



Zsaleh Rahimi, MS, RD

Hypocaloric Enteral Nutrition Support:
More than just reduced calories



Agenda

Introduction

Who is at risk?

Potential Deficiencies

How to manage/monitor

Summary



Introduction

As pediatric dietitians, we know that proper nutrition and growth effect more than just weight, but also milestones is the literal fuel for meeting milestones, improved outcomes, brain development (neonates), prevent infections, so on and so forth.

We are constantly calculating needs based on growth goals, ensuring that our patients meet their needs to continue to gain appropriate weight to support linear growth and thrive in all aspects of their lives.

Today we will be focusing specifically on the population of neuro-devastated trach/vent dependent children who, after finding stability on vents, tend to become significantly hypometabolic, throwing off balance of growth with excessive and disproportional quality of weight gain and the risks for malnutrition and deficiencies as we clinicians attempt to listen to their body's needs.





Primary Goal

Proportional, Quality Growth and Prevention of Deficiencies



Goals



- ✓ Proportional Growth
 - ✓ What is this patient demonstrating as a need?
- ✓ Prevent deficiencies
 - ✓ EFAD
 - ✓ Protein
 - ✓ Lytes
- ✓ Fracture risk prevention



Who is at risk?





At Risk:

- HIE/Neurologically Compromised
 - Low energy expenditure
- Trach/Vent
 - Transitional phase after brand new trach placement.
- Endocrinology
 - Hypothyroidism
 - Cushing's Disease
 - Hypogonadism
 - Growth Hormone Deficiency



High BMI and Risks: Trach/Vent



Increased respiratory workload



Impaired gas exchange



Reduced lung volume caused by cranial displacement of the diaphragm from increased abdominal tissue mass and by increased chest wall tissue.



Case Study



Case Study: Interval History



WB is a 19 year old male with history of Pena Shokeir syndrome and associated pulmonary hypoplasia and neuromuscular weakness, chronic respiratory failure with trach/vent, epilepsy, GT, hypothyroidism, knee osteomyelitis with gout who presented to the ED following routine labs in neuro clinic finding hyponatremia, hypokalemia and hypochloremia per MD note. Admit for workup for etiology of abnormal labs.

Nutrition consult received to evaluate potential nutrition causes for lab abnormalities.

Parents were not in the room at time of visit, but in the hospital. Discussed baseline feeds and tolerance with mom over the phone.



Case Study: Home Regimen



Per Mom:

GT: Compleat Pediatric Reduced Calorie @ 150 ml 5XD via pump over 1 hr

- **(6am, 10am, 2pm, 6pm, 10pm)**

Water for feeds:

- **Daytime: 200 ml 5XD (100 ml before and after each feed) by gravity bolus.**
- **Overnight: 478 ml via pump at 70 ml/hr x 6 hrs (MN to 6am)**

Per mom, well tolerated at home and provided consistently daily leading up to this admission - no recent holds on to nutrition support.

This is consistent with last RD recs in pulm clinic (see below)

Per Pulm RD note (7/20/21):

Recommend continue with current GT feeds of Compleat Pediatric Reduced Calorie- 750 ml/d

Continue to provide 150cc of formula X 5/day via GT pump.

Continue daytime water flushes to 200 ml x 5 bolus

Continue night-time water intake to 470ml @ 78ml/hr X 6 hours overnight

Continue with the current intake of multi-vitamins.

Continue Vitamin C supplementation of 500 mg/d"

Labs: Admission

LABORATORY	05/20/2022 00:00	05/19/2022 00:00
Other Hematology		
<input type="checkbox"/> Sed Rate		
Blood Chemistry		
<input type="checkbox"/> Sodium	(L) 132	129 - 134 [3] (L)
<input type="checkbox"/> Potassium	4.2	3.5 - 4.3 [3] (L)
<input type="checkbox"/> Chloride	99	97 - 101 [3] (L)
<input type="checkbox"/> CO2 Total	24	22 - 25 [3]
<input type="checkbox"/> Anion Gap	9	8 - 12 [3]
<input type="checkbox"/> BUN	7	6 - 7 [3]
<input type="checkbox"/> Creatinine	(L) 0.57	0.48 - 0.55 [3]
<input type="checkbox"/> Glucose Lvl	88	84 - 100 [3]
<input type="checkbox"/> Magnesium Lvl		
<input type="checkbox"/> Calcium	8.7	8.3 - 8.9 [3] (L)
<input type="checkbox"/> Phosphorus		
<input type="checkbox"/> Uric Acid		
<input type="checkbox"/> Protein Total		
<input type="checkbox"/> Albumin		
<input type="checkbox"/> Bilirubin Total		
<input type="checkbox"/> C-Reactive Protein		(H) 16.4
<input type="checkbox"/> AST		
<input type="checkbox"/> ALT		
<input type="checkbox"/> Alk Phos		
<input type="checkbox"/> Osmolality		
<input type="checkbox"/> Procalcitonin		



Hyponatremia



Hyponatremia



- Hyponatremia is defined as a plasma sodium concentration of less than 135 mEq/L
 - One of the most common electrolyte derangements in both adults and children.
 - Increased occurrence in children with respiratory infection though the exact mechanism is unknown with multiple

Hyponatremia: Treatment



Breakdown baseline nutrition intake:

1. Too much water at baseline?
 - See other lytes/labs to better judge)
2. Meeting Na RDA for age?
 - If not, supplement the difference with NaCl Before reducing fluid and monitor.
3. Reduce fluid as needed
 - As long as BUN/Cr are not starting to increase, then kiddo is OK.



Weight/BMI?

Evaluate/Trend Anthros



Weight/Calories



- How is BMI?
- Weight trend?
- When was last time nutrition plan changed?

Anthropometrics



Anthropometric Data

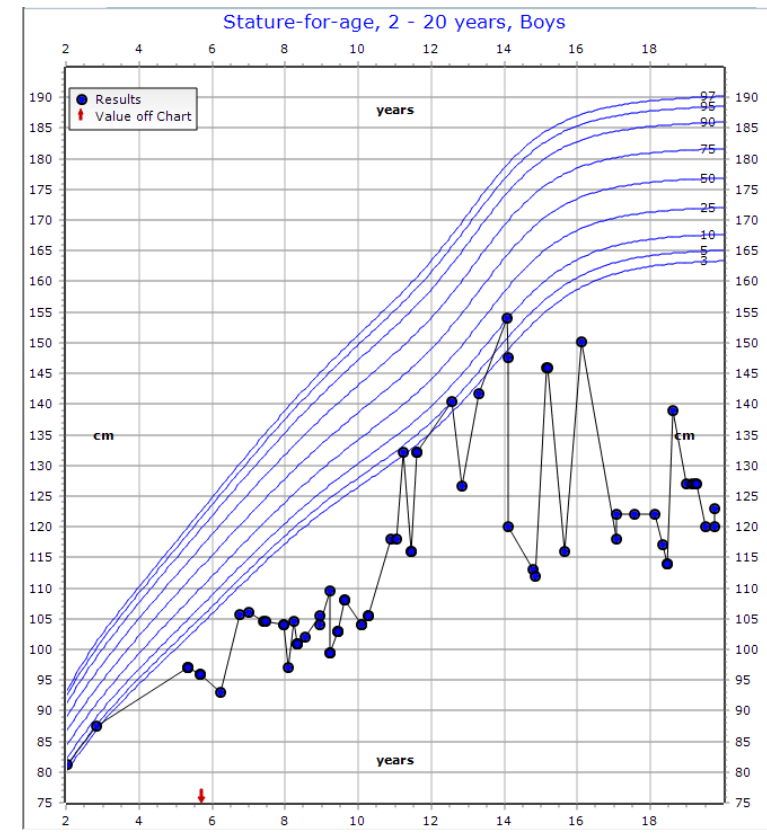
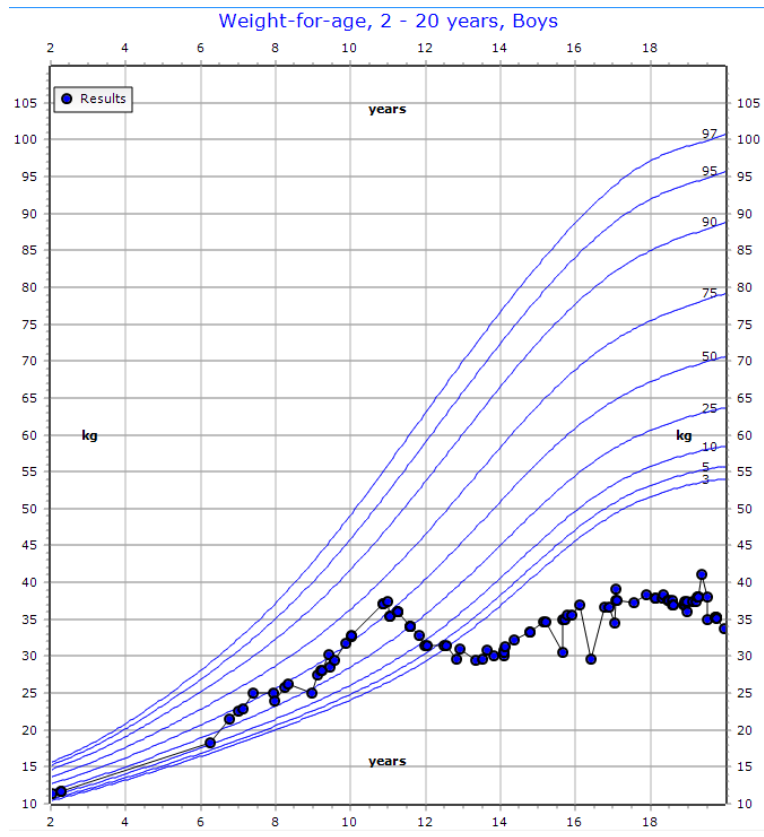
Age: 19 Years 9 Months

Admission Weight: 35.20 kg (05/16/22)

Med Calc Weight: 35.10 kg (05/17/22)

Data	Percentile
Routine Weight: 35.10 kg (05/17 11:07)	<3%ile (Z-score=-6.1)
Weight Change from Last RD Note: Routine weight not documented since last RD note	
Height: 123 cm (05/17/22 11:07)	<3%ile (Z-score=-7.3)
BMI: 23.20 kg/m ² (05/17/22 11:07)	54%ile (Z-score=0.1)
DBW: _	%DBW

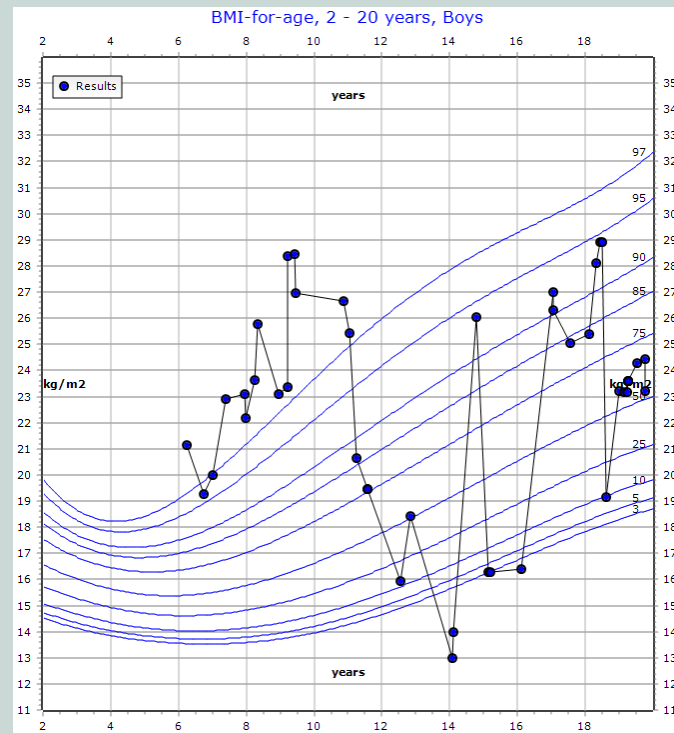
Weight for Age/Length for age



BMI



Always confirm
with NFPE





Evaluate Baseline Regimen



Evaluate Baseline Regimen

35.1 kg MC wt	Modality	Amount	Calories (kcal/d)	Protein (g/d)	Fat (g)	Na (mg)	K (mg)	Cl (mg)	Fluid (ml/d)
Baseline feeds prior to admission	Compleat peds reduced cal	150 5XD (750 ml)	450	22.5	15	570	1275	405	666
	H2O flush	200 5XD +70ml/hr x 6 hrs overnight	---	---	---	---	---	---	1420
	Total	---	450 kcal/d	22.5g/d 0.6g/kg	15g 0.4 g/kg	570 mg/d	1275 mg/d	405 mg/d	2086 ml/d
Estimated Needs: REE = 1216		----	<608 kcal/d (<50% REE per demo needs)	28-35g (0.8-1 g/kg)	GOAL 0.5g/kg	RDA 1500 mg/d	RDA 4700 mg/d	RDA 2300 mg/d	1802 ml FM

Predictive Equations



(Wt in Kg) (Ht in cm)	Schofield Method	
	Basal Metabolic Rate (BMR) (kals/day)	
Age	Male	Female
0-3 y/o	$(0.167 \times \text{wt}) + (15.174 \times \text{ht}) - 617.6$	$(16.252 \times \text{wt}) + (10.232 \times \text{ht}) - 413.5$
3-10 y/o	$(19.59 \times \text{wt}) + (1.303 \times \text{ht}) + 414.9$	$(16.969 \times \text{wt}) + (1.618 \times \text{ht}) + 371.2$
10-18 y/o	$(16.25 \times \text{wt}) + (1.372 \times \text{ht}) + 515.5$	$(8.365 \times \text{wt}) + (4.65 \times \text{ht}) + 200$
≥ 18 y/o	$(15.057 \times \text{wt}) + (1.004 \times \text{ht}) + 705.8$	$(13.623 \times \text{wt}) + (23.8 \times \text{ht}) + 98.2$

(Wt in Kg) (Ht in cm)	WHO Equation	
	Resting Energy Expenditure (REE) (kals/day)	
Age	Male	Female
0-3 y/o	$60.9 \times \text{wt} - 54$	$61 \times \text{wt} - 51$
3-10 y/o	$22.7 \times \text{wt} + 495$	$22.5 \times \text{wt} + 499$
10-18 y/o	$17.5 \times \text{wt} + 651$	$12.2 \times \text{wt} + 746$
≥ 18 y/o	$15.3 \times \text{wt} + 679$	$14.7 \times \text{wt} + 496$


Multiply BMR or REE by Stress Factor According to Illness Severity	
REE/BMR $\times 1.3$	<ul style="list-style-type: none"> Well Nourished on bedrest w/ Mild-Moderate stress
REE/BMR $\times 1.5$	<ul style="list-style-type: none"> Normally active child with mild-moderate stress Inactive w/ severe stress (i.e., trauma, stress, cancer) Minimal Activity and malnutrition requiring catch-up growth
REE/BMR $\times 1.7$	<ul style="list-style-type: none"> Active requiring catch-up growth or active with severe stress



Protein?

Meeting Needs?





Protein and Fluid Predictors

Age	ASPEN Protein Recommendations
0-2 years	2-3g/kg/day
2-13 years	1.5-2g/kg/day
13-18 years	1.5 g/kg/day

Holiday Segar Method	
Weight in Kg	Fluid Needs
1-10 kg	100 mL/kg
11-20 kg	1000 mL + 50 mL/kg for each kg >10 kg
>20 kg	1500 mL + 20 mL/kg for each kg >20 kg

Protein



- Needs usually are not met if reducing calories by decreasing formula alone and not monitoring.
- Protein Modulators:
 - Beneprotein
 - Prostat
 - Complete Amino Acid mix
 - Lean High protein food sources for BTF

How to Create a Custom Recipe



What are your goal calories?

Decrease by an additional ~ 20-30% if you are planning on adding protein and fat.



Are you meeting minimum fat need?

Add fat as needed (Fat options next slide)
0.5g/kg minimum goal



Add Protein

Aim for higher end estimated protein needs for age/weight.



Fluid

Monitor Electrolytes

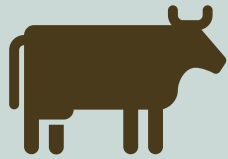
Commercial Formula Options



- Reducing volume of current formula: 1.0-1.5 kcal/mL
 - Add Protein modular
- Reduced Calorie Formulas: 0.6 kcal/mL
 - Pediasure Reduced Calorie
 - Compleat Reduced Calorie
- High Protein Formulas
 - Replete
- Keto formulas
 - Perfect when calorie needs are extremely low to avoid adding a fat modular.
 - Still need to add protein and water.
- Custom formulas (RD created recipes)

Helps meet kcal, pro, fluid and especially micronutrient needs without having to create custom recipe. Dependent on how low calories need to go

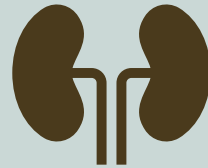
When to switch to a Reduced Cal and Why



When Protein needs to longer met.

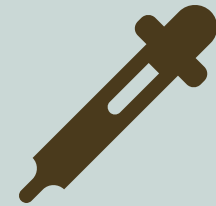
Aspen

Simplifies home recipe for parents – don't need to add additional protein modular.



Hyponatremia

Offers more proportional electrolyte delivery.



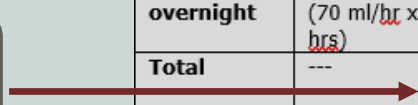
Still need to monitor lytes for response/reaction.

Breakdown of Plan



Modality	Amount	Calories (kcal/d)	Protein (g/d)	Fat (g)	Na (mg)	K (mg)	Cl (mg)	Fluid (ml/d)
<u>Compleat peds reduced cal</u>	115 5XD (575 ml)	342	17.3	11.5	437	978	310.5	510.6
<u>Benebro</u>	14g (2 scoops)	50	12	0	0	0	0	10.6g dry displacement
<u>NanoVM t/f</u>	2 scoops/day	13	0	0	0	1170	540	---
<u>Liquigen</u>	12ml	54	0	6	---	---	---	10ml displaced
<u>H2O flush daytime</u>	170 5XD (850 ml)	---	---	---	---	---	---	850
<u>H2O flush overnight</u>	420 ml (70 ml/hr x 6 hrs)	---	---	---	---	---	---	420
Total	---	459 kcal/d	29/d 0.8g/kg	17.5g 0.5 g/kg	437 mg/d	2148 mg/d	850.5 mg/d	1780 ml/d
Estimated Needs: REE = 1216	----	<608 kcal/d (<50% REE per demo needs)	28-35g (0.8-1 g/kg)	GOAL 0.5g/k g	RDA 1500 mg/d	RDA 4700 mg/d	RDA 2300 mg/d	1802 ml FM

Calories Unchanged



Interventions



1. Reduce Volume of feeds to Compleat Pediatric Reduced Calorie @ 115 ml 5XD via pump over 1 hr (6am, 10am, 2pm, 6pm, 10pm)

2. Start Liquigen: 6ml BID mixed into feeds

3. Start Beneprotein: 7g (1 scoop) BID mixed into feed

- Mix into feed that do not have liquigen.

4. Water For Feeds:

- Daytime: 170 ml 5XD (85 ml before and after each feed by gravity)
- Overnight: 420 ml water total via pump @ 70 ml/hr x 6 hrs (12am-6am)

5. Start MVI: NanoVM t/f: 2 scoops/day

- Can provide as 1 scoop BID with feeds

*See above table for macro/micro nutrient breakdown.

6. Check vitamin D, 25 OH level given high risk for fractures with no new level over the last year.

7. Start Cholecalciferol @ 50 mcg/day to match home intake/maintenance dosing until new level returns.

8. Will likely need additional KCl and NaCl supplementation as there is no formula that will meet 100% of needs given the very low calorie requirements of this patient.

- Continue to monitor and supplement lytes as needed.

9. Check Essential Fatty Acid panel as it appears patient has been receiving lower than needed fat at baseline.

10. Weigh q MWF (Sling scale, same time of day, dry diaper)

- Goal for stable weight.
- RD to adjust feeds as needed during this admit to achieve this.

Proposed Changes: Nutrition Optimization

Modality	Amount	Calories (kcal/d)	Protein (g/d)	Fat (g)	Na (mg)	K (mg)	Cl (mg)	Fluid (ml/d)
<u>Compleat peds reduced cal</u>	115 5XD (575 ml)	342	17.3	11.5	437	978	310.5	510.6
<u>Benepro</u>	14g (2 scoops)	50	12	0	0	0	0	10.6g dry displacement
<u>NanoVM t/f</u>	2 scoops/day	13	0	0	0	1170	540	---
<u>Liquigen</u>	12ml	54	0	6	---	---	---	10ml displaced
H2O flush daytime	170 5XD (850 ml)	---	---	---	---	---	---	850
H2O flush overnight	420 ml (70 ml/hr x 6 hrs)	---	---	---	---	---	---	420
Total	---	459 kcal/d	29/d 0.8g/kg	17.5g 0.5 g/kg	437 mg/d	2148 mg/d	850.5 mg/d	1780 ml/d
Estimated Needs: REE = 1216	----	<608 kcal/d (<50% REE per demo needs)	28-35g (0.8-1 g/kg)	GOAL 0.5g/k g	RDA 1500 mg/d	RDA 4700 mg/d	RDA 2300 mg/d	1802 ml FM

Monitoring



Weight:

Goals met?



Labs:

How is BUN? May require fluid and/or protein adjustments

How are electrolytes?

Test for EFAD if $< 0.5\text{g/kg}$ fat and/or if s/s of deficiency (+)



Tolerance:



n/v/d or allergic reactions?



Labs

LABORATORY	06/03/2022 00:00	06/02/2022 00:00	06/01/2022 00:00	05/31/2022 00:00	05/30/2022 00:00	05/29/2022 00:00	05/28/2022 00:00	05/27/2022 00:00	05/26/2022 00:00	05/25/2022 00:00	05/24/2022 00:00	05/23/2022 00:00	05/22/2022 00:00	05/21/2022 00:00	05/20/2022 00:00	05/19/2022 00:00
Other Hematology																
<input type="checkbox"/> Sed Rate																
Blood Chemistry																
<input type="checkbox"/> Sodium	143	(H) 147	142	142	141	141	139	140	138 - 141 [2]	139 - 150 [3] 141 - 148 [3] 120 - 129 [4] 120 - 121 [3] 127 - 131 [2] (L) 132					129 - 134 [3]	
<input type="checkbox"/> Potassium	3.8	3.7	4.2	* 4.3	(L) 3.2	* 3.8	* 4.0	(L) 3.0	3.9 - 4.7 [2]	3.9 - 6.1 [3] 3.0 - 5.0 [3] 4.7 - 5.5 [4] 4.2 - 4.3 [3]	3.9 - 4.0 [2]	4.2				3.5 - 4.3 [3] (L)
<input type="checkbox"/> Chloride	(H) 115	(H) 117	(H) 115	(H) 115	(H) 115	* (H) 117	(H) 116	(H) 113	111 - 114 [2] 117 - 120 [3] 108 - 120 [3] 87 - 98 [4] (L) 87 - 89 [3] (L) 94 - 95 [2] (L) 99						97 - 101 [3] (L)	
<input type="checkbox"/> CO2 Total	(L) 16	(L) 13	(L) 15	(L) 16	(L) 12	* (L) 12	(L) 11	(L) 17	17 - 19 [2] (L) 11 - 16 [3] (L) 13 - 18 [3] (L) 17 - 20 [4] (L) 20 - 21 [3] (L) 24 - 25 [2]						22 - 25 [3]	
<input type="checkbox"/> Anion Gap	13	(H) 17	11	11	14	11	13	10	9 - 11 [2]	11 - 13 [3]	11 - 16 [3] (H) 12 - 14 [4]	11 - 12 [3]	9 - 12 [2]	9		8 - 12 [3]
<input type="checkbox"/> BUN	9	11	9	7	8	8	9	7	6 - 8 [2]	12 - 15 [3]	17 - 24 [3] (H) 27 - 28 [4] (H) 24 - 26 [3] (H) 13 - 17 [2]	7				6 - 7 [3]
<input type="checkbox"/> Creatinine	(L) 0.60	(L) 0.57	(L) 0.61	(L) 0.66	(L) 0.64	* (L) 0.68	0.80	0.89	1.00 - 1.18 [2]	1.31 - 1.59 [3]	1.79 - 3.10 [3]	3.17 - 3.61 [4]	2.50 - 3.04 [3]	1.11 - 1.39 [2]	(L) 0.57	0.48 - 0.55 [3]
<input type="checkbox"/> Glucose Lvl	80	89	90	78	93	84	* 75	78	79 - 114 [2]	70 - 122 [3] (H) 82 - 113 [3]	94 - 134 [4] (H) 76 - 96 [3]	85 [2]	88			84 - 100 [3]
<input type="checkbox"/> Magnesium Lvl											2.3					
<input type="checkbox"/> Calcium	9.2	9.3	8.9	8.4	8.7	8.4	8.6	8.5	8.4 - 9.1 [2]	8.1 - 8.4 [3] 8.0 - 8.6 [3] 7.8 - 8.3 [4] 7.7 - 8.2 [3] 8.2 - 8.9 [2] (L) 8.7						8.3 - 8.9 [3] (L)
<input type="checkbox"/> Phosphorus											3.3					
<input type="checkbox"/> Uric Acid				5.3									6.5			
<input type="checkbox"/> Protein Total																
<input type="checkbox"/> Albumin													(L) 3.1			
<input type="checkbox"/> Bilirubin Total																
<input type="checkbox"/> C-Reactive Protein		(H) 2.6		(H) 1.0					(H) 3.6		(H) 7.5		(H) 18.0	(H) 21.6		(H) 16.4
<input type="checkbox"/> AST																
<input type="checkbox"/> ALT																
<input type="checkbox"/> Alk Phos																
<input type="checkbox"/> Osmolality													(L) 255	(L) 272		
<input type="checkbox"/> Procalcitonin																





What to Monitor when Reducing Formula

Protein intake

Fat intake

Vitamin/Mineral intake

Monitor electrolytes.

Are you checking fat content?

Are you monitoring lytes?

Are you meeting RDA for age?

Is this child at risk for fractures?



True or False?

You don't need to test for EFAD if patient is with obesity.





Answer:

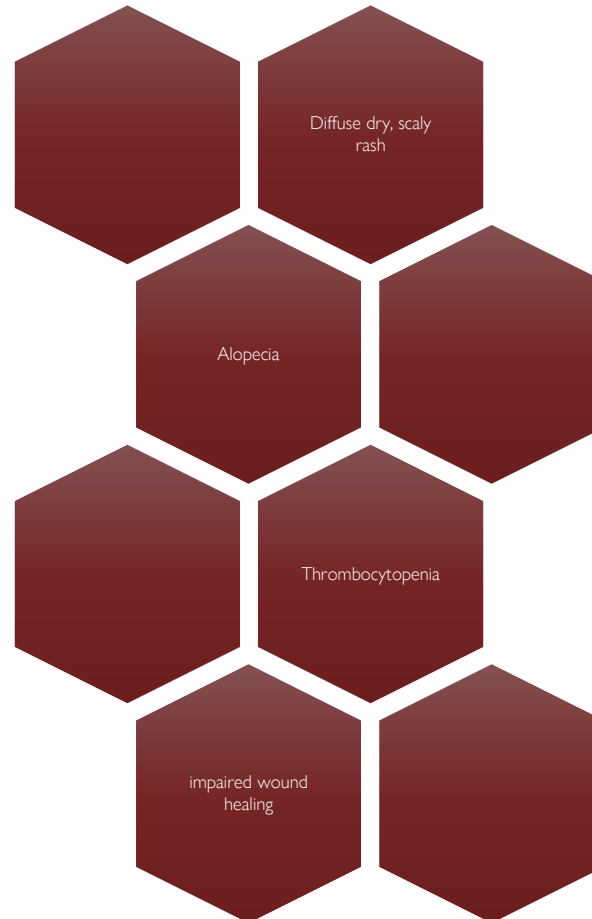
FALSE.

Essential Fatty Acids



- “The term essential fatty acids (EFA) refers to those polyunsaturated fatty acids (PUFA) that must be provided by foods because these cannot be synthesized in the body yet are necessary for health. There are two families of EFA, omega-3 (ω -3) and omega-6 (ω -6).”

Signs of EFAD



EFAD: Who's at Risk?



- TPN with lipids held
- Fat malabsorptive conditions such as cystic fibrosis
- Acrodermatitis Enteropathica
- Peripheral Vascular Disease
- Multiple Sclerosis
- Alcoholism
- Anorexia Nervosa
- AIDS
- Protein energy malnutrition (kwashiorkor and marasmus)
- ****Low calorie diets with < 0.5g fat/kg****

EFAD: Development and Dx



- Can take x13 days of inadequate intake to develop EFAD.
- Biochemical evidence of EFAD is confirmed by a triene-to-tetraene ratio of >0.2
- The Triene/Tetraene (T/T) ratio is another marker for essential fatty acid status. It is calculated as the ratio of Mead acid to arachidonic acid. This ratio, combined with measurements of the essential fatty acids and Mead acid, gives a more complete picture of the degree and nature of fatty acid deficiency. An elevated ratio shows a relative excess of triene (3 double bonds) compared to tetraene (4 double bonds), which results from essential fatty acid deficiency.

EFAD: The Effects



- EFAD can lead to:
 - FTT
 - Elevated transaminases
 - Thrombocytopenia
 - poor wound healing
 - scaly dermatitis
 - hypertriglyceridemia (HTG)

EFAD: Treatment



- Adding back fat in PN
 - IL
 - SMOF
 - Omegavan
- Adding fat to the diet/nutrition plan
- Topical
- Estimates have suggested 21 days for repletion.

Bone Health



- Increased risk for fractures.
 - Monitor vitamin D, 25 OH level.
 - Ask X-Ray techs to please comment on how bone looks
 - Any osteopenia noted?
 - Medications that can decrease absorption
 - AEDs
 - Steroids
 - Decreased nutrient intake/poor nutrition
 - Yes, decreasing formula for weight management contributes.

Outpatient F/U



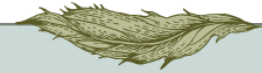
- Communicate
 - Whenever possible, explain the needs and share the specialty recipes with outpatient nutrition.
 - I tend to attach recipes to my notes.
 - Recommend RD management for thorough and in-depth management/monitoring.
 - F/U labs to look out for and how to treat.
 - I tend to ask our medical teams to include certain monitoring and respective supplementation plans to PMD in d/c paperwork.

Speak to your Formula Reps!



- Requesting newer companies on making reduced cal versions of formulas.
- Create a reduced calorie BTF

Summary



Goal: proportional growth and prevention of deficiencies.



Ask for labs



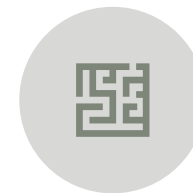
Organize your thoughts



Monitor



Communicate



Takes a LOT of practice!



Thank you



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