healing in 43%-63% of patients in some series, accompanied by reduction in disease activity index, weight gain and elevation of serum albumin[50,51]. PN was proved a useful adjunctive therapy for UC patients requiring bowel rest and nutritional support, though not useful in induction of remission[52].

Since EN was shown to be at least as efficient as

PN with lower costs and fewer significant side effects, the current indications for PN support are restricted to severe malnutrition and for nutritional support pre- and postoperatively, in both CD and UC[53,54].

Home parenteral nutrition

CD accounts for up to 20% of the adult population on home PN[55,56]. PN has an important role in maintaining the nutritional status and improving the quality of life of these patients, but it is associated with significant morbidity and potentially life-threatening complications. In a retrospective series of 41 patients on home PN for CD over an 11-year period (121 patient-years of home PN), 58.5% of patients had one or more PN-related complications necessitating hospitalization. There were eight deaths, one directly caused by catheter-related sepsis[57].

Experience in children using home PN is limited. Strobel *et al*[58] have reported their experience in 17 pediatric patients, all of whom had severe CD. All 17 patients showed weight gain and symptomatic improvement and 10 had height catch up. Complete remission was obtained in 12 patients during the first course of PN[58].

Enteral nutrition for adult patients with CD

EN was shown to induce clinical remission, improve nutritional status, improve body composition, induce mucosal healing, decrease pro-inflammatory cytokine levels and reduce serum inflammatory markers in patients with CD[59-63]. The theory behind the mechanism of action of EN is multi-factorial (Table 5)[64-67].

Three meta-analyses and two Cochrane Database Systematic Reviews published in recent years examined the efficacy of EN compared to corticosteroids in CD[68-72]. The most recent Cochrane meta-analysis that included 192 patients treated with EN and 160 treated with steroids yielded a pooled OR of 0.33 favoring steroid therapy (95% CI: 0.21-0.53). In patients in whom remission was achieved, the relapse rates at 12 mo were identical (65% and 67%) regardless of the therapy. Similar results were reported in all meta-analyses of adult patients. It must be remembered, however, that since meta-analyses are based on intention to treat analysis, they also reflect the lower acceptance of this form of treatment in adults. Furthermore, comparison of efficacy alone between EN and corticosteroids is insufficient, as the two treatment modalities possess entirely different safety profiles. In contrast to corticosteroids, EN has minor, immediate side effects and no known long-term adverse effects. Adult patients should be considered also for EN if: (1) there is a potential for a high lifetime corticosteroid dose, including adolescents and patients in their thirties; (2) there is a high risk for osteoporosis; (3) the patients are steroid-refractory, steroid-dependent or steroid-intolerant; (4) the patients request alternative treatment.

Type and content of formula

Elemental formulae (protein provided as amino acids) were utilized in the initial studies in adults with IBD. Studies comparing elemental formulae to polymeric (whole protein) drinks showed that the two formulae were equally efficacious. Similar conclusions were reached by the Cochrane Database Systematic review that examined one form of EN *versus* another for inducing remission of active CD. Meta-analysis of 10 trials comprising 334 patients found no difference in the efficacy of elemental *versus* non-elemental formulae (OR 1.10, 95% CI: 0.69-1.75). Subgroup analyses performed to evaluate the different types of elemental and non-elemental diets (elemental, semi-elemental and polymeric) showed no significant differences[72]. The reviewers concluded that protein type does not influence the effectiveness of EN.

Table 5 The mechanism of action of enteral nutrition in CD

Proposed mechanism of action	Ref.
Improvement of nutritional status	[59]
Down regulation of pro-inflammatory cytokines	[64,65]
Anti-inflammatory effects	[61,62]
Promote epithelial healing	[62,65]
Decrease gut permeability	[66]
Decrease antigenic load to the gut, bowel rest	[59]
Modification of gut flora	[67]

The influence of fat quantity and quality of enteral diets on the outcome in CD has been examined in several studies. The use of diets with a very low fat content (0.6%-1.3% of total calories) has been associated with good outcomes[73], while those containing high quantities of fat (12%-30% of total calories) were associated overall with less favorable outcomes, in particular when large amounts of linoleic acid were present[74,75]. The 2007 Cochrane Database Systematic review examined seven trials (209 patients), treated with EN formulae of differing fat content (low fat: < 20 g/1000 kcal *versus* high fat: > 20 g/1000 kcal), and found no significant difference in efficacy between the 2 (OR 1.13, 95% CI: 0.63-2.01). Similarly, the effect of very low fat content (< 3 g/1000 kcal) or type of fat (long chain triglycerides) did not demonstrate a difference in efficacy in active CD, although a non significant trend favoring very low fat and very low long chain triglyceride content was demonstrated[72].

Different modifications in composition of enteral formulae have also been evaluated. Such modifications include fat and/or protein content as described, and the addition of bioactive peptides such as glutamine, growth factors (transforming growth factor-β2), butyrate, omega-3 fatty acids and antioxidants[61,76-79]. Addition of bioactive peptides to enteral diet formulae may have specific anabolic or anti-inflammatory actions. Up to now, such modifications of enteral diets-elemental diets or diets containing specific components-have not been shown to have any advantage over standard polymeric diets.

EN and disease location in adults with either CD or UC

In patients with CD, disease location was not found to predict induction of remission with EN. Zachos *et al*[72] concluded, after extensive review of the literature, that a definite statement about the impact of disease location upon response to EN cannot be made because of

insufficient data. There is no evidence to support the use of EN as primary therapy in UC.

EN FOR MAINTENANCE OF REMISSION IN ADULTS WITH CD

Ongoing EN supplementation may help maintain remission and reduce the use of corticosteroids. When using this strategy, supplementary oral formula is provided in combination with a normal diet throughout the day. This approach may also be used in combination with maintenance medical therapy.

The Cochrane IBD group published the results of a meta-analysis on the role of EN for maintenance of remission in CD[80]. The main outcome measure was the occurrence of a clinical or endoscopic relapse. Two studies met the inclusion criteria and were included in the review. In the first, elemental and polymeric feeds (providing 35%-50% of the patients' calorie intake in addition to an unrestricted normal diet) were equally effective for maintenance of remission, allowing withdrawal of steroid therapy (OR 0.97, 95% CI: 0.24-3.92)[81]. In the second study, 51 patients with CD in remission were randomized to receive half their calories in the form of an elemental formula or to an unrestricted diet for up to 2 years[82]. The treatment group had a much lower relapse rate (34%) than the unrestricted diet group (64%), OR 0.3, 95% CI: 0.09-0.94). This study was halted before the expected end as a result of the interim analyses by the monitoring board, who found a significant benefit for the use of EN formula to maintain remission. Thus, the available evidence suggests that supplementary EN may be effective for maintenance of remission in CD.

Yamamoto investigated the impact of EN on the clinical and endoscopic recurrence after surgical resection for CD. Forty consecutive patients who underwent resection for ileal or ileocolonic CD were randomized to receive partial EN (EN group), or a regular diet (non-EN group). Ileocolonoscopy was performed at 6 and 12 mo after operation. Six months after operation, five patients (25%) in the EN group and 8 (40%) in the non-EN group developed endoscopic recurrence (P = 0.50). Twelve months after operation, endoscopic recurrence was observed in six patients (30%) in the EN group and 14 (70%) in the non-EN group (P = 0.027). One patient (5%) in the EN group and 7 (35%) in the non-EN group developed clinical recurrence during the 1-year follow-up (P = 0.048). Thus, long-term EN supplementation may significantly reduce clinical and endoscopic recurrence after resection for CD[65].

EXCLUSIVE ENTERAL NUTRITION (EEN) FOR INDUCTION OF REMISSION IN CHILDREN WITH CD

Pediatric studies showed that treatment with EEN can induce remission in up to 85% of newly diagnosed patients. The first meta-analysis of pediatric studies included five trials (147 patients). EEN was found as effective as corticosteroids in inducing remission (RR 0.95, 95% CI: 0.67-1.34)[83]. In a second meta-analysis in children, 11 RCTs (n = 394) were included[84]. Seven RCTs (n = 204) compared EEN with corticosteroid therapy. Based on the pooled results of four RCTs (n = 144), no significant differences in the remission rates between EEN and steroids were found (RR 0.97, 95% CI: 0.7-1.4). Four RCTs (n = 190) compared two EEN regimens[84]. Because of a lack of data, formal pooling of results was not possible for many outcomes (e.g. time until remission, duration of remission, growth data).

In conclusion, there are no differences in efficacy between EEN and corticosteroid therapy in the treatment of acute CD in children. Improved growth and nutritional status while avoiding the side effects of steroids make EEN the preferred choice for first-line therapy in children with active CD.

Johnson *et al*[85] investigated whether partial enteral nutrition (PEN) may be as effective as EEN in induction of remission in children with CD. They randomized children with active CD to either receive all of their nutrition as elemental diet (EEN) or only 50% (PEN). Total nutritional intake was similar in both groups, but the remission rate was higher in the EEN group (42%) then in the PEN group (15%)[85].

Elemental and polymeric formulae were shown to be equally effective in children with CD. In a randomized, non-blinded, multicenter, controlled trial in Sweden, 16 children with CD received Elemental 028 Extra (E028E) and 17 received Nutrison Standard (NuS). No significant difference was found between the 2 groups in remission rate at 6 wk (intent-to-treat analysis): E028E 11/16 (69%) and NuS 14/17 (82%), nor in the decrease in the Pediatric Crohn's Disease Activity Index (PCDAI) and adult CDAI. Patients treated with NuS gained more weight than patients with E028E. A polymeric diet may be superior to elemental diet in the treatment of pediatric CD where the primary aim is to increase the patient's weight[86].

EEN and disease location in children

Studies in children showed contradictory results with regard to the effect of disease location on EEN. Two studies found no difference in the remission rate of children with ileal *versus* isolated colonic disease[87,88]. In contrast, a recent report noted a decreased response rate in patients with isolated colonic disease[89]. EEN is beneficial in children with peri-anal disease, whether isolated or in combination with luminal disease[88]. As in adults, there is no convincing evidence that the effect of EN is restricted to small bowel disease only. The influence of disease location and other factors on response to EEN requires further evaluation.

Duration of remission/time to the first relapse in children

The meta-analysis of Dziechciarz *et al*[84] identified two RCTs (n = 43) that investigated duration of remission after EN. One study showed a significant reduction in

the time to relapse in the EN group compared with the corticosteroid group (n = 19, mean difference -0.4 year, 95% CI: -0.6 to -0.2)[22]. In the second RCT (n = 24), a similar trend was reported (the mean duration of remission was 7 mo in the EN group *versus* 10 mo in those treated with corticosteroids)[40].

The relapse rate after EN treatment is 50%-90% at 12 mo in adult studies. This is difficult to assess in the pediatric literature, as many of the reports are of selected groups with a short follow-up period, often of < 12 mo. Fell reported a follow-up of over 10 mo in 23 children who entered remission with EN, with 9 (39%) children relapsing (1 within 2 mo)[62]. The risk factors for early relapse are not well defined but probably include disease severity at onset, disease extent, and disease site, with colitis being more likely to relapse. There have been no long-term pediatric outcome studies after initial treatment with EN.

EN FOR MAINTENANCE OF REMISSION IN PEDIATRIC CD

Prospective studies investigating the role of long-term supplementation of a normal diet with EN in children with CD are limited[90,91]. Belli *et al*[92] reported on eight children with CD and severe growth failure whose clinical course was good on a regimen of elemental diet in one out of every 4 mo. Using this strategy they succeeded in reversing growth arrest, while decreasing prednisone requirements and PCDAI prior to puberty. Thus, maintenance EN can assist in maintaining remission, aid in ensuring adequate and appropriate growth, in addition to postponing the need for steroids.

LONG TERM OUTCOMES OF CHILDREN TREATED WITH EEN

Knight *et al*[88] retrospectively reviewed the long-term outcomes of 44 children treated with EEN over several years in a single pediatric IBD centre, with follow-up periods ranging between 1 and 7 years. Most children who continued maintenance EN had no relapse after remission was established and almost half of the patients have had no need for corticosteroids since diagnosis. In those who did require steroids, therapy was delayed by a median period of 68 wk (range 6-190). In addition, the authors showed improved weight Z scores 12 mo after diagnosis (compared to baseline values), but no improvement in height Z scores[88]. An additional pediatric retrospective study looked at 37 children who received EEN, comparing outcomes in these children to those of 10 children treated with steroids[93]. The initial remission rate in those managed with EEN was similar to that of corticosteroids (86.8% and 90%, respectively). Children managed with EEN achieved greater mucosal healing (64.8% *vs* 40%). Furthermore, EEN therapy led to significantly enhanced nutritional improvements and linear growth recovery compared to steroids. Both groups were managed with maintenance amino salicylic acid (5-ASA) therapy. The EEN treated group had a much longer duration of remission in the 12-mo follow-up period[93].

QUALITY OF LIFE AND EEN

Administration of EEN has been found to be difficult in adult patients as reflected by treatment dropout rates as high as 55%. The influence of therapy on quality of life (QOL) during and following EEN were evaluated in two recent studies of children with CD. One showed improved QOL scores in 24 of 26 children treated with EEN for active CD, with 90% of the children achieving remission. Even the three children who received their enteral formula *via* a nasogastric tube reported overall improvements in QOL[94]. Children receiving EEN through nasogastric tubes emphasized the difficulties associated with the use of these tubes. However, it seems that the improvements in bowel symptoms and overall well-being may outweigh the negative aspects[95].

SIDE EFFECTS OF EEN

EEN is safe and generally well tolerated. Side effects are minimal (23.5%) and include nausea, abdominal pain, flatulence, or diarrhea[96]. The only reported severe adverse event associated with EEN is a single case of refeeding syndrome[97].

DIETARY FACTORS AND THE RISK OF IBD

Several studies examined the association between specific dietary patterns and the risk of CD, including the amount of energy, fat type and quantity, carbohydrates, specific amino acids and fiber. This issue is beyond the scope of this review and the reader is referred to previous and recent publication on dietary factors predisposing to IBD in adults and children[98-100].

CONCLUSION

Malnutrition is common in IBD, the etiology is multifactorial, and it is associated with adverse consequences. Its management requires identification and treatment of the nutritional deficits. PN may correct nutritional deficits and maintain nutritional status. However, EN has similar efficacy to PN with lower costs and fewer complications and is thus the modality of choice. Several studies have attested the efficacy of enteral formulations to control disease activity in adult CD patients. EN is considered the therapy of choice for children with active CD especially in the presence of growth retardation. It was shown to induce clinical remission, mucosal healing, modulate mucosal immune events, nutritional improvement and resumption of growth.

Therefore, in children, EN should be considered as the treatment of choice when acceptable by the family and child. Although not efficacious as steroids in

inducing remission in adults with CD, nutritional therapy has the advantages of controlling inflammation, mucosal healing and overall nutritional status with minimal adverse effects.

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