Prematurity:
Optimizing Growth in the NICU for Later Metabolic Outcomes

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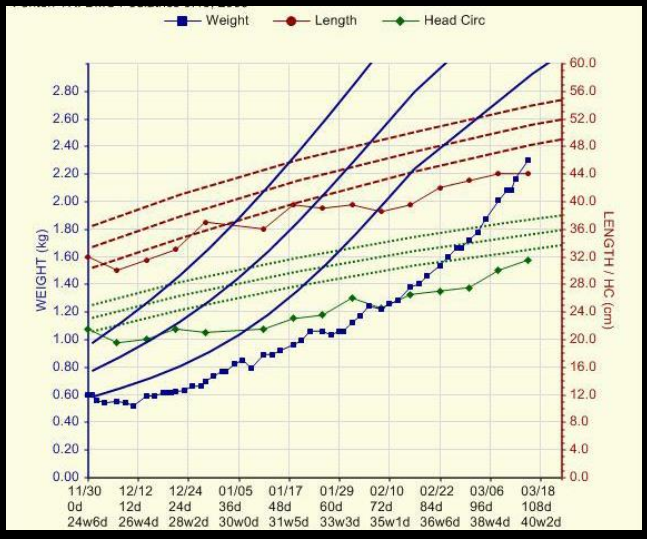
Disclosures

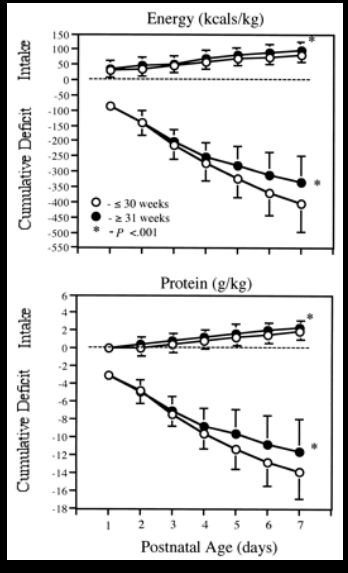
There are no financial relationships to disclose.

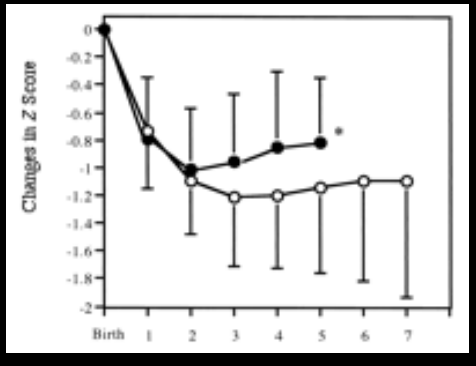
NICU Nutrition: Goal

To achieve postnatal growth velocity that mimics intrauterine growth rates (AAP)



Prematurity/Catch-up growth





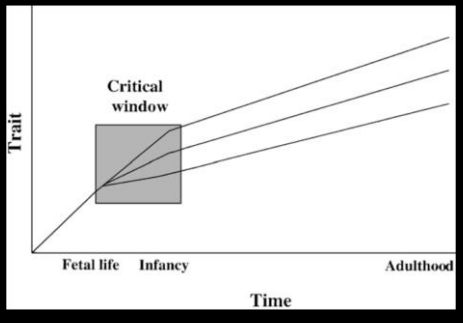
Embleton et al. 2001

Postnatal Growth → Neurocognitive Outcomes

Better NICU weight gain in preterm infants →

- Higher MDI/PDI developmental scores at 18M
- Lower rates of CP
- Lower rates of neurodevelopmental impairment
- Higher developmental scores at 5yr

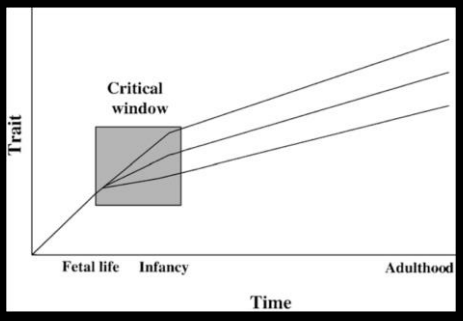
SGA → Metabolic Outcomes: Barker's Hypothesis



LBW →

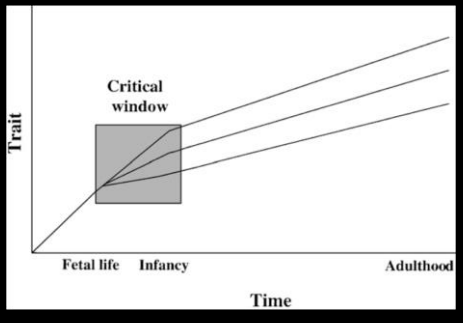
- Higher rates of obesity
- Insulin resistance/DM2
- HTN
- High TG/low HDL

SGA → Metabolic Outcomes: Barker's Hypothesis



Rapid 'catch-up' growth → increased adiposity; linked with adult obesity

Prematurity → Metabolic Outcomes



Prematurity →

- Higher visceral adiposity
- Decreased insulin sensitivity
- Higher blood pressure

?? related to rapid catch-up growth

Prematurity/SGA → Metabolic Outcomes: Summary

- SGA → early signs of metabolic syndrome
- SGA/rapid catch-up growth → early signs of metabolic syndrome
- Prematurity → early signs of metabolic syndrome, ?? related to catch-up growth

Prematurity = nutrient-restricted fetus

Preterm babies: ??high IUGR rates

NICU nutrition inadequate?

[fetal/NICU environmental stressors]

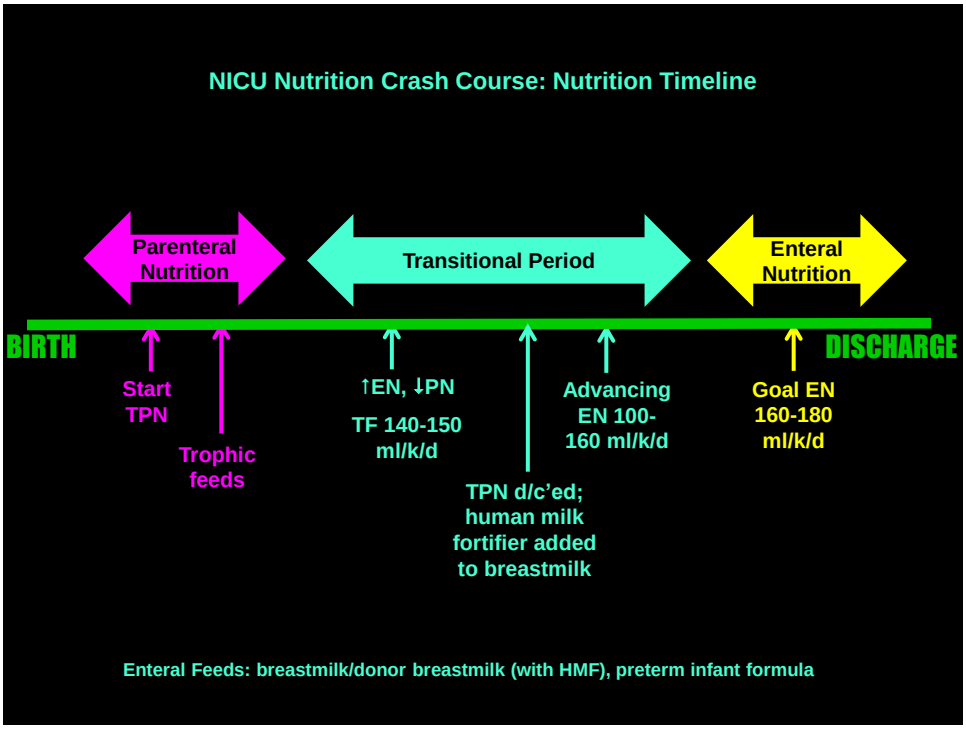
Catch-Up Growth:
Neurocognitive Development vs. Metabolic Syndrome?

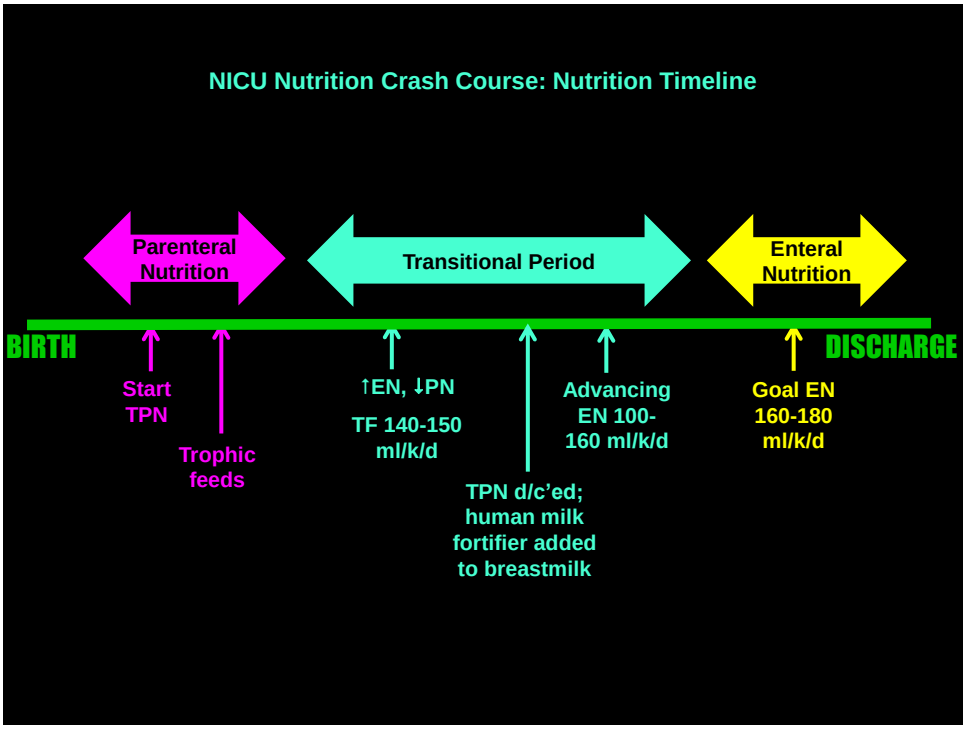
I'm a NICU Nutritionist.

What's the Bottom Line?

Nutritional Management in NICU

- NICU Nutrition: Crash Course
- Nutritional strategies: Then vs. Now
- Optimizing Kcal vs. Protein; protein-energy ratios
- Our NICU research


NICU Nutrition Crash Course: Nutrition Timeline
Parenteral Nutrition
Transitional Period
Enteral Nutrition
BIRTH
DISCHARGE
Start TPN
Trophic feeds
↑EN, ↓PN
TF 140-150 ml/k/d
Advancing EN 100-160 ml/k/d
Goal EN 160-180 ml/k/d
TPN d/c'ed; human milk fortifier added to breastmilk
Enteral Feeds: breastmilk/donor breastmilk (with HMF), preterm infant formula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TPN d/c'ed; human milk fortifier added to breastmilk

GOAL:

Optimize Nutrition at each step to:

(1) MAINTAIN TARGETED NUTRIENT INTAKES →
MAINTAIN TARGETED GROWTH RATES

(2) AVOID NEED FOR CATCH-UP GROWTH

NICU Nutrition Timeline: Old vs. New Trends

Old Guidelines:

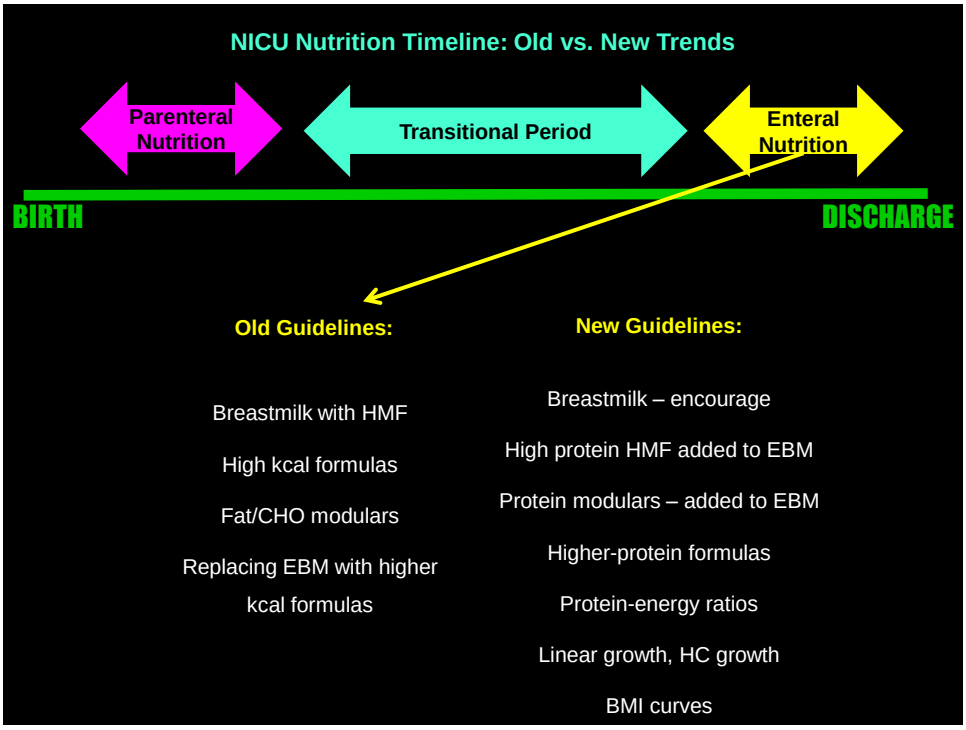
Metabolic immaturity →
Slow dextrose, IL advancement

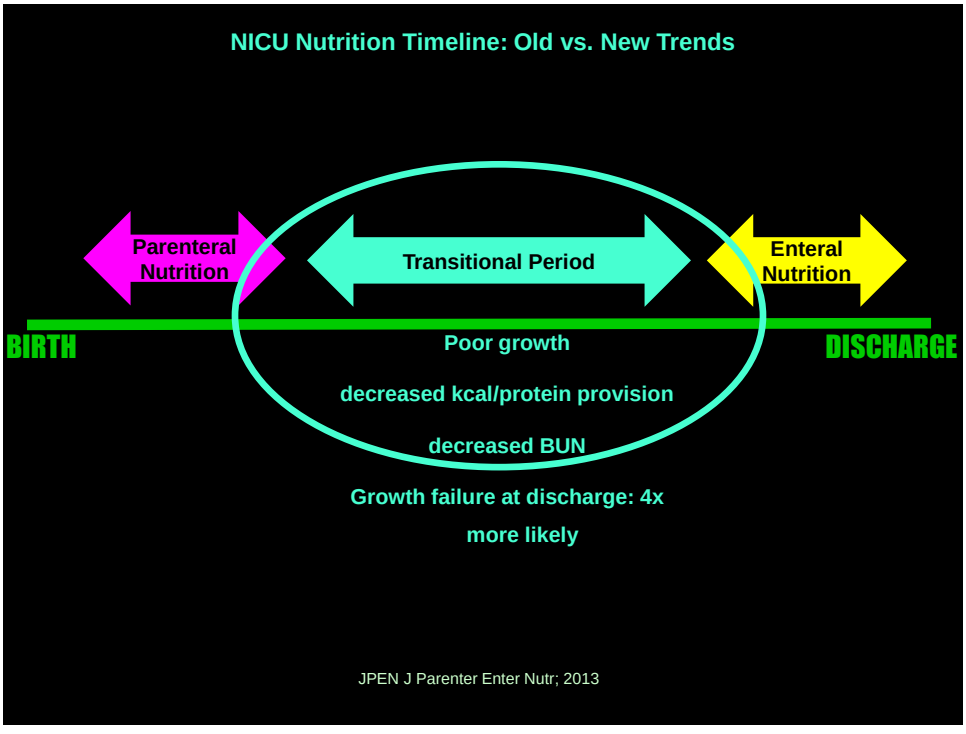
Lower protein – renal function??

New Guidelines:

more aggressive nutrient provision

"Starter TPN" – higher protein, promotes anabolism


NICU Nutrition Timeline: Old vs. New Trends
Parenteral Nutrition
Transitional Period
Enteral Nutrition
BIRTH
DISCHARGE
Old Guidelines:
Breastmilk with HMF
High kcal formulas
Fat/CHO modulars
Replacing EBM with higher kcal formulas
New Guidelines:
Breastmilk – encourage
High protein HMF added to EBM
Protein modulars – added to EBM
Higher-protein formulas
Protein-energy ratios
Linear growth, HC growth
BMI curves


NICU Nutrition Timeline: Old vs. New Trends
Parenteral Nutrition
Transitional Period
Enteral Nutrition
BIRTH
DISCHARGE
Poor growth
decreased kcal/protein provision
decreased BUN
Growth failure at discharge: 4x more likely
JPEN J Parenter Enter Nutr; 2013

NICU Nutrition Timeline: Old vs. New Trends

	Old Guidelines
How to write PN order?	TF 140 as if infant NPO; run PN at lower rate to maintain TF 140
What to do if feeds held?	Return TPN to NPO rate (TF140)
Preferred feeds?	Unfortified EBM; HMF added at EN 100-120 ml/kg

Nutritional Guidelines during Transition

	Old Guidelines	Revised Guidelines
How to write PN order?	TF 140 as if infant NPO; run PN at lower rate to maintain TF 140	Concentrate PN kcal/AA in 100ml/kg; run at adjusted rate to maintain TF 140
What to do if feeds held?	Return TPN to NPO rate (TF140)	Run TPN at 100ml/kg; piggyback additional D5% to maintain TF140 until new PN compounded.
Preferred feeds?	Unfortified EBM; HMF added at EN 100-120 ml/kg	Unfortified EBM; HMF added at EN 100-120 ml/kg

Demographic/Clinical Factors	Group 1 – Study Group (n=63) n (%)	Group 2 - Controls (n=153) n (%)	*p-value*
Ethnicity			NS
Males	43 (68)	79 (52)	0.025
Gestational age (week ± SD)	29± 2.03	28.8±2.1	0.462
BW (grams ± SD)	1331±339.8	1273±342.6	0.256
Postnatal steroids	2 (3.2)	4 (2.6)	0.82
IVH ≥ Stage 3	0 (0)	8 (5.2)	0.064
BPD	5 (7.9)	11 (7.2)	0.859
Sepsis	4 (6.3)	29 (18.9)	0.019
NEC ≥ stage 2	2 (3.2)	10 (6.5)	0.327
Respiratory support on DOL 1:			
mechanical ventilation	14 (22.2)	42 (27.5)	0.425
CPAP	45 (71.4)	100 (65.3)	0.388
room Air	5 (8.1)	11 (7.2)	0.825

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z-score at birth ± SD	-0.16 ± 0.59	-0.29 + 0.52	0.117
z-score at DOL 7 ± SD	-0.97 ± 0.48	-1.03 ± 0.46	0.401
z-score at start of transition ± SD	-1.02 ± 0.52	-1.1 ± 0.47	0.254
z-score at end of transition ± SD	-1.1 ± 0.55	-1.3 ± 0.52	0.0078
z-score at CGA 35 wk ± SD	-1.2 ± 0.73	-1.5 ± 0.65	0.0036

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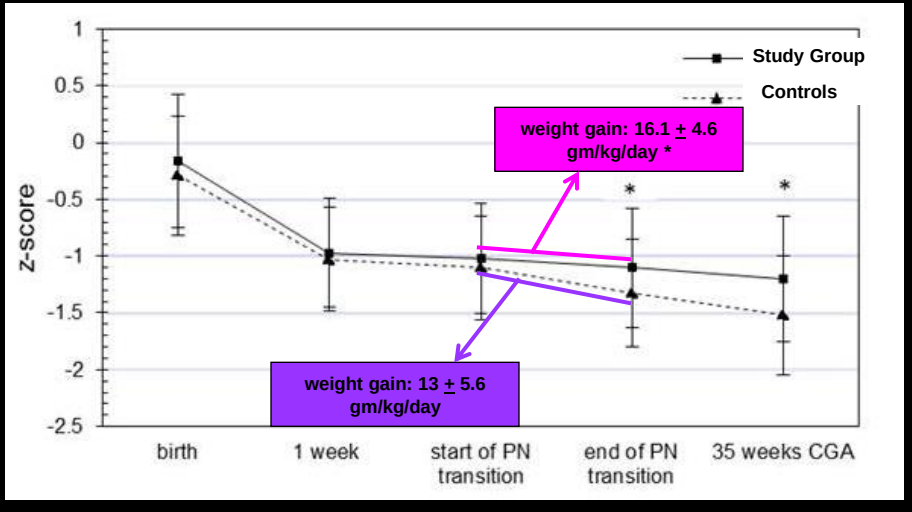
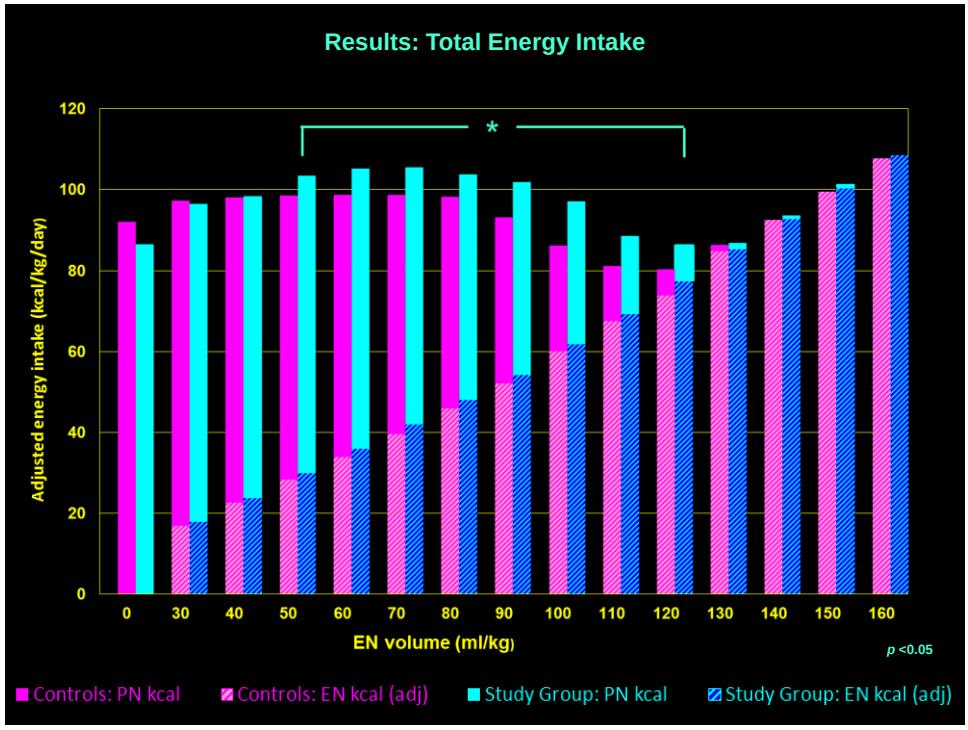
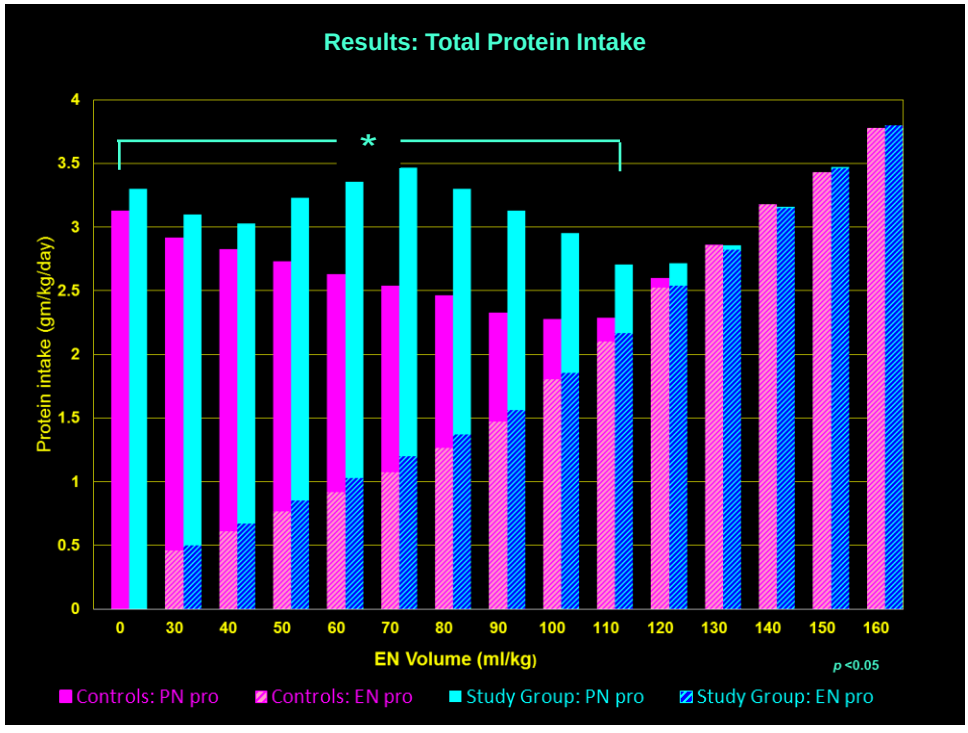
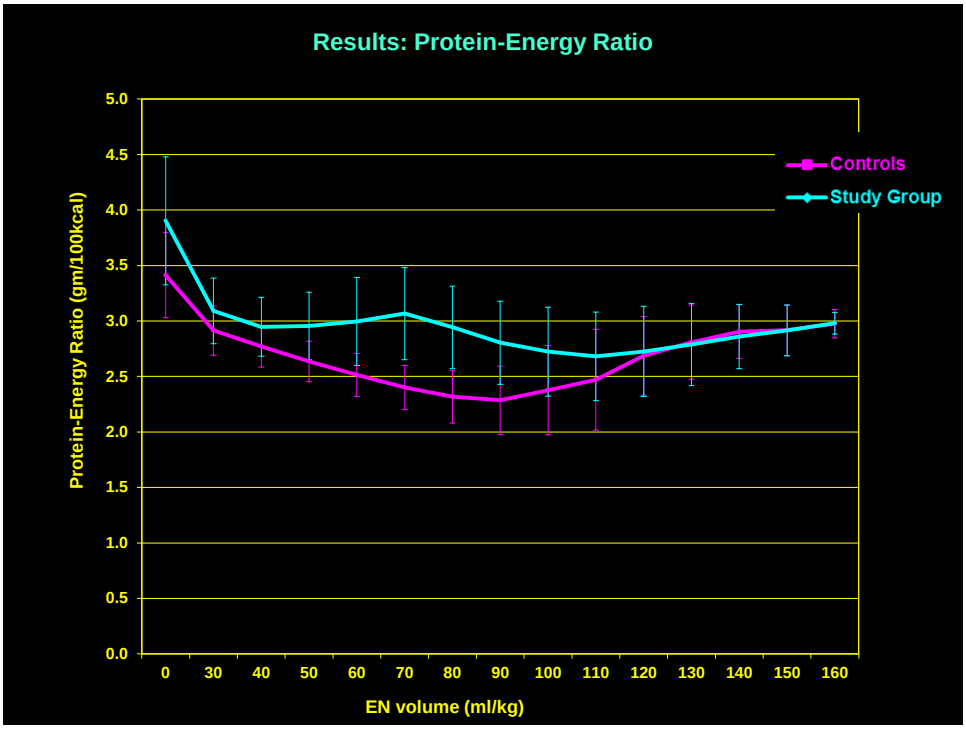
Results: Trends in z-score

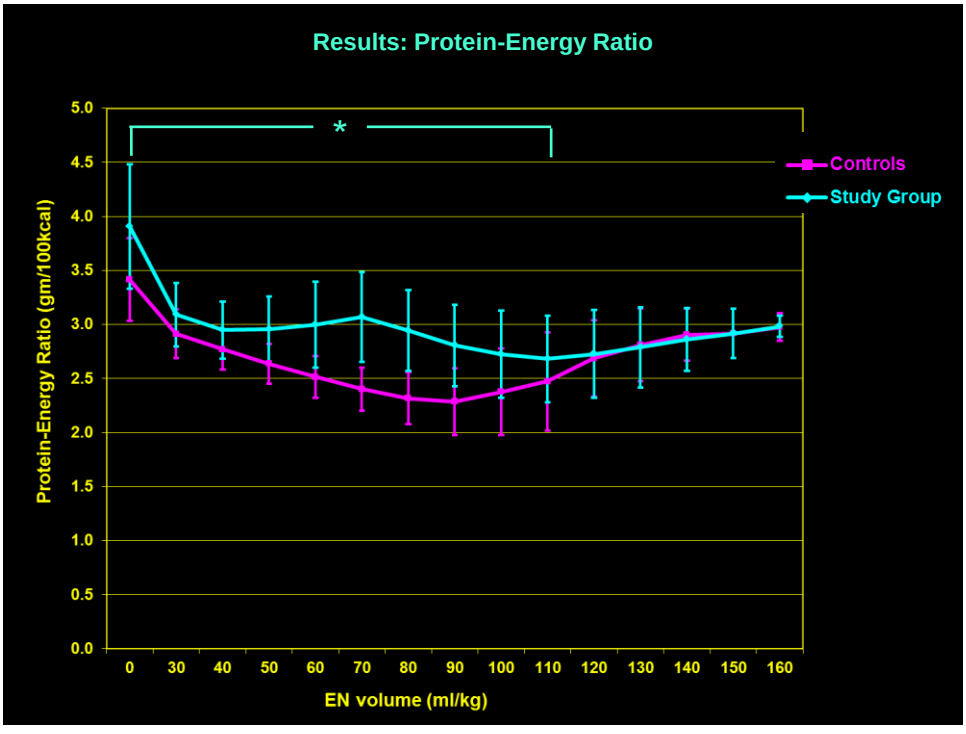


*p<0.01


Results: Total Energy Intake
Adjusted energy intake (kcal/kg/day)
120
100
80
60
40
20
0
*
0 30 40 50 60 70 80 90 100 110 120 130 140 150 160
EN volume (ml/kg)
p <0.05
Controls: PN kcal
Controls: EN kcal (adj)
Study Group: PN kcal
Study Group: EN kcal (adj)


Results: Total Protein Intake
Protein intake (gm/kg/day)
4
3.5
3
2.5
2
1.5
1
0.5
0
*
0 30 40 50 60 70 80 90 100 110 120 130 140 150 160
EN Volume (ml/kg)
p <0.05
Controls: PN pro
Controls: EN pro
Study Group: PN pro
Study Group: EN pro


Results: Protein-Energy Ratio
Protein-Energy Ratio (gm/100kcal)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
30
40
50
60
70
80
90
100
110
120
130
140
150
160
EN volume (ml/kg)
Controls
Study Group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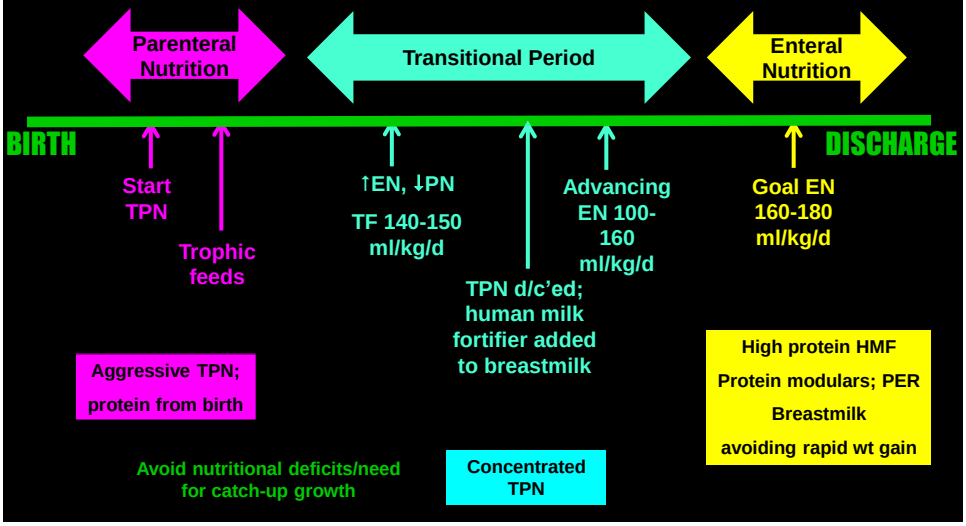
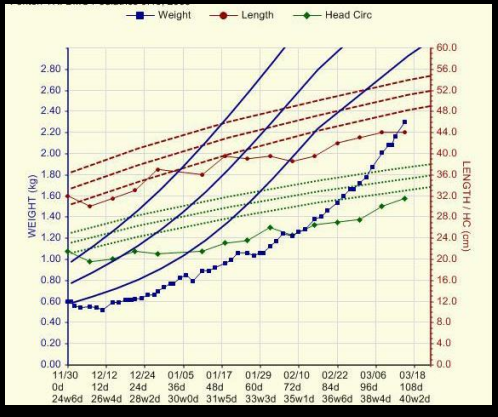
*
Protein-Energy Ratio (gm/100kcal)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
30
40
50
60
70
80
90
100
110
120
130
140
150
160
EN volume (ml/kg)
Controls
Study Group

NICU Nutrition: Summary of Newer Trends



NICU Nutrition Growth Goals: Old vs. New Trends



Old Guidelines:

Get them to 10th percentile!!

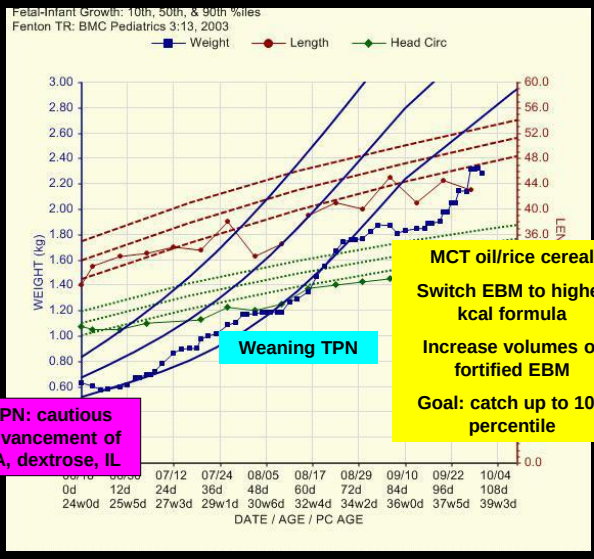
New Guidelines:

Maintain their growth curve

Prevent 'nutrition lags' at each step of nutrition timeline

Avoid rapid catch-up growth

Case Study



TPN: cautious advancement of AA, dextrose, IL

Weaning TPN

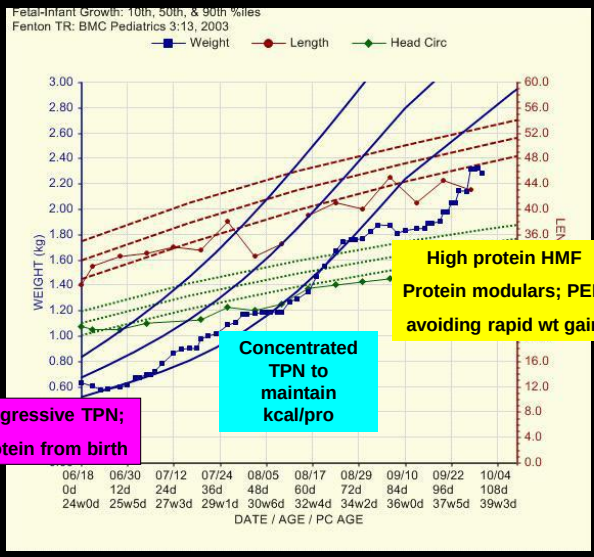
MCT oil/rice cereal

Switch EBM to higher kcal formula

Increase volumes of fortified EBM

Goal: catch up to 10th percentile

Case Study



Aggressive TPN; protein from birth

Concentrated TPN to maintain kcal/pro

High protein HMF

Protein modulars; PER avoiding rapid wt gain

Questions?