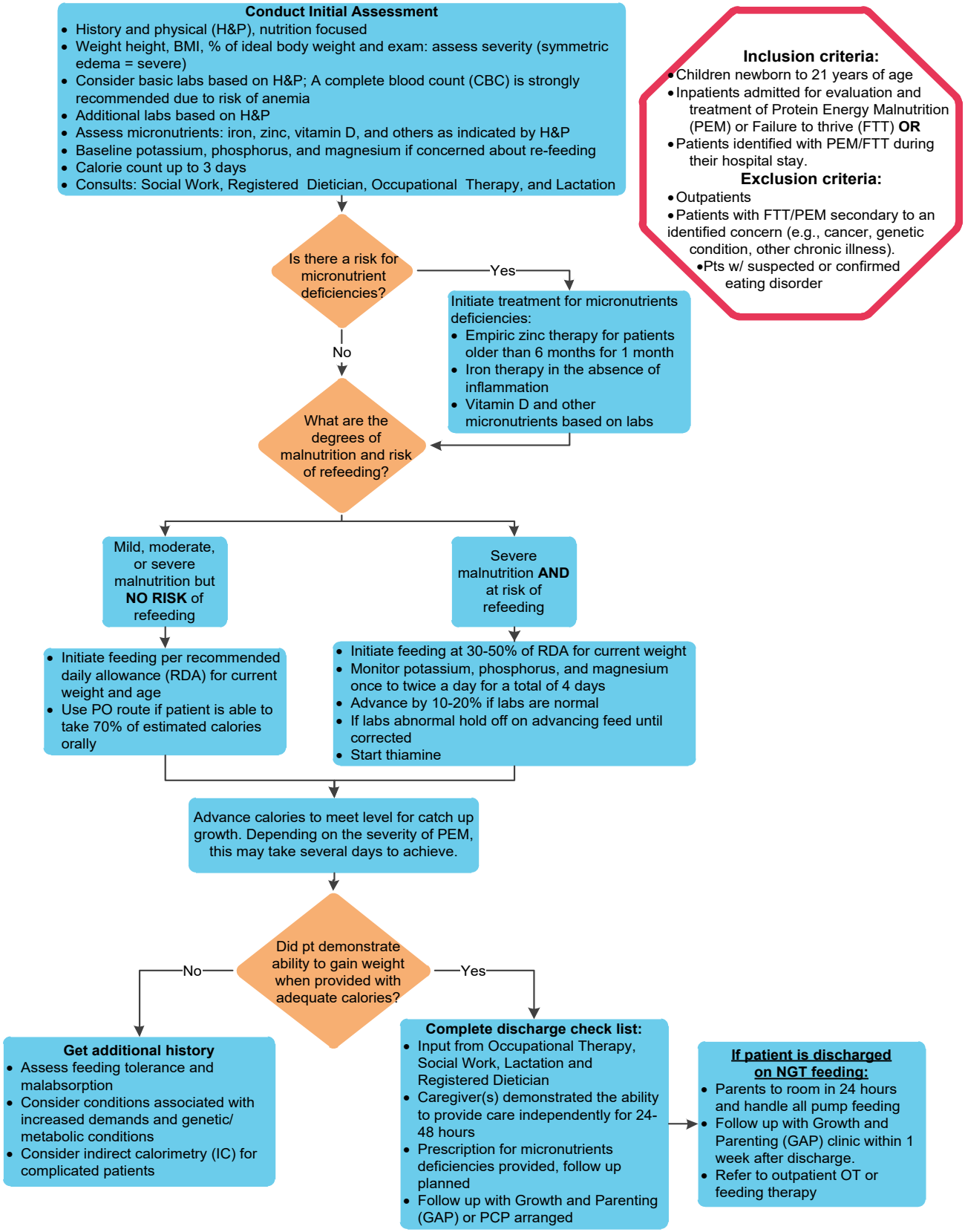
PROTEIN ENERGY MALNUTRITION (FAILURE TO THRIVE)

ALGORITHM



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TARGET POPULATION

Inclusion Criteria

- Children newborn to 21 years of age
- Inpatients admitted for evaluation and treatment of Protein Energy Malnutrition (PEM) or Failure to Thrive (FTT) **OR**
- Patients identified with PEM/FTT during their hospital stay

Exclusion Criteria

- Outpatients
- Patients with PEM/FTT secondary to an identified condition (e.g., cancer, identified genetic conditions, or other chronic illness).
- Patients with a suspected or confirmed eating disorder

DEFINITIONS AND CLASSIFICATION

Protein Energy Malnutrition (PEM) or **Failure to Thrive (FTT)** is defined as an imbalance between nutrient requirement and intake, resulting in cumulative deficits of energy, protein or micronutrients that may negatively affect growth, development and other relevant outcomes [1].

Growth assessment is based on the indicated growth chart in Epic. Select growth chart in Epic based on patient age and any relevant conditions (e.g., Down syndrome, etc.).

Table 1. Normal Rate of Weight Gain

Age (months)	Grams/day
0-3	20-30
3-6	15-20
6-9	10-15
9-12	10
12-18	6
18-24	6
24-36	6

Refeeding (marasmus and Kwashiorkor)

Severe malnutrition (marasumus) is defined as weight for height (or length) less than -3 Z-score, or less than 70% of the median reference value. Kwashiorkor is defined by the presence of symmetrical edema (edematous malnutrition). Marasmus and Kwashiorkor commonly coexist and a simple unified approach to clinical management can be applied to both [1, 2].

Table 2. Nutritional Status Assessment

Method	No malnutrition	Mild malnutrition	Moderate malnutrition	Severe malnutrition
Weight for height percent of median [3]	>90%	80-89%	70-79%	<70%
Weight for height z score* [4]	> -1	-1 to -1.9	-2 to -2.9	< -3
BMI z score* [4]	> -1	-1 to -1.9	-2 to -2.9	<-3
Length/height z score* [4]	Not Applicable	No data but z score* less than -2 suggest stunting	No data but z score* less than -2 suggest stunting	<-3

*Z scores can be found by placing the cursor on any number on the growth chart in Epic.

INITIAL EVALUATION

- History and physical exam
- Diagnostic Tests and Studies to be considered in patients admitted for management of malnutrition:
  - CBC with differential and red cell indices (strongly recommended due to the risk of anemia)
  - Comprehensive metabolic panel
  - Baseline magnesium (Mg), phosphorus (Phos), and potassium (K) (in patients at risk for refeeding syndrome)
  - Inflammatory markers such as erythrocytes sedimentation rate (ESR) and C reactive protein (CRP)
  - Iron studies with ferritin (in patients at risk for iron deficiency).
  - Vitamin D (based on the presence of risk factors for deficiency)
  - Celiac screening (based on clues from H&P)
  - Stool examination for fat (if concerned about fat malabsorption based on H&P, or in infants who fail to gain weight despite adequate breast milk or formula intake).

ADDITIONAL EVALUATION AND CONSIDERATION FOR CONSULTS

- When considering endocrine etiologies for poor growth, please assess linear growth, taking into consideration family history and being small for gestational age. Keep in mind that endocrine causes of FTT seem to be rare even in the selected population of patients referred to pediatric endocrine outpatient clinics. Actually, the majority of patients referred for endocrine evaluation in the setting of PEM had a pure nutritional deficiency [5].
- Refer to Appendix A for information about when to consider inborn errors of metabolism/genetics [6].
- Refer to Appendix B for information about Cystic Fibrosis (CF) and pancreatic insufficiency [7].
- Renal tubular acidosis: is a rare cause of PEM, and when suspected it is recommend to use a venous blood gas (VBG) for determination of serum bicarbonate concentration for the evaluation of a child with PEM who is thought to have a metabolic acidosis [8].
- Consult Nutrition M.D. in all cases of severe malnutrition, edematous malnutrition (Kwashiorkor), and for patients on highly restrictive or unusual diets with possible many micronutrient deficiencies.

CLINICAL MANAGEMENT

1. Initiate a multidisciplinary approach including but not limited to registered dietitians, social worker, occupational and speech therapists and lactation consultants [9].
2. Inpatient admission is not necessary for all children with FTT [10]. It is indicated for severe malnutrition especially when there is concern about refeeding syndrome, and in complicated social situations [11].
3. Dehydration:
   - Oral hydration is preferred over IV hydration. Use standard pediatric electrolytes solutions. Recommended rate is 5-10 mL/kg/hour for 2-12 hours [1]
   - IV hydration: Refer to Intravenous Fluid Therapy Clinical Care Guideline
4. Starting and advancing feeding:
   - If the patient is not at risk of refeeding syndrome it is reasonable to start with age appropriate caloric recommended daily allowance (RDA). Refer to Appendix C.
   - When there is risk of refeeding syndrome start at 30-50% of caloric RDA and advance slowly by 10-20% per day.

- Patients on oral feed can be transitioned to adlib feeding when tolerating full feed. It is normal for patients recovering from malnutrition to consume over 200 Kcal/kg /day[2]
- Patients with low intake or on tube feeding need to be provided with extra calories for catch up growth after they tolerate full feed.
- Depend on the severity of malnutrition, it may take 2-14 days to be able to initiate catch up growth [11]
- Catch up growth calculations: a rough estimate is to provide RDA calorie for age based on ideal body weight. Fluid requirements: as appropriate for age. For edematous malnutrition, keep fluids at or less than maintenance.
- Calorie goal needs to be adjusted based on how well the patient is gaining weight. Some patients with severe malnutrition may require a high caloric intake to initiate weight gain. Consult with a registered dietician and see Appendix D for specific calculations for catch up growth.

5. Feeding Modality:

Infants less than 1 year old	Toddlers and children older than 1 year old
• Breast milk or formula. Make sure to assess the adequacy of nursing. • Do not concentrate breast milk or formula beyond 24 kcal/oz to avoid the increase in osmolality with associated diarrhea and malabsorption.	• Use nutritional supplements (e.g., Boost, Nutren, etc.) • Start with the standard 1Kcal/1mL concentration.
• Feed every 2-3 hours to prevent hypoglycemia.	• Offer 3 meals and 2-3 snacks on a consistent schedule. Educate parents to avoid "grazing" and constant sipping on fluids.

- Consult RD if a higher concentration needed (i.e., fluid restriction). Please refer to CHCO nutrition handouts for concentrating formulas.
- NGT feeding is recommended if the child cannot take 70% of the recommended intake orally [1], but offer the diet orally at each feed first.

6. Monitoring and goals:
   - Daily weight: preferred pre-breakfast, post-void
   - 3 days calorie count
   - For breastfed infants: check weight before and after feeding for at least 24 hours.
   - Accepted goal for catch up growth is 150% the average weight gain for age [11] . This may not happen until the outpatient phase.
7. Micronutrients:
   - Zinc, Iron and Vitamin D, and Thiamine are common deficiencies in the FTT patients. However, a detailed diet history is essential to diagnose other micronutrient deficiencies.
   - For indications and dosing of micronutrients, please refer to Table 3.

Table 3. Micronutrient Indications and Dosing

Medication	Recommended Dose	Indications for Use	Clinical Pearls
Zinc [7]	PO: 1 mg/kg/day elemental zinc divided 1-3 times/day. Adult dose: 50 mg three times daily.	Over 6 months of age. Zinc supplementation should be initiated empirically for any patient with malnutrition/FTT.	Larger doses may be needed with impaired absorption or excessive loss of zinc in the intestines
Iron (Ferrous Sulfate) [10]	PO: 3-6 mg/kg/day elemental iron divided 1-4 times daily. Adult dose: 300 mg given 2-4 times daily or 250 mg (extended release) 1-2 times daily	Initiate when ferritin is less than 20 with no inflammation (not for use during acute phase of illness)	Separate from other supplements by 1-2 hours for maximal absorption.
Vitamin D	**Age 0-10:** • 25(OH)D<10 ng/mL: 2000 IU (4000 IU if obese) • 10 to 20 ng/mL: 1000 IU (2000 IU if obese) • 20 to 30 ng/mL: 400-800 IU (1000 IU if obese) **Age 10-18:** • 25(OH)D<10 ng/mL: 4000 IU (8000 IU if obese) • 10 to 20 ng/mL: 2000 IU (4000 IU if obese) • 20 to 30 ng/mL: 800 IU (1000 IU if obese)	Initiate when 25(OH)D levels are below 30 ng/mL based on risk factors. Refer to Vitamin D Deficiency Clinical Pathway for details.	• Consider increased supplementation in patients with at-risk medical conditions. • Dosing amount should be inclusive of all supplements (i.e., Vitamin D, multivitamin, Omega-3, etc.). • For the most current recommendations on Vitamin D supplementation, please refer to the Vitamin D Deficiency Clinical Pathway.
Thiamine [*Green book*]	IM/IV: 10-25 mg/dose daily PO: 10-50 mg/dose orally every day for 2 weeks, then 5-10 mg/dose orally daily for 1 month	Initiate in patients with severe malnutrition at risk for refeeding syndrome	Give thiamine IV/IM for critically ill patients with malnutrition/FTT.

REFEEDING SYNDROME

Risk factors

- Patients with marasmus or Kwashiorkor particularly if there is greater than 10% weight loss over a couple of months
- Patients who are not fed for 7-10 days with evidence stress and depletion

Features [12, 13]

- Abnormalities of fluid balance and electrolytes (low potassium, low phosphorus, low magnesium)
- Abnormalities of glucose metabolism (high glucose, high insulin level)

Treatment

- When electrolytes abnormalities occur, hold off the advancement of feed to correct
- For enteral dosing recommendations, refer to Table 4. For IV electrolyte replacement recommendations please refer to the Intravenous Fluid Therapy Clinical Care Guideline.

Monitoring

- Check refeeding labs (magnesium, potassium, phosphorus) one or twice a day for 4 days. The risk of refeeding syndrome is minimal after 4 days of feeding.

Table 4. Enteral Electrolyte Replacement

Note: For IV replacement, please refer to the Intravenous Fluid Therapy clinical pathway

Electrolyte	Enteral Dosing Recommendations	Clinical Pearls	Formulations
Phosphorus	2-3 mMol/kg/day divided three or four times daily. Adult dose: 50-150 mMol/day divided three or four times daily.	1 mmol =31 mg Enteral phosphorus replacement can be given as a sodium salt, potassium salt, or a combination of both salt forms	**K-phos neutral:** 8 mmol phos, 13 mEq Na, 1.1 mEq K per tab **Phos-NaK powder:** 8 mmol phos, 6.9 mEq Na, 7.1 mEq K per packet **Sodium Phosphate:** 3 mmol phos, 4 mEq Na per mL **Potassium Phosphate:** 3 mmol phos, 4.4 mEq K per mL
Magnesium	PO: 10-20 mg/kg/dose **elemental** magnesium 4 times/day Adult dose: 300 mg **elemental** magnesium 4 times daily	Separate from phosphorus supplementation 1-2 hours to ensure maximal absorption.	**Magnesium Oxide 140 mg cap**= 84.5 mg elemental Magnesium, **Magnesium Hydroxide** 500 mg elemental magnesium per 15 mL, **Magnesium Gluconate** 54 mg elemental magnesium per 5 mL
Potassium	PO: 2-5 mEq/kg/day in 2-4 divided doses Adult: 40-100 meQ/day in 2-4 divided doses	Liquid formulations should be diluted to minimize gastric irritation. Take tabs/caps with a full glass of water. Max single dose: 20-25 mEq	**Potassium Chloride liquid**: 20 mEq/15 mL (10%) or 40 mEq/15 mL (20%) **KCL Extended Release Caps**: 8 or 10 mEq caps (also available in sprinkle cap) **KCL Extended Release Tabs**: 8, 10, 15, or 20 mEq tabs

DISCHARGE

Literature review did not yield evidence based criteria for discharge readiness. It is our group consensus to consider the following factors in addition to the patient demonstrating weight gain in the hospital:

- Caregiver should demonstrate ability to provide responsive feeding and understanding of hunger and satiety cues.
- Caregiver should demonstrate mastery of preparing formula using the teach-back method.
- Room in for 24 hours and providing all feeds with no assistance from staff is essential to ensure the plan is practical for post discharge.
- Follow up is planned with either Growth and Parenting (GAP) clinic or PCP within 2-5 days from discharge.

RELATED DOCUMENTS

- Vitamin D Deficiency clinical pathway
- Intravenous Fluid Therapy clinical pathway
- Nutrition Screening, Assessment, and Reassessment Policy
- Naso/Orogastic Tubes: Education for Outpatient Nasogastric Tube Placement
- Parent/Family Nutrition Handouts

APPENDIX A. WORKUP FOR SUSPECTED INBORN ERROR OF METABOLISM/GENETICS [5]

When to consider inborn error of metabolism:

- History of acute life threatening symptoms like ketoacidosis and hypoglycemia
- Recurrent attacks of vomiting, lethargy and diarrhea
- Liver dysfunction
- Developmental delay, hypotonia, stroke, ataxia
- Cardiomyopathy, myopathy
- Hearing loss or visual impairment
- Organomegaly
- Dysmorphic features
- Pancytopenia

Plan: metabolic consult, labs to consider:

- Serum amino acids
- Plasma acycarnitione
- Ammonia
- Blood Lactate, pyruvate
- CK
- Urine organic acids.

APPENDIX B. CONSIDERATIONS FOR CYSTIC FIBROSIS/PANCREATIC INSUFFICIENCY: UNDERSTANDING THE NEWBORN SCREEN [6]

- The newborn screen (NBS) identifies infants at risk for CF by screening for hypertrypsinogenemia. Next then the CF transmambrane conductance regulator gene (CFTR) is interrogated for mutations.
- Individuals identified by the newborn screen are diagnosed with CF if they have an elevated sweat chloride level, or they have inherited 2 disease causing mutations in the CFTR gene.
- Not all CFTR mutations are disease causing. The term CFTR-related metabolic syndrome (CRMS) refers to infants identified on the newborn screen who have normal sweat chloride test, and up to 2 mutations in the CFTR gene, at least 1 of them not a “CF causing mutation”
- Infants with CRMS can be totally asymptomatic. However they can also present with poor weight gain due to pancreatic insufficiency. Other symptoms include recurrent sinus infections, wheezing, and recurrent diarrhea.
- Our approach: check fat in stool when considering CF or CRMS as a cause for poor growth.

APPENDIX C. ESTIMATED ENERGY NEEDS FOR PEDIATRIC PATIENTS

Age	Range of energy needs (Kcal/kg/day)
Preterm	110-130
Term 0-6 months	90-120
7-12 months	90-120
1-3 years	75-100
4-6 years	65-90
7-10 years	55-70
11-14 years	40-55
15-18 years, males 15-18 years, females	40-55 30-40
Adult	25-35

APPENDIX D: CATCH UP GROWTH CALCUATIONS

In cases of severe malnutrition where growth may take a long period of time, these calculations can be useful in consultation with the registered dietician (RD):

- Consider the total weight deficit and the amount of time desired to achieve ideal body weight (IBW).
- The energy cost of each gram of new growth is 5 Kcal [14].
- Patients 2 or younger: Total Kcal/kg/day needed = (RDA Kcal/kg based on weight age×IBW)÷actual weight [15].
- Patients older than 2: *Extra* Kcal/kg/day needed= [weight deficit (g)×5] ÷ days to correct.

APPENDIX E. ICD 10 CODES

ICD-10 description	ICD-10 code
Severe protein energy malnutrition	E43
Moderate protein energy malnutrition	E44.0
Mild protein energy malnutrition	E44.1

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Nutrition Quality Improvement Committee – December 15, 2016
Clinical Care Guideline and Measures Review Committee – February 14, 1017
Pharmacy & Therapeutics Committee – March 9, 2017

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LAST DATE OF REVIEW OR REVISION	March 9, 2017
APPROVED BY	 Lalit Bajaj, MD, MPH Medical Director, Clinical Effectiveness

REVIEW | REVISION SCHEDULE

Scheduled for full review on March 9, 2021

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