

OBJECTIVES

- Define malnutrition and describe its current management in infants
- Review evidence on infants managed with energy and nutrient-dense formulas
- List clinical applications of energy and nutrient-dense formulas

5

What is Malnutrition?

“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.”

*Academy of Nutrition & Dietetics
American Society of Parenteral & Enteral Nutrition*

Mehta, et al. J Parenter Enteral Nutr. 2013;37(4):460-481

6

Malnutrition: Etiology

- Inadequate Intake**
 - Supply concerns
 - Improper mixing
 - Reflux
 - Feeding difficulties
 - Neglect/abuse
 - Acute illness
- Increased Energy Needs**
 - Chronic lung disease
 - Congenital heart defects
 - Renal failure
 - Hyperthyroidism
 - Chronic infection
- Inadequate Absorption**
 - GI conditions
 - Cystic fibrosis
 - Milk protein allergy
 - Inborn errors of metabolism

Carvalho-Salemi, et al. J Acad Nutr Diet. 2018;118(1):40-51

9

Malnutrition: Risk Factors

Medical

- Low birth weight
- Reflux
- Congenital anomalies
- Acute and chronic illness

Psychosocial

- Poor feeding techniques
- Post-partum depression (PPD)
- Poverty
- Abuse

Homan. American Family Physician. 2016;94(4):295-300

10

Malnutrition: Diagnostic Criteria

Primary Indicators when a **Single Data Point** is Available

	Wt-for-lt z-score	BMI-for-age z-score	Lt/ht-for-age z-score	MUAC z-score
Mild Malnutrition	-1 to -1.9	-1 to -1.9	No data	≥ -1 to -1.9
Moderate Malnutrition	-2 to -2.9	-2 to -2.9	No data	≥ -2 to -2.9
Severe Malnutrition	-3 or greater	-3 or greater	-3	≥ -3 or greater

Primary Indicators when **Two or More Data Points** are Available

	Wt gain velocity (<2y)	Wt loss (2-20y)	Deceleration in wt-for-lt/ht z-score	Inadequate nutrient intake
Mild Malnutrition	<75% expected	5% usual BW	Decline of 1	51-75% estimated
Moderate Malnutrition	<50% expected	7.5% usual BW	Decline of 2	26-50% estimated
Severe Malnutrition	<25% expected	10% usual BW	Decline of 3	≤25% estimated

Guib, et al. Reference data on gains in weight and length during the first two years of life. Pediatrics. 1995;116(3):355-362. World Health Organization data for patients <1 years old.
Reproduced from Bekker, et al. Nutr Clin Pract. 2015; 30(1):147-161. © 2015, American Society of Parenteral and Enteral Nutrition.

11

Malnutrition: Prevalence in US

45%

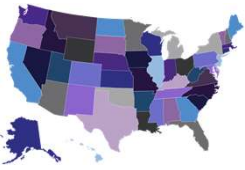
Of children with chronic disease having nutrition risk

10%

Of infants in primary care settings

4%

Of hospitalized infants



Daymont, et al. Acad Pediatr. 2020;20:405-412. Carvahio-Salemi, et al. J Acad Nutr Diet. 2018;118:40-51

12

Poll Question
RESPOND IN THE RIGHT-HAND PANEL IN THE LIVE EVENT – CLICK ‘SUBMIT’ WHEN DONE

Estimate the percentage of infants you see with malnutrition

- A. Less than 4%
- B. About 4%
- C. More than 4%
- D. Does not apply to my practice

13

Malnutrition: WHO recommendations

Target intake:
105-126kcal/kg/d

Weight gain:
5-10g/kg/d

World Health Organization. Food and Agriculture Organization of the United Nations. Protein and amino acid requirements in human nutrition. 2007
WHO = World Health Organization

15


Malnutrition: Nutrition Management in the US

①

Feed more volume,
more often

②

Concentrate formula



③

Use a higher-calorie
formula at standard
concentration

④

Start with a “base”
and then supplement
or fortify


Simental. J Pediatr Gastroenterol Nutr. 2020;71:5453

16

Malnutrition: Nutrition Management Abroad

Energy and nutrient dense formula

- 30kcal/oz term infant formula
- High protein/nutrient content
- 360mOsm/kg
- Ready to feed/sterile
- Nutritionally complete
- Used in Europe for 20+ years
- Supported by clinical evidence



17

Nutrition Management: Key Parameters



Growth → Tolerance

Nutritional Status → Safety

18

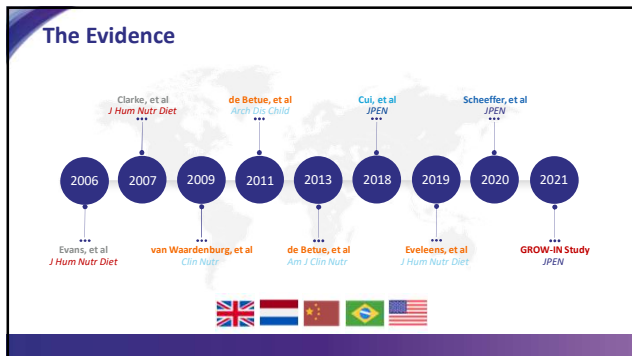
Poll Question

RESPOND IN THE RIGHT-HAND PANEL IN THE LIVE EVENT – CLICK 'SUBMIT' WHEN DONE

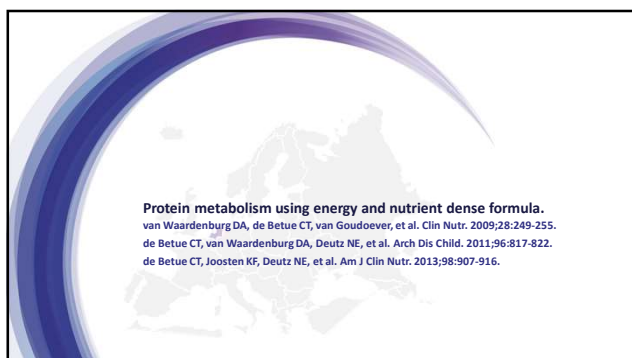
Which practice do you use most often for feeding infants with growth failure?

- A. Increase volume and frequency of feeds
- B. Concentrate powdered formula
- C. Use a higher-calorie formula at standard concentration
- D. Start with a “base” and then supplement or fortify

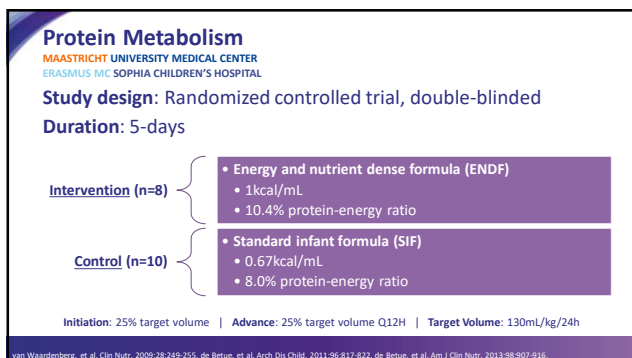
19



21



22




24

Protein Metabolism
MAASTRICHT UNIVERSITY MEDICAL CENTER
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Study Population: n=18

- *Route of nutrition:* enteral
- *Age:* 4 weeks to 12 months
- *Gestation:* term or preterm, **but** >40 weeks postmenstrual age
- *Diagnosis:* respiratory syncytial virus



van Waardenberg, et al. Clin Nutr. 2009;28:249-255. de Betus, et al. Arch Dis Child. 2011;96:817-822. de Betus, et al. Am J Clin Nutr. 2013;98:907-916

25

Protein Metabolism
MAASTRICHT UNIVERSITY MEDICAL CENTER
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Nitrogen balance

Plasma amino acid

Stable isotope

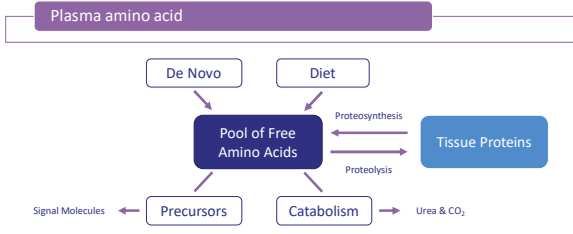
- Whole body protein
- Splanchnic phenylalanine extraction
- Arginine and citrulline tracer

van Waardenberg, et al. Clin Nutr. 2009;28:249-255. de Betus, et al. Arch Dis Child. 2011;96:817-822. de Betus, et al. Am J Clin Nutr. 2013;98:907-916

26

Protein Metabolism
MAASTRICHT UNIVERSITY MEDICAL CENTER
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Plasma amino acid



De Novo

Diet

Pool of Free Amino Acids

Tissue Proteins

Proteosynthesis

Proteolysis

Precursors

Signal Molecules

Catabolism

Urea & CO₂

Furst, e-SPEN. 2009;2(4):e62-e65. Hoffer, J-PEN. 2016;40(4):460-474. Avenous, et al. (2016). The molecular nutrition of amino acids and protein (pp.289-303). Academic Press.

28

Protein Metabolism

MAASTRICHT UNIVERSITY MEDICAL CENTER
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Stable isotope

A

Hydrogen: ^1H → ^2H
Deuterium

Stable isotopes differ in mass due to the different number of neutrons. Typically ^1H , ^{13}C , ^{15}N , ^{18}O .

B

AA tracer: ^{14}C , ^{15}N
Deuterium oxide: $^2\text{H}_2\text{O}$

Incorporation of stable isotopes into a range of biological compounds creates an array of **stable isotope tracers** to investigate metabolism.

C

Whole Body: $^2\text{H}_2\text{O}$ (Whole body water, turnover & EE), ^{15}N (Whole body protein turnover)

Tissue Specific: ^{15}N (Tissue synthesis, turnover & EE), ^{14}C (High turnover of protein turnover)

Single Protein: ^{15}N (On target protein synthesis, turnover & EE), ^{14}C (Target protein turnover)

Day to Day: ^{15}N (Daily protein turnover)

Fig. 6. Isotopes (hydrogen, deuterium, ^{13}C , ^{14}C , ^{15}N , ^{18}O) can be incorporated into biological tissues and (1) the type and rate of incorporation. (2) They can provide...

Wilkinson, et al. Clin Nutr Open Sci. 2021;36:211-225.

29

Protein Metabolism

MAASTRICHT UNIVERSITY MEDICAL CENTER
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Outcomes: Nutrient Intake and Tolerance

Intake	ENDF	SIF	Tolerance	ENDF	SIF
Volume	No difference		Stooling	No difference	
Energy (kcal/kg/d)*	112±19	82±4	Emesis	No difference	
Protein (g/kg/d)*	2.8±0.3	1.5±0.1			

*p<0.01

van Waardenberg, et al. Clin Nutr. 2009;28:249-255
ENDF = energy and nutrient dense formula; SIF = standard infant formula; GRV = gastric residual volume

31

Protein Metabolism

MAASTRICHT UNIVERSITY MEDICAL CENTER
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Outcomes: Protein Anabolism

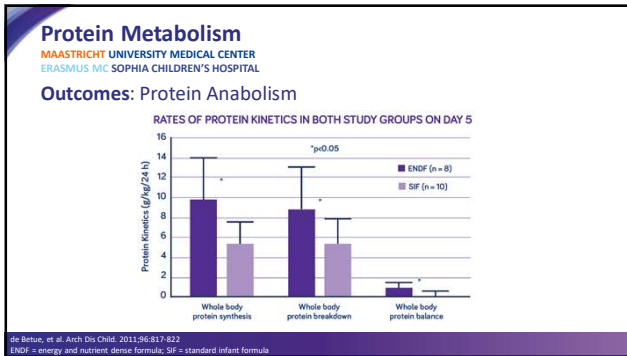
Nitrogen balance	ENDF	SIF
Day 5 (mg/kg/d)*	297±41	123±23
All in positive nitrogen balance	by Day 2	by Day 4

*p<0.01

CUMULATIVE NITROGEN BALANCE, DAYS 2-5

van Waardenberg, et al. Clin Nutr. 2009;28:249-255
ENDF = energy and nutrient dense formula; SIF = standard infant formula

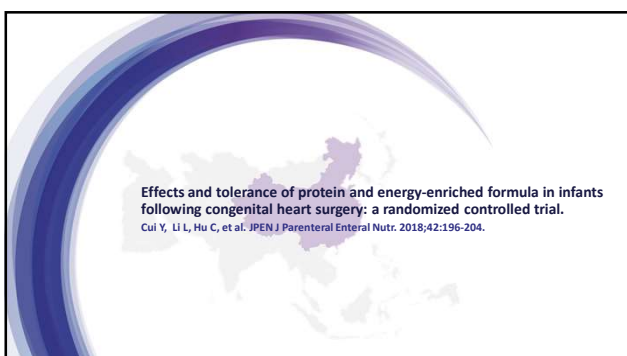
32



33



34



35

Cui, et al. 2018.
GUANGZHOU WOMEN AND CHILDREN'S MEDICAL CENTER

Study design: Randomized controlled trial, double-blinded
Duration: 5-days

Intervention (n=26)	<ul style="list-style-type: none"> • Energy and nutrient dense formula (ENDF) • 1kcal/mL • 10.4% protein-energy ratio
Control (n=24)	<ul style="list-style-type: none"> • Standard infant formula (SIF) • 0.67kcal/mL • 8.0% protein-energy ratio

Initiation: 12-24h post-op at 1mL/kg/h | Advance: 1mL/kg/h Q6H as tolerated | Target Volume: 130mL/kg/24h

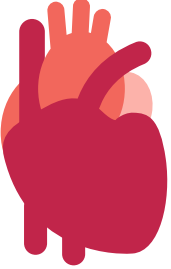
Cui, et al. JPEN J Parenter Enteral Nutr. 2018;42:196-204

37

Cui, et al. 2018.
GUANGZHOU WOMEN AND CHILDREN'S MEDICAL CENTER

Study Population: n=50

- Route of nutrition: enteral
- Age: 4 weeks to 12 months
- Diagnosis: CHD
- Surgical Status: post-operative biventricular repair



Cui, et al. JPEN J Parenter Enteral Nutr. 2018;42:196-204
CHD = congenital heart defects

38

Cui, et al. 2018.
GUANGZHOU WOMEN AND CHILDREN'S MEDICAL CENTER

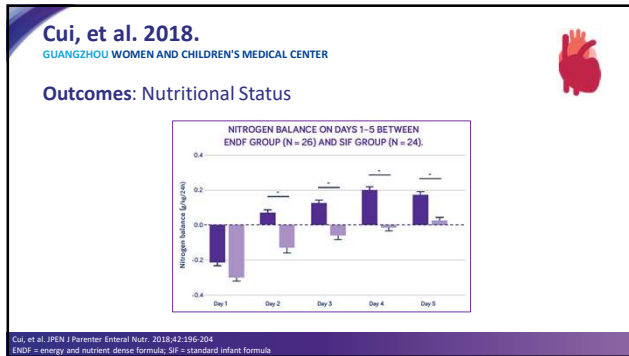
Outcomes: Nutrient Intake

Days	ENDF vs. SIF			Adequate kcal & Protein*
	Higher kcal	Higher Protein	Higher CHO & Fat	
1	✓	✓✓	✓✓	
2	✓	✓		ENDF
3	✓	✓	✓	ENDF
4	✓	✓	✓	ENDF
5	✓	✓	✓	ENDF

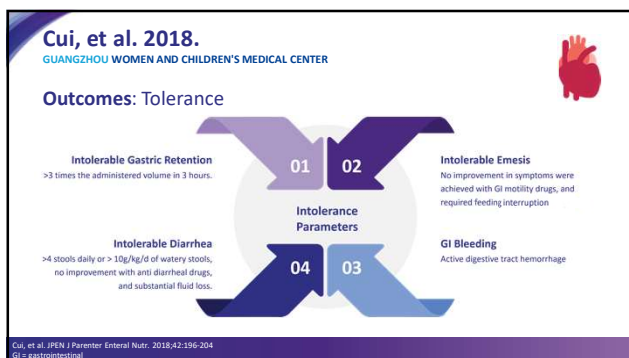
*87kcal/kg/d, 2.67g protein/kg/d; ✓✓p<0.01; ✓p<0.05

Cui, et al. JPEN J Parenter Enteral Nutr. 2018;42:196-204
ENDF = energy and nutrient dense formula, SIF = standard infant formula, CHO = carbohydrates

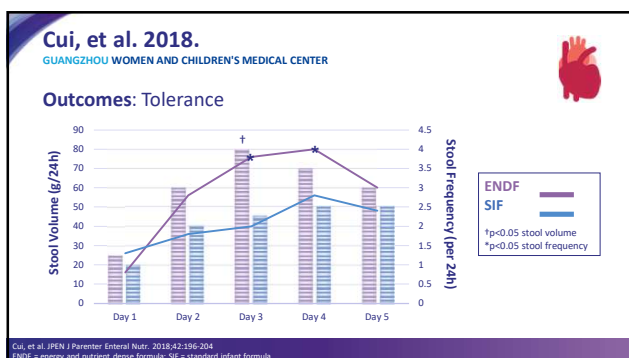
39



40



41



42

Cui, et al. 2018.
GUANGZHOU WOMEN AND CHILDREN'S MEDICAL CENTER

Nutritional Status
1) Achieve positive nitrogen balance in as little as 2 days
2) Promote anabolism compared to SIF

Tolerance
1) Equivalent tolerance to SIF
2) Well-tolerated in critically ill infants, including infant's post-op for CHD repair

Safety
Safe in infants with growth failure due to CHD & other causes of growth failure

43

Should high-energy infant formula be given at full strength from its first day of usage.
Evans S, Twaissi H, Daly A, et al. J Hum Nutr Diet. 2006;19:191-197.

44

Evans, et al. 2006.
BIRMINGHAM CHILDREN'S HOSPITAL

Study design: randomized controlled trial, non-blinded
Duration: 2-weeks

Intervention (n=18)	<ul style="list-style-type: none">• Energy and nutrient dense formula (ENDF)• Full strength (30 kcal/oz) at day 1
Control (n=12)	<ul style="list-style-type: none">• Energy and nutrient dense formula (ENDF)• Titration schedule:<ul style="list-style-type: none">• Day 1: 80% (24 kcal/oz)• Day 2: 90% (27 kcal/oz)• Day 3: 100% (30 kcal/oz)

Evans, et al. J Hum Nutr Diet. 2006;19:191-197.

46

Evans, et al. 2006.
BIRMINGHAM CHILDREN'S HOSPITAL

Study Population: n=30

- Route of nutrition: PO or enteral
- Previous feed: 93% - standard infant formula (20kcal/oz)
- Age: < 12 months
- Diagnosis: failure to thrive

Evans, et al. J Hum Nutr Diet. 2006;19:191-197
PO = per os, GI = gastrointestinal, Onc = oncology, Resp = respiratory, Neuro = neurological, CHD = congenital heart defects

47

Evans, et al. 2006.
BIRMINGHAM CHILDREN'S HOSPITAL

Outcomes: Tolerance

	Day 1 + 2		Day 3 + 4	
	Full Strength	Stepwise	Full Strength	Stepwise
Stools per day:	6.5 (0-11)	2.0 (1-6)	3.5 (0-13)	2.0 (1-8)
	p=0.02		p=0.06	
Vomits per day:	0.5 (0-9)	0.0 (0-5)	0.0 (0-4)	1.0 (0-7)
	p=0.17		p=0.20	

Evans, et al. J Hum Nutr Diet. 2006;19:191-197

48

Evans, et al. 2006.
BIRMINGHAM CHILDREN'S HOSPITAL

Outcomes: Tolerance

Days 1+2 bowel movements by age

Evans, et al. J Hum Nutr Diet. 2006;19:191-197

49

Evans, et al. 2006.
BIRMINGHAM CHILDREN'S HOSPITAL

Tolerance

- 1) Full strength from day 1
- 2) Gradual introduction in infants <12 weeks old




Safety

Safe in infants with growth failure due to CHD & other causes of growth failure



Evans, et al. J Hum Nutr Diet. 2006;19:191-197
CHD = congenital heart defects

50



Weight improvement with the use of protein and energy enriched nutritional formula in infants with a prolonged PICU stay.
Eveleens R, Dungen D, Verbruggen S, et al. J Hum Nutr Diet, 2019;21(1):3-10.

51

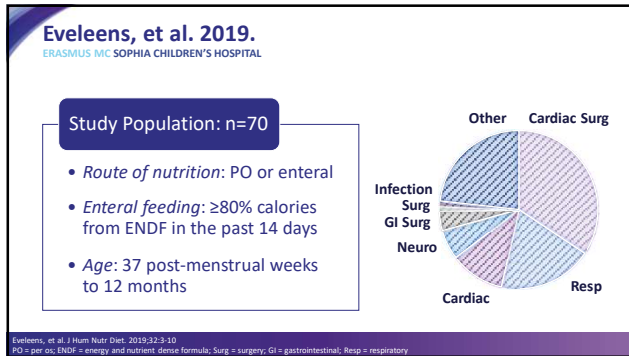
Eveleens, et al. 2019.
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Study design: Retrospective Cohort Study
Duration: 2+ weeks

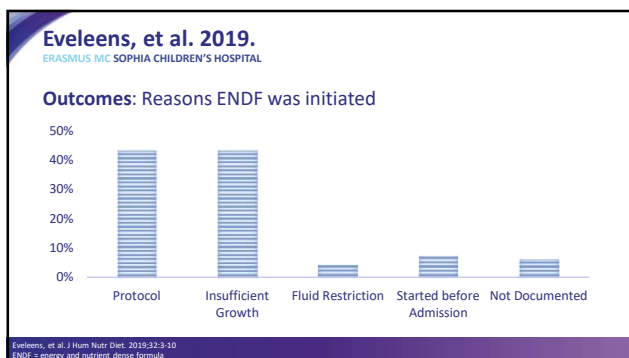
- 1**
Breast Milk
- 2**
Energy and Nutrient Dense Formula
If not available:
- 3**
Standard Infant Formula
Once goal weight achieved:

Eveleens, et al. J Hum Nutr Diet. 2019;32:3-10

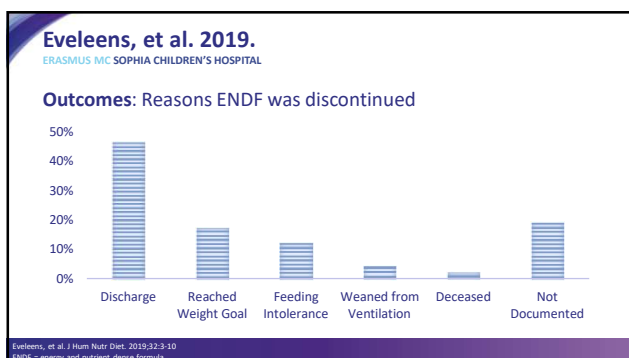
54



55



56



57

Eveleens, et al. 2019.
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Outcomes: Nutritional Intake

Route of Nutrition:

- Post-pyloric: 45 (64%)
- Feeding strategy
 - Continuous: 27 (39%)
 - Bolus: 10 (14%)
 - Both: 33 (47%)

Nutrient Intake:

- Energy: 104.6±19.4 kcal/kg/d
- Protein: 2.72±0.50g/kg/d

Eveleens, et al. J Hum Nutr Diet. 2019;32:3-10

59

Eveleens, et al. 2019.
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Outcomes: Growth

Weight-for-age (WFA) z-scores over time (n = 70)

Eveleens, et al. J Hum Nutr Diet. 2019;32:3-10
ENDF = energy and nutrient dense formula

60

Eveleens, et al. 2019.
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

Outcomes: Tolerance

Eveleens, et al. J Hum Nutr Diet. 2019;32:3-10
GI = gastrointestinal

63

Eveleens, et al. 2019.
ERASMUS MC SOPHIA CHILDREN'S HOSPITAL

The diagram features a central blue icon of a baby in a stroller. Three arrows point from this icon to three separate boxes. The top box is blue and contains a stomach icon, labeled 'Tolerance' with the text 'Well-tolerated by infants in the PICU'. The bottom box is purple and contains a shield icon, labeled 'Safety' with the text 'Safe and well tolerated in critically ill infants'. To the left of the central icon, the word 'Growth' is written above the text 'Supports catch-up growth'.

Growth
Supports catch-up growth

Tolerance
Well-tolerated by infants in the PICU

Safety
Safe and well tolerated in critically ill infants

Eveleens, et al. J Hum Nutr Diet. 2019;32:3-10
PICU = pediatric intensive care unit

64

Case Study
- Baby Girl Christina -

Amy Gelfand, MPH, RDN, LD
Medical Science Liaison

65

Case Study – Baby Girl Christina
ROYAL ALEXANDRA CHILDREN'S HOSPITAL

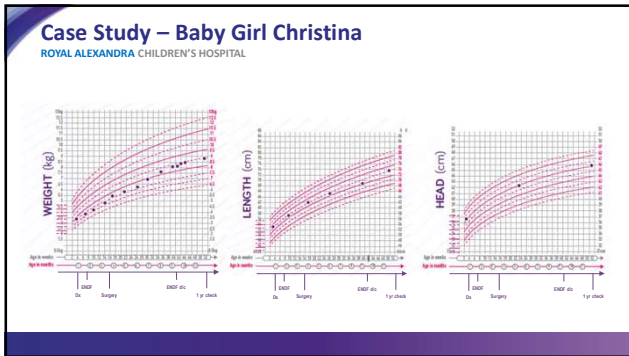
Clinical Features

- Admitted at 4 weeks with viral illness
- Observation: tachypneic
- ECG: confirmed ventricular septal defect (VSD)

Feeding History

- Feeding difficulties: breastfeeding → standard infant formula
- 4 weeks: sporadic, but on average intake was 110mL/kg/d (75kcal/kg/d)
- 7 weeks: unsuccessful achieving target volume (120mL/kg/d), therefore
 - Introduced ENDF
 - NG-tube placed

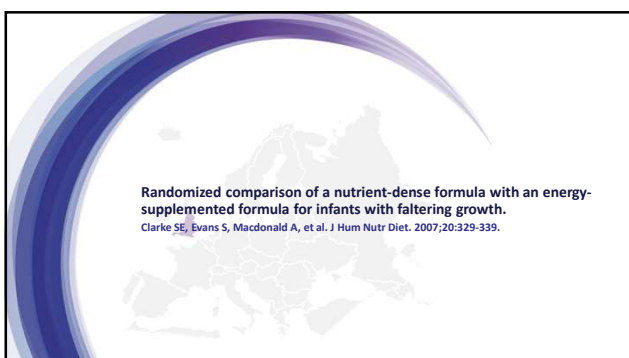
67



68

- Case Study – Baby Girl Christina**
ROYAL ALEXANDRA CHILDREN'S HOSPITAL
- 1 ENDF was well-tolerated
 - 2 Weight gain pattern improved while on ENDF
 - 3 Growth patterns successfully maintained after ENDF was discontinued

69



70

Clarke, et al. 2007.
BIRMINGHAM CHILDREN'S HOSPITAL

Study design: randomized controlled trial, open-label
Duration: 6-weeks

Intervention (n=26)	<ul style="list-style-type: none"> • Energy and nutrient dense formula (ENDF) • 1kcal/mL • 2.6g protein/100kcal [10.4% PE]
Control (n=23)	<ul style="list-style-type: none"> • Energy supplemented formula (ESF) • 1kcal/mL • 1.4g protein/100kcal [5.5% PE]

Initiation: step-wise over 4 days | Target kcal intake: 150-200kcal/kg/d

Clarke, et al. J Hum Nutr Diet. 2007;20:329-339

72

Clarke, et al. 2007.
BIRMINGHAM CHILDREN'S HOSPITAL

Study Population: n=49

- Route of nutrition: PO or enteral
- Age: < 12 months
- Diagnosis: failure to thrive

Clarke, et al. J Hum Nutr Diet. 2007;20:329-339
PO = per os; CHD = congenital heart defect; GI = gastrointestinal; CF = cystic fibrosis

73

Clarke, et al. 2007.
BIRMINGHAM CHILDREN'S HOSPITAL

Outcomes: Nutrient Intake

	Daily Volume
ENDF	140mL/d
ESF	143mL/d

ENDF vs. ESF

Clarke, et al. J Hum Nutr Diet. 2007;20:329-339
ENDF = energy and nutrient dense formula; ESF = energy supplemented formula

74

Clarke, et al. 2007.
BIRMINGHAM CHILDREN'S HOSPITAL

Outcomes: Growth

	Within ENDF group (n=26)	Within ESF group (n=23)	Between groups
Weight-for-age z-score	0.29 p=0.007	0.49 p=0.006	p=0.26
Length-for-age z-score	-0.18 p=0.42	-0.28 p=0.01	p=0.30

Clarke, et al. J Hum Nutr Diet. 2007;20:329-339
ENDF = energy and nutrient dense formula, ESF = energy supplemented formula

75

Clarke, et al. 2007.
BIRMINGHAM CHILDREN'S HOSPITAL

Outcomes: Nutritional Status

- ENDF: BUN stayed within normal limits for all in group
- ESF: 50% decrease in BUN concentration

Clarke, et al. J Hum Nutr Diet. 2007;20:329-339
ENDF = energy and nutrient dense formula, ESF = energy supplemented formula, BUN = blood urea nitrogen

76

Clarke, et al. 2007.
BIRMINGHAM CHILDREN'S HOSPITAL

Outcomes: Tolerance

	ENDF (n=26)	ESF (n=23)	P-value
Stools per day	2.5 (0.7-4.5)	2.5 (1.0-4.8)	NS
Emesis per day	0.33 (0-1.8)	0.30 (0-5)	NS

Clarke, et al. J Hum Nutr Diet. 2007;20:329-339
ENDF = energy and nutrient dense formula, ESF = energy supplemented formula

77

Clarke, et al. 2007.
BIRMINGHAM CHILDREN'S HOSPITAL

Growth
Supports catch-up growth

Nutritional Status
Improved calorie & protein intake

Tolerance
Equivalent tolerance to current practice of ESF

Safety
Safe in infants with growth failure due to CHD & other causes of growth failure

Clarke, et al. J Hum Nutr Diet. 2007;20:329-339
ESF = energy supplemented formula, CHD = congenital heart defects

78

Poll Question
RESPOND IN THE RIGHT-HAND PANEL IN THE LIVE EVENT – CLICK ‘SUBMIT’ WHEN DONE

What is your typical approach to advance to high-energy feedings? (*high energy = >20 kcal/fl oz*)

- A. No transition – straight to goal
- B. 1 to 2 days to transition
- C. 2 to 3 days to transition
- D. 3+ days to transition

79

Energy- and protein enriched formula improves weight gain in infants with malnutrition due to cardiac and noncardiac etiologies.
Goday PS, Lewis JD, Sang CJ, et al. JPEN J Parenteral Enteral Nutr. 2021;1-13.

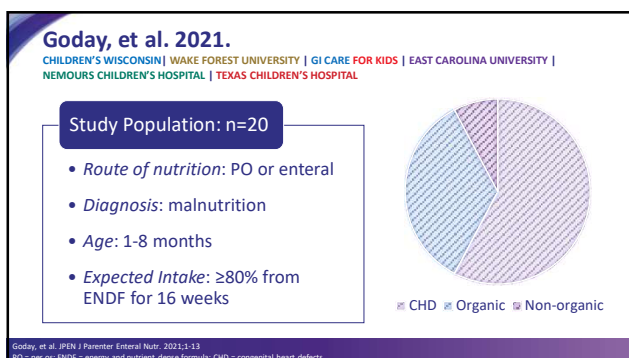
80



81



82



83

Goday, et al. 2021.
CHILDREN'S WISCONSIN | WAKE FOREST UNIVERSITY | GI CARE FOR KIDS | EAST CAROLINA UNIVERSITY | NEMOURS CHILDREN'S HOSPITAL | TEXAS CHILDREN'S HOSPITAL

Outcomes: Nutrient Intake

	kcal/kg/d
Total energy intake	123±32
ENDF intake	116±32

94%

Goday, et al. JPEN | Parenter Enteral Nutr. 2021;1-13

85

Goday, et al. 2021.
CHILDREN'S WISCONSIN | WAKE FOREST UNIVERSITY | GI CARE FOR KIDS | EAST CAROLINA UNIVERSITY | NEMOURS CHILDREN'S HOSPITAL | TEXAS CHILDREN'S HOSPITAL

Outcomes: Growth

Weight-for-Age	Length-for-Age	Weight-for-Length	Head Circumference
+0.86 ± 0.74 mean WAZ from baseline (p=0.0001)	+0.25 ± 0.61 mean LAZ from baseline (p=0.003)	+0.77 ± 0.81 mean WLZ from baseline (p=0.0001)	+0.54 ± 0.68 mean HCZ from baseline (p=0.001)

Goday, et al. JPEN | Parenter Enteral Nutr. 2021;1-13
WAZ = weight-for-age z-score; LAZ = length-for-age z-score; WLZ = weight-for-length z-score; HCZ = head circumference z-score

86

Goday, et al. 2021.
CHILDREN'S WISCONSIN | WAKE FOREST UNIVERSITY | GI CARE FOR KIDS | EAST CAROLINA UNIVERSITY | NEMOURS CHILDREN'S HOSPITAL | TEXAS CHILDREN'S HOSPITAL

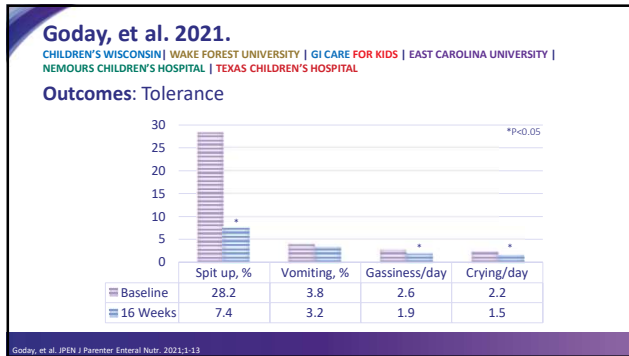
Outcomes: Growth

Percentage of infants who achieved weight gain velocity > WHO median:

Stage	Percentage
≥1 time point	87%
Overall study period	63%
“Early Success”	13%

Goday, et al. JPEN | Parenter Enteral Nutr. 2021;1-13
WHO = World Health Organization

87



88



89

Poll Question
RESPOND IN THE RIGHT-HAND PANEL IN THE LIVE EVENT – CLICK 'SUBMIT' WHEN DONE

Which finding from the US-based GROW-IN clinical trial is most relevant to your practice?

- A. WELL TOLERATED in infants with poor growth
- B. SUPPORTS GROWTH: ENDF supported improvement in 4 anthropometric z-scores
- C. SUPPORTS NUTRIENT INTAKE: helped meet target energy intakes
- D. SAFE: Safe in infants with growth failure due to CHD & other causes

90

Summary of Evidence

	Well-tolerated	Higher nutrient intake	Helps meet goals sooner	Support weight gain	Supports anabolism	Studied in CHD
van Waardenburg 2009 de Betue 2011 de Betue 2013	●	●	●		●	
Cui 2018	●	●	●		●	●
Evans 2006	●					
Eveleens 2019	●			●		●
Scheeffe 2020	●			●		●
Clarke 2007	●	●		●		●
Goday 2022	●	●		●		●

91

Application based on the Evidence

	Initiation	Advancement	Target	
			Volume	Calories
van Waardenburg 2009 de Betue 2011 de Betue 2013	25% target	25% target q12h	130mL/kg/24h	-
Cui 2018	1mL/kg/h	1mL/kg/h q6h	130mL/kg/24h	-
Evans 2006	Full strength	-	-	-
		Day 2: 27kcal/oz Day 3: 30kcal/oz	-	-
Eveleens 2019	-	-	-	Twice REE
Scheeffe 2020	-	-	-	120-150kcal/kg/d
Clarke 2007	Stepwise over 4 days		-	150-200kcal/kg/d
Goday 2022	Set by site PI, and based on individual needs (age, medical condition)			

92

Guidelines to Successfully Introduce ENDF

Infants <12 weeks of age:

- Administer full strength formula & alternate with current feed, OR
- Dilute to 24kcal/oz and titrate to full strength over 3 days to avoid frequent stools

Infants >12 weeks to 18 months

- Full strength and full transition from day 1
- Alternate breast milk/feeding and ENDF feeding

93

Summary

Clinical research has shown that:

- 1** ENDF provides optimal energy, protein, and micronutrients to support lean tissue gain for catch-up growth and support increased protein needs during critical illness.
- 2** ENDF has equivalent tolerability to standard (20kcal/oz), and energy supplemented (30kcal/oz) infant formula.
- 3** ENDF promotes catch-up growth in disease and non-disease related growth failure.

94

References

- Mehta NM, Corkins MR, Lyman B, et al. Defining pediatric malnutrition: a paradigm shift toward etiology-related definitions. JPEN J Parenter Enteral Nutr. 2013;37(4):460-481.
- Carvalho-Salemi J, Salemi JL, Wong-Vega MR, et al. Malnutrition among hospitalized children in the United States: changing prevalence, clinical correlates, and practice patterns between 2002 and 2011. J Acad Nutr Diet. 2018;118(1):40-51.
- Homan GJ. Failure to thrive: a practical guide. Am Fam Physician. 2016;94(4):295-299.
- Guo SM, Roche AF, Fomon SJ, et al. Reference data on gains in weight and length during the first two years of life. J Pediatr. 1991;119(3):355-362.
- Becker P, Carney LN, Corkins MR, et al. Consensus statement of the Academy of Nutrition and Dietetics/American Society of Parenteral and Enteral Nutrition: indicators recommended for the identification and documentation of pediatric malnutrition (undernutrition). Nutr Clin Pract. 2015;30(1):147-161.
- Daymont C, Hoffman N, Schaefer EW, et al. Clinician diagnoses of failure to thrive before and after switch to World Health Organization growth curves. Acad Pediatr. 2020;20(3):405-412.
- Joint WHO/FAO/UNU Expert Consultation. Protein and amino acid requirements in human nutrition. World Health Organ Tech Rep Ser. 2007;935:1-265.
- Simental S. J Pediatr Gastroenterol Nutr. 2020;71:S453.
- van Waardenburg DA, de Betue CT, Goudoever JB, et al. Critically ill infants benefit from early administration of protein and energy-enriched formula: a randomized controlled trial. Clin Nutr. 2009;28(3):249-255.
- de Betue CT, van Waardenburg DA, Deutz NE, et al. Increased protein-energy intake promotes anabolism in critically ill infants with viral bronchiolitis: a double-blind randomized controlled trial. Arch Dis Child. 2011;96(9):817-822.
- de Betue CT, Joosten KF, Deutz NE, et al. Arginine appearance and nitric oxide synthesis in critically ill infants can be increased with a protein-energy-enriched enteral formula. Am J Clin Nutr. 2013;98(4):907-916.
- Furst P. Basics in clinical nutrition: proteins and amino acids. E-SPEN, the European e-Journal of Clinical Nutrition and Metabolism. 2009;2(4):e62-e65.
- Hoffer LJ. Human protein and amino acid requirements. JPEN J Parenter Enteral Nutr. 2016;40(4):460-474.
- Averous, et al. (2016). The molecular nutrition of amino acids and protein (pp.289-303). Academic Press.
- Wilkinson DJ, Brook MS, Smith K. Principles of stable isotope research – with special reference to protein metabolism. Clin Nutr Open Sci. 2021;36:111-125.
- Cui Y, Li L, Hu C, et al. Effects and tolerance of protein and energy-enriched formula in infants following congenital heart surgery: a randomized controlled trial. JPEN J Parenter Enteral Nutr. 2018;42(1):196-204.
- Evans S, Twaiisi H, Daly A, et al. Should high-energy infant formula be given at full strength from its first day of usage? J Hum Nutr Diet. 2006;19(3):191-197.
- Eveleens RD, Dungen DK, Verbruggen SCAT, et al. Weight improvement with the use of protein and energy enriched nutritional formula in infants with a prolonged PICU stay. J Hum Nutr Diet. 2019;32(1):3-10.
- Scheeffler VA, Ricachinevsky CP, Freitas AT, et al. Tolerability and effects of the use of energy enriched infant formula after congenital heart surgery: a randomized controlled trial. JPEN J Parenter Enteral Nutr. 2020;44(2):348-354.
- Clarke SE, Evans S, Macdonald A, et al. Randomized comparison of a nutrient-dense formula with an energy-supplemented formula for infants with faltering growth. J Hum Nutr Diet. 2007;20(4):329-339.
- Goday PS, Lewis JD, Sang CJ, et al. Energy- and protein-enriched formula improves weight gain in infants with malnutrition due to cardiac and noncardiac etiologies. JPEN J Parenter Enteral Nutr. 2021:1-13.

Type your questions in the Q&A panel
Make sure you select 'All Panelists'

1. Please provide feedback through the survey - 3 ways to access:

Aim your smartphone camera at this → QR code	OR access the survey at: bit.ly/surv_JL2	OR after live event: survey in post-event email and pops up when you exit
--	---	--

To receive your certificate of attendance:

- 2.** Find the **event code** at end of survey
- 3.** Visit www.NutriciaLearningCenter.com
Enter **event code** into your NLC Dashboard
Certificate of Attendance added to your NLC profile!

Nutricia Learning Center is provided by Nutricia North America
For questions on this webinar or Nutricia's products, please email: NutritionServices@nutricia.com or call: 1-800-365-7354

