NASPGHAN
North American Society for Pediatric Gastroenterology, Hepatology and Nutrition

NASPGHAN FOUNDATION
For Children's Digestive Health & Nutrition

Enteral Nutrition as First-Line Therapy in Treating Children and Adolescents With Crohn's Disease

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Introduction

Exclusive enteral nutrition (EEN) using liquid formulas is recognized as an efficacious therapy for the induction of remission in pediatric Crohn's disease (CD). However, EEN has not been universally adopted and various treatment protocols are used.

The mechanism of action of EEN for the induction of remission remains conjectural. Hypotheses include elimination of dietary antigenic exposure, overall nutritional repletion, correction of intestinal permeability, diminution of intestinal synthesis of inflammatory mediators via reduction in dietary fat, and provision of important micronutrients to the diseased intestine. EEN has been shown to exert changes on the intestinal microbiome, which may relate to its efficacy.

Target Audience

This activity is designed for pediatricians, pediatric and adult gastroenterologists, primary care physicians, physician assistants, nurse practitioners, and other health care professionals who are interested in treating children and young adults with CD.

Learning Objectives

In dealing with patients who have CD and for whom enteral nutrition is a treatment option, participants completing this activity should be better able to:

- Summarize the evidence for efficacy of enteral nutrition as first-line therapy in the induction of remission in pediatric-onset CD
- Identify barriers hindering the widespread use of this therapy
- Identify essential components for a successful program
- Provide practical points for using EEN as first-line therapy with the hope that it will lead to increased use of this therapy

Physicians

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Cynthia King-Moore has nothing to disclose.
Matt Kilby, medical writer, has nothing to disclose.

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Introduction

Exclusive enteral nutrition (EEN) using liquid formulas is recognized as an efficacious therapy for the induction of remission in pediatric Crohn's disease (CD). However, EEN has not been universally adopted and various treatment protocols are used.[1-3]

The mechanism of action of EEN for the induction of remission remains conjectural. Hypotheses include elimination of dietary antigenic exposure, overall nutritional repletion, correction of intestinal permeability, diminution of intestinal synthesis of inflammatory mediators via reduction in dietary fat, and provision of important micronutrients to the diseased intestine.[4,5] EEN has been shown to exert changes on the intestinal microbiome, which may relate to its efficacy.[4,6]

Studies have shown that EEN induces remission in up to 85% of children with newly diagnosed CD. A Cochrane meta-analysis comparing efficacy of induction between corticosteroids and EEN favored corticosteroids; however, both pediatric and adult patients were included in this analysis.[7] A meta-analysis of data from 5 pediatric randomized controlled trials involving 147 children found that EEN and corticosteroids were equally effective.[8] Several small studies have also indicated a benefit of EEN in inducing remission in recurrent disease.[9,10] EEN has been demonstrated to induce mucosal healing at 10 weeks.[11]

EEN has a positive effect upon linear growth compared to corticosteroids.[12] This is important in pediatric CD, as up to 46% exhibit growth impairment at presentation and 85% have lost weight. Final adult height potential may never be realized in many.[13] Inflammation, malnutrition, and corticosteroid therapy are often contributory factors for growth faltering. Additionally, corticosteroids may adversely affect bone density and increase the risk of adrenal insufficiency, avascular necrosis, Cushingoid features, acne, and hypertension.

The North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) has recently published a clinical report on the use of enteral nutrition (EN) and for the control of intestinal inflammation in pediatric CD. Specific attention was placed upon review of the evidence for efficacy of therapy, assessment of variations in care, identification of barriers to its widespread use, and compilation of the necessary components for a successful program. This newsletter was created as an adjunct to this clinical report with the intention of providing practical advice for health care providers in using EEN in pediatric CD.

Case Study 1: *Shelly*

Shelly is an 8-year-old girl with a 1-year history of intermittent abdominal pain and increased stool frequency. More recently, Shelly is having 6–8 nonbloody stools daily, poor appetite, and a 6-lb weight loss. She has occasional mouth sores and has not grown in height in over 9 months. Laboratory values show iron deficiency anemia, hypoalbuminema, and elevated inflammatory markers. Small bowel imaging shows wall thickening in the terminal ileum with no strictures. Colonoscopy shows presence of cobblestoning of the terminal ileum and partial ulceration of the cecum. Biopsies show acute and chronic inflammation with granulomas consistent with CD.

Shelly has growth failure and weight loss. Can EEN treat both the CD and growth failure? Based on studies that show induced remission in up to 85% of children with newly diagnosed CD, EEN is a good option for initial induction therapy in this case.[9,10,11,14,15] Strong supporting evidence resulted in independently published recommendations for first-line usage of EEN in pediatric CD from the European Society for Clinical Nutrition and Metabolism,[16] the Japanese Society for Pediatric Gastroenterology, Hepatology, and Nutrition,[17] and the British Society for Paediatric Gastroenterology, Hepatology, and Nutrition.[18] While EEN has variable effects on weight gain,[11,19-21], positive effects on linear growth are clearly established when compared with corticosteroids, even within 10 weeks to 8 months.[12] While efficacious, corticosteroids are also associated with multiple adverse effects, including adrenal suppression, increased risk of infections, hypertension, Cushingoid features, growth impairment, and deficits in bone density.[22] The latter two

are often present in CD patients at the time of diagnosis related to the underlying inflammation.[23]

Shelly and her family are leaning toward steroid therapy and think tube feeds may be more work than they can manage. Are there key selling points to have the family reconsider EEN? To make sure Shelly and her family have an accurate understanding of EEN, they should be educated on its fundamental aspects. EEN involves provision of nutrition using liquid formulas administered either orally or, if the patient is unable to drink it, through a nasogastric (NG) tube.[24] If long-term treatment is warranted, insertion of a gastrostomy tube should also be considered; however, this is only an option after the patient has responded to an initial trial period of EN. EEN does have challenges, which will be detailed later in the newsletter, but it is important to highlight its efficacy, including its benefit on linear growth[12] and absence of the adverse effects patients will risk by taking corticosteroids.[22]

Is it possible for Shelly to drink the formula and not require a tube at all? EEN can be taken orally or using a NG tube.[24] Orally, the patient drinks required amounts divided throughout the day, which may have advantages for some patients, including avoiding the need for NG tube placement and the ability to take the formula with them. However, many of these formulas have low palatability, and taste fatigue is a real concern that may result in nonadherence or premature discontinuation of EEN. Use of 1.5 kcal/mL formula versus 1.0 kcal/mL formula may enhance oral intake, but because of potential difficulties in drinking the formula preparations, NG administration may be a better choice for many patients.

How long will this patient require EEN to induce remission? The duration of therapy is a compromise between adequate compliance and optimization of benefits; however, lack of consistency in the appropriate timeframe for this therapy can add to existing confusion. The time it takes to achieve clinical remission is variable, with inflammatory markers improving in as little as 1 week[6] and remission reported in 11 days to 2.5 weeks.[25] While data examining the time ranges for remission are lacking, some patients may require longer than 2.5 weeks to achieve remission. According to some published reports, duration of EEN therapy can vary from 3 to 12 weeks,[25,26] with an average of 8.5 ± 1.7 weeks.[27] A period of at least 8 weeks is recommended in the NASPGHAN clinical report, though some physicians continue EEN for up to 12 weeks.[24] It is important to allow at least 3–4 weeks of treatment before deciding if EEN will be effective, though continued administration beyond 3–4 weeks may provide benefits in previously unresponsive patients. As with any therapy, reevaluation sooner than 3–4 weeks may be required if a patient's clinical status is deteriorating despite introduction of EEN. If EEN is not effective in inducing remission, other induction therapies will be required. In this situation, it may be appropriate to continue with feedings to ensure nutritional repletion.

Shelly requires catch-up calories—what is the best method to determine realistic caloric and nutritional requirements so that she starts to grow and gain weight but not gain excessive weight? Once the decision is made to use EEN, the total calorie and fluid estimates are calculated based on baseline energy requirements and activity levels.[24] In general, 120% of the recommended dietary allowance may be required. While EEN is generally an extremely safe therapy, rare cases of refeeding syndrome have been reported in children and adolescents with inflammatory bowel disease (IBD).[28-30] Refeeding, a condition characterized by fluid shifts and electrolyte abnormalities, may occur when significantly malnourished patients receive EN. If a child with significant malnutrition (eg, body mass index [BMI] z score < –1.5) requires EEN, the physician should consider an initial hospitalization period to monitor and treat refeeding syndrome, including daily electrolytes, gradual refeeding, and phosphate supplementation. **Table 1** provides examples of equations used to predict the basal metabolic rates (BMR) and resting energy expenditure (REE) for patients based on sex and age, and the sample worksheet at the end of the newsletter shows additional considerations when formulating the necessary dietary requirements. With oral feedings, Shelly should take at least 3 or 4 portions a day at progressive volumes until the "goal" volume is achieved by day 3 or 4. Patients receiving NG EEN should start at half of their recommended volume and increase to goal feeds over 1–2 days. Once the full volume is reached, it can be adjusted based on whether the child is hungry as well as with changes in weight, BMI, and activity levels. Her family should also be advised to stop further progression if she becomes overfull.

Will Shelly be able to eat with the EEN therapy? Along with calculating caloric (energy) requirements, it is important to ensure that Shelly's fluid requirements are also met.[24] Ingestion of formula alone does not necessarily meet the total necessary fluid intake, so deficits must be made up by water or "allowed" clear fluids, which can

include clear sodas, soup broth, and popsicles. Protocols regarding food consumption during EEN differ; however, one study of 50 children in the United Kingdom reported that those receiving standard EEN (n = 24) had a 42% remission rate compared to 15% in children receiving half of their energy as formula and the other half as normal food.[34] Despite these results, some pediatric units still allow addition of various foods to EEN,[27] and some data report that allowing conventional foods as 10% of energy intake does not appear to effect EN induction therapy efficacy.[35] However, it is difficult to monitor the child's intake to ensure only 10% of their calorie needs are being met by food and beverages other than formula. In any case, it is important that the child is consuming adequate nutrition so that complaints of hunger are minimized, as is unwarranted eating.

Can partial EN (PEN) be used for maintenance therapy? Several studies have assessed the role of PEN in the maintenance of remission and prevention of relapse. Such an approach may delay requirements for further therapy, such as steroids, and may optimize growth and nutrition.[24] Maintenance strategies can include overnight NG feedings with healthy eating during the day, short bursts of NG feedings every few months, or oral supplementation throughout the day in addition to normal eating. These approaches may also be combined with maintenance medical therapy, but results might be limited by poor compliance. Two Canadian studies have shown positive results for NG maintenance therapy, including reduced relapse rate (43% of patients receiving nightly feeds relapsed after 1 year compared to 79% who discontinued supplemental feedings),[36] significant height and weight gains, decreased CD Activity Index scores, and decreased prednisone use when compared to conventional medical therapy.[37] A more recent study in adult patients found that using PEN was as effective as 6-mercaptopurine in maintaining remission over 2 years (both therapies were combined with 5-aminosalicylic acid).[38] Three Japanese studies also highlighted the benefits of PEN in adult populations. A study of 51 patients with CD in remission randomized to receive half of their energy as elemental formula or to have an unrestricted normal diet resulted in a relapse rate in the PEN group that was nearly half of that in those with an unrestricted diet.[39] Two studies have shown positive effects of PEN in adult patients after intestinal resection. Compared to patients on a standard diet, patients receiving PEN had decreased endoscopic recurrence at 6 and 12 months[40] and decreased clinical recurrence of disease at 5 years.[41] One potential limitation in extrapolating the Japanese studies to a North American patient population is that the Japanese comparator groups likely had a diet that was much lower in animal protein and fat and higher in

TABLE 1. *Equations to Predict BMR and REE in Children Ages Ages 3–18 Years*[24]

Source	Patient Demographic	Equation
Schofield[31]	Female, 3–10 years	BMR = (16.97 x Wt) + (161.8 x Ht) + 371.2
	Male, 3–10 years	BMR = (19.6 x Wt) + (130.3 x Ht) + 414.9
	Female, 10–18 years	BMR = (8.365 x Wt) + (465 x Ht) + 200
	Male, 10–18 years	BMR = (16.25 x Wt) + (137.2 x Ht) + 515.5
Food and Agriculture Organization (FAO)/World Health Organization (WHO)/ United Nations University (UNU)[32]	Female, 3–10 years	REE = (22.5 x Wt) + 499
	Male, 3–10 years	REE = (22.7 x Wt) + 495
	Female, 10–18 years	REE = (12.2 x Wt) + 746
	Male, 10–18 years	REE = (17.5 x Wt) + 651
Oxford[33]	Female, 3–10 years	BMR = (15.9 x Wt) + (210 x Ht) + 349
	Male, 3–10 years	BMR = (15.1 x Wt) + (74.2 x Ht) + 306
	Female, 10–18 years	BMR = (9.4 x Wt) + (249 x Ht) + 462
	Male, 10–18 years	BMR = (15.6 x Wt) + (266 x Ht) + 299

All equations are in kcal. Weight (Wt) is measured in kg and height (Ht) in m.

omega 3 fatty acids than a typical American diet. More research is needed to further delineate the role of PEN as a maintenance therapy.

What equipment will be necessary for Shelly if she chooses the EEN therapy option? EEN via NG tube requires a variety of supplies, including tubing, bags (small and/or large) for day and night feeding, a stethoscope, syringes, and an ambulatory feeding pump, which makes this an expensive intervention.[24] However, the costs of treatment are somewhat offset by the fact that the family is either not purchasing food or is purchasing very limited food for the EEN patient during treatment. Furthermore, the costs of tubes, bags, and pumps may be covered by private insurance plans. Various types of tubing is also available, including silicon tubing that can stay in place for up to 4 weeks based on manufacturer recommendations. Polymeric formula is a less expensive option than semielemental or elemental formulas, whereas oral intake avoids any need for NG supplies. In either option, issues of cost are important to address. Availability of programs that can cover or offset the cost of EEN can potentially increase interest. Teaching and support should also be available to patients receiving EEN, and this is discussed in more detail below.

There are 3 categories of enteral formulas available to Shelly—polymeric, semielemental and elemental—which is the most effective for induction therapy? While available data does not show any differences in efficacy between elemental or semielemental formulas,[7,11,42] polymeric formulas have been associated with better weight gain than elemental diets.[43] Polymeric formulas are also generally less expensive and more palatable than other options, which can make it easier to implement in terms of cost and adherence in children.[24]

If Shelly chooses EEN, will she need to be admitted to hospital? Hospital admission is not required to begin EEN; however, teaching and ongoing support is important.[24] This can be done as an outpatient or inpatient, depending on institutional resources, though outpatient education is a less expensive option. For patients using a NG tube, the family should be taught proper tube care and formula preparation and how to flush the tube, clear blockages, operate the feeding pump, and clean formula bags. Proper placement and replacement techniques are also necessary, as tubes can be accidentally pulled out during physical activity. This information can be provided by an experienced nurse or dietitian. Instructional videos and written resource materials may be useful supplementary aids.[44]

Shelly's family lives 2 hours from the gastroenterology clinic. What will Shelly's family do if something goes wrong, such as if they run out of formula, the pump malfunctions, or she does not appear to be doing well on the feeds? In situations where patients live at an inconvenient distance from their specialist, it is necessary to provide them with additional support.[24] This can include, but is not limited to, having available dietitian and nurse contacts for emergencies and coordinating involvement with their local physician. A home health agency with experience in managing enteral feeds and NG tubes and that includes a dietitian on the team may also be a useful asset. Telephone follow-up may address many issues a family may have with respect to EEN in a timely, efficient manner and help to decrease anxiety, clinic visits, and hospital admissions. Planning is the key to success, including prediction of the amount of formula needed and knowledge of shipment requirements (eg, time from order to receipt of product and minimum order sizes). A nurse should also discuss strategies for dealing with technical issues of pumps and tubing.

Shelly has iron deficiency anemia and global nutritional depletion. Does she require supplementation over and above the daily allotment of formulas? Pediatric patients with CD often have significant deficits in bone mass.[45-48] Suboptimal vitamin D status, which has been reported in 16%–34% of children with IBD, may contribute to low bone mineral density.[45,49,50] Iron deficiency with and without anemia is also prevalent in pediatric CD.[51] EEN formulas usually contain maintenance levels of iron and vitamin D and other minerals and vitamins. Children with IBD who have a deficiency of vitamin D and/or iron may require supplementation in quantities greater than that present in the formulation.

How often should Shelly be followed? Once Shelly begins EEN, it is important to closely monitor her progress, especially during the first 2 weeks.[24] The physician and/or dietitian should follow up regularly by telephone or scheduled clinic visits to appropriately monitor blood work and symptoms, document response to treatment, observe weight changes, assess adherence, and ensure Shelly is neither hungry nor overfull. Follow-up is also a good opportunity to troubleshoot and address questions or difficulties and may provide Shelly and her family a

sense of security that further improves adherence. It is also important to coordinate communication among Shelly's health care providers to bolster a team approach to her care.

Shelly wants to choose EEN but is most apprehensive about going back to school with a tube. How can the health care team assist her with problem-solving? Social support can be just as important as support for the treatment itself, especially in pediatric patients with NG tubes who may fear alienation from peers. The health care team can assist these patients by helping them locate appropriate resources, including social workers, support groups, or another family with a child being treated with EEN.[24] The family should also be aware of effective ways to reintegrate Shelly into the classroom and potential extracurricular activities. Parents should be encouraged to meet with teachers, the principal, the school nurse, and any other involved individuals to explain why Shelly is being treated and what is required of the school. This open approach will help ensure Shelly receives appropriate support and acceptance. Enlisting the school nurse to help address difficulties that may arise with feeds and/or NG tubes will facilitate ongoing care. She or her caregivers should also be encouraged to speak to the class as a whole to address any questions and concerns among students. Members of the health care team can directly help facilitate this by visiting the school or communicating directly with the staff.

Case Study 2: *Steve*

Steve is a 15-year-old with newly diagnosed CD. He has a 3-month history of diarrhea, which increasingly became bloody. He has had tenesmus and crampy abdominal pain. Steve plays on his high school basketball team, but over the past month, he finds his energy is so low by the midafternoon that he has had trouble keeping up with his peers and has been missing games. He is anemic, with elevated platelets but normal albumin. Magnetic resonance enterography demonstrates a short segment of involvement in the terminal ileum, without a stricture, but a more extensive involvement of the ascending and proximal transverse colon. Upper endoscopy shows mild focal antral gastritis with focal cryptitis. On lower endoscopy, the rectal, sigmoid, and descending colonic mucosal appears normal, but there is significant disease from the transverse colon to the cecum with cobblestoning and ulceration. Histology shows chronic inflammation with scattered granulomas. You discuss the diagnosis and treatment options with Steve and his parents. His parents are very interested in EEN as a treatment option, but the patient is not convinced. He is very reluctant to have a NG tube and has a number of questions. He is concerned that he will be teased or bullied and is not sure how he will explain the tube to his friends. He also does not think he can play competitive basketball with a tube in his nose.

Steve's CD mostly involves the colon. Is EEN as effective for colonic CD as it is for small bowel involvement? Though some evidence tends to favor EEN in small bowel disease rather than active colonic disease,[52] it is unclear that EEN provides a better outcome in one disease type over another.[24] While one study found that 92% of patients with ileal disease and 82% of patients with ileocolonic disease achieved remission versus 50% of patients with isolated colonic disease,[52] another study resulted in much more similar remission rates (77% vs. 79% in isolated small bowel disease and isolated colonic disease, respectively[53]). Until more definitive results prove otherwise, EEN should be considered in all patients with CD, regardless of disease extent.

Can Steve play basketball with EEN? Patients and parents are often concerned about the amount of physical activity possible with NG EEN. Steve's feeding regimen will allow for periods off of EEN, which should make him available for many extracurricular activities, including sports. The patient can take his time off at different times each day if he wishes. It is important to remember to tape the tube securely to ensure it is not accidentally pulled out, especially for contact sports.

Is teasing and bullying an issue for kids on tube feeds? Bullying can be an issue for any child and especially those that are perceived as different from their peers. However, there are steps to proactively confront this potential issue before it occurs. The involvement of a psychologist or social worker may help facilitate Steve's reintroduction into the school environment.[24] Honesty about Steve's condition and education of his peers, teachers, coaches, and school administrators are also essential. Steve should also be provided with a good support system that includes his family, friends, and health care team. Each patient will require an individualized approach. Some may find it helpful to talk and educate close friends first, so they can rely on them for support when they return to school. A video from IWK Health Centre in Canada also contains helpful tips to address this issue and can also be shown to the patient's class as an educational tool.[44]

Steve wants to attend the school dance in 2 weeks, but doesn't want to go wearing the tube. What are his options? As previously mentioned, the feeding regimen can be made flexible to account for extracurricular activities; thus, Steve's time off can be adjusted to coincide with the dance. Because Steve's family has been taught how to place the tube, it can be removed prior to and replaced following the dance. Also, many adolescents can learn to insert the tube themselves, increasing their sense of independence and "ownership" of the tube feeding process. This will facilitate opportunities like going to this dance, where Steve could then easily take out the tube, go to the dance, and replace it on his return home.

Steve continues to play basketball. With his increased activity, he feels hungry and notices he gets very thirsty. What should he do? Patients should be educated about their fluid needs, understanding that increased activity or hot weather, which both increase perspiration, will require increased fluid intake. Tube feeding is typically designed to meet the minimum fluid and nutritional requirements, but patients have the option to consume additional clear fluids, such as popsicles and soup broth, in addition to formula and water intake.[24] As previously mentioned, the tube feeding rate may also be adjusted if a patient complains of hunger, their activity level increases, and/or their weight gain is inadequate.

After the basketball tournament, Steve wants to go with the team to celebrate. They are going to a restaurant and then to the movie theater. Steve isn't sure how to handle this, as he won't be able to eat. What should he do? It is important for Steve not to let EEN limit his social interactions. If he wants to attend a social event, he should be encouraged to do so, but it is important to plan ahead. While Steve is not able to eat the restaurant's food, he can drink clear fluids, including clear sodas, and bring a supply of gum or hard candy as a snack. He can also consider any offers from his friends to buy him food once his EEN period is over as an incentive to adhere to his treatment, using the "IOU" as a reward.

Summary

EEN has proven efficacy in treating pediatric CD and avoids the adverse events seen with corticosteroid therapy, including reduced growth; however, it has not been universally adopted as a first-line therapy. Although studies have shown up to 85% remission rates in children with CD, patients, such as Shelly and Steve, and their families are likely to have a myriad of questions and concerns. With careful planning and proper education, these obstacles can be met with a team-oriented approach that ensures appropriate therapy and social support.

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Sample Worksheet for Initiation of EEN via NG Tube for Shelley

Shelley, 8 years old, was diagnosed with ileocecal CD. She was 19 kg (3%ile) and 121 cm (10%–25%ile) at diagnosis. Shelley has lost 2.72 kg over the past month, which is a severe loss;[54] she is underweight at 84% ideal body weight (IBW). Her IBW is 22.5 kg (based on a ht/age of 6 years, 11 months). Healthy weight range is 90%–110% IBW. Shelley and her family have chosen EEN via NG tube as her therapy and are brought into the medical day unit for education for NG tube placement and feedings.

Energy Requirements

Baseline energy requirements are calculated using an appropriate pediatric energy equation of choice. For the purpose of this example, we will use a combination of 2 equations[33,55] and take the average of the two.

STEP 1

Using the Dietary Reference Intake (DRI) equation:[55]

EER = 135.3 – (30.8 x 8 yr) + 1.2* {(10.0 x 19 kg) + (934 x 1.21 m)} + 20
= 135.3 – 246.4 + 1.2 {190 kg + 1130 m} + 20
= 135.3 – 246.4 + 1.2 {1320} + 20
= 135.3 – 246.4 + 1584 + 20
= 1493 calories/day

**Physical Activity Factor (see table on page 10)*

STEP 2

Using the FAO/WHO/UNU equation:[33]

a. REE = (22.5 x 19) + 499
= 926 calories/day

b. 926 calories x 1.5 = 1389 calories/day

Activity Stress Adjustment Factors for FAO/WHO/UNU:

REE x 1.3

Well-nourished child at bed rest, mild-to-moderate stress, minor surgery

REE x 1.5

Normally active child with mild-to-moderate stress; inactive child with severe stress, such as trauma, sepsis, cancer, extensive surgery; or child with minimal activity and malnutrition who requires catch-up growth

REE x 1.7

Active child who requires catch-up growth or active child with severe stress

STEP 3

Take the average of the results from the DRI and FAO/WHO/UNU equations:

Initiate feeds at 1441 calories/day

Fluid Requirements

Maintenance fluid requirements can be determined using the Holliday–Segar equation:[54]

- 100 ml/kg for the 1st 10 kg of wt
- 50 ml/kg for the 2nd 10 kg of wt
- 20 ml/kg for the remaining wt

Shelley weighs 19 kg, so will require a minimum of 1450 ml fluid daily, calculated as

10 kg x 100 ml/kg = 1000 ml
9 kg x 50 ml/kg = 450 ml
1450 ml/day

She will require "extra" fluid if she has diarrheal losses, is very active, or is in a hot climate. This "extra" fluid can be easily met through the allotment of allowed clear fluids and liberal water intake orally each day.

Formula Selection

Shelley will be started on a routine enteral formula containing 1 kcal/ml. Most of these products are isotonic, which helps with tolerance. The product will be infused through the NG tube, so palatability of the product is not a concern.

Initiation of NG Feeds

As a reminder, Shelley requires an average of 1440 kcal/day and 1450 ml fluid daily. Shelley's initial goal feeding rate will be 60 ml/hr x 24 hours; however, as she will be receiving 8–12 weeks of EEN, she will be given 4 hours off daily to allow her some freedom from feeds. Feeds will be initiated at 50% goal rate at 30 ml/hr and increased by 5 ml/hr every 4 hours, based on tolerance, until she reaches her "adjusted" goal feed of 72 ml/hr x 20 hr daily. It will take about 36 hours to advance her feeds to goal. If Shelley was over 12 years of age, her feeds could be advanced by 10 ml/hr every 4–6 hours, as tolerated. Shelley should be encouraged to drink liberal water by mouth throughout feed progression to ensure her daily maintenance fluid requirements of 1450 ml are met. Otherwise, to avoid confusion in terms

of tolerance to formula during rate progression, other clear fluid should be avoided until tolerating goal rate for a few hours.

Refeeding Concerns

Shelley is not at risk for refeeding syndrome at this time, as she had a relatively short onset of CD prior to diagnosis. She has been eating and drinking about 2/3 her usual amounts every day. Electrolyte levels are within normal range. Instead, if Shelley did have an extended prediagnosis period and had become significantly malnourished, precautions would be required to prevent refeeding syndrome. Feeds would be progressed more slowly, perhaps over several days (3–5 days) with careful daily monitoring of electrolytes, particularly, phosphate, potassium, and magnesium. Overfeeding should be avoided: "start low and go slow."[56]

Clear Fluid Allowance

To break the monotony of EEN, allow a determined quantity of clear fluids each day. For Shelley, allow about 750 ml clear fluid and unlimited water orally. Caution should be used to "limit" clear fluid intake to avoid providing excessive sugary, empty calories. Complaints of hunger should be satisfied with small rate increases of formula.

Dealing With Hunger

If Shelley complains of hunger once she has been tolerating goal feeds, advance her rate by 5 ml/hr/day every 1–2 days until she feels satisfied. Avoid overfeeding, which may promote unnecessary weight gain; have her weighed at home once every month and call the dietitian. Track her weight changes at that time and adjust the feeds accordingly.

Physical Activity Coefficients (PA Values) to Use in Estimated Energy Requirement (EER) Equations

	Sedentary	*Low Active*	*Active*	*Very Active*
	Typical daily living tasks (vacuum, walking to the bus)	Typical daily living tasks + 30–60 min of moderate activity (walking 5–7 km)	Typical daily living tasks + 60 min of moderate activity (walking 5–7 km)	Typical daily living tasks + 60 min of moderate activity + an extra 60 min of vigorous activity or 120 min of moderate
Boys *3–18 years*	1.0	1.13	1.26	1.42
Girls *3–18 years*	1.0	1.16	1.31	1.56
Overweight Boys *3–18 years*	1.0	1.12	1.24	1.45
Overweight Girls *3–18 years*	1.0	1.18	1.35	1.60

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