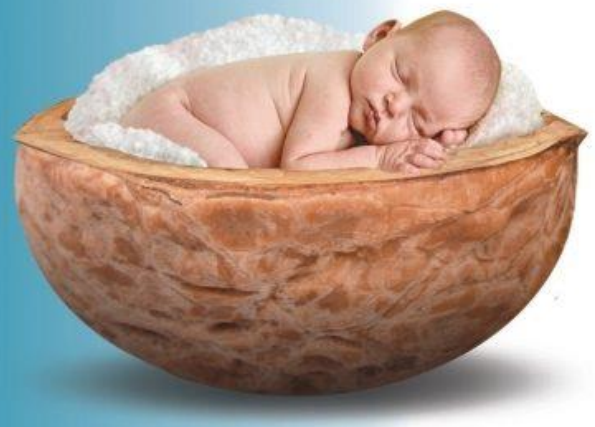
NEONATUS
2018

Międzynarodowa Konferencja
Naukowo-Szkoleniowa
27-28 września 2018



HOW TO DO EARLY NUTRITION in VLBW INFANTS

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NUTRITIONAL CHALLENGES in EARLY NUTRITION

Strategies to Prevent Postnatal Growth Failure

- Early Total Parenteral Nutrition
- Gut Priming and Early Advancement of Enteral Feeding
- Transition from TPN to Enteral Feedings

TPN

Limit Catabolism

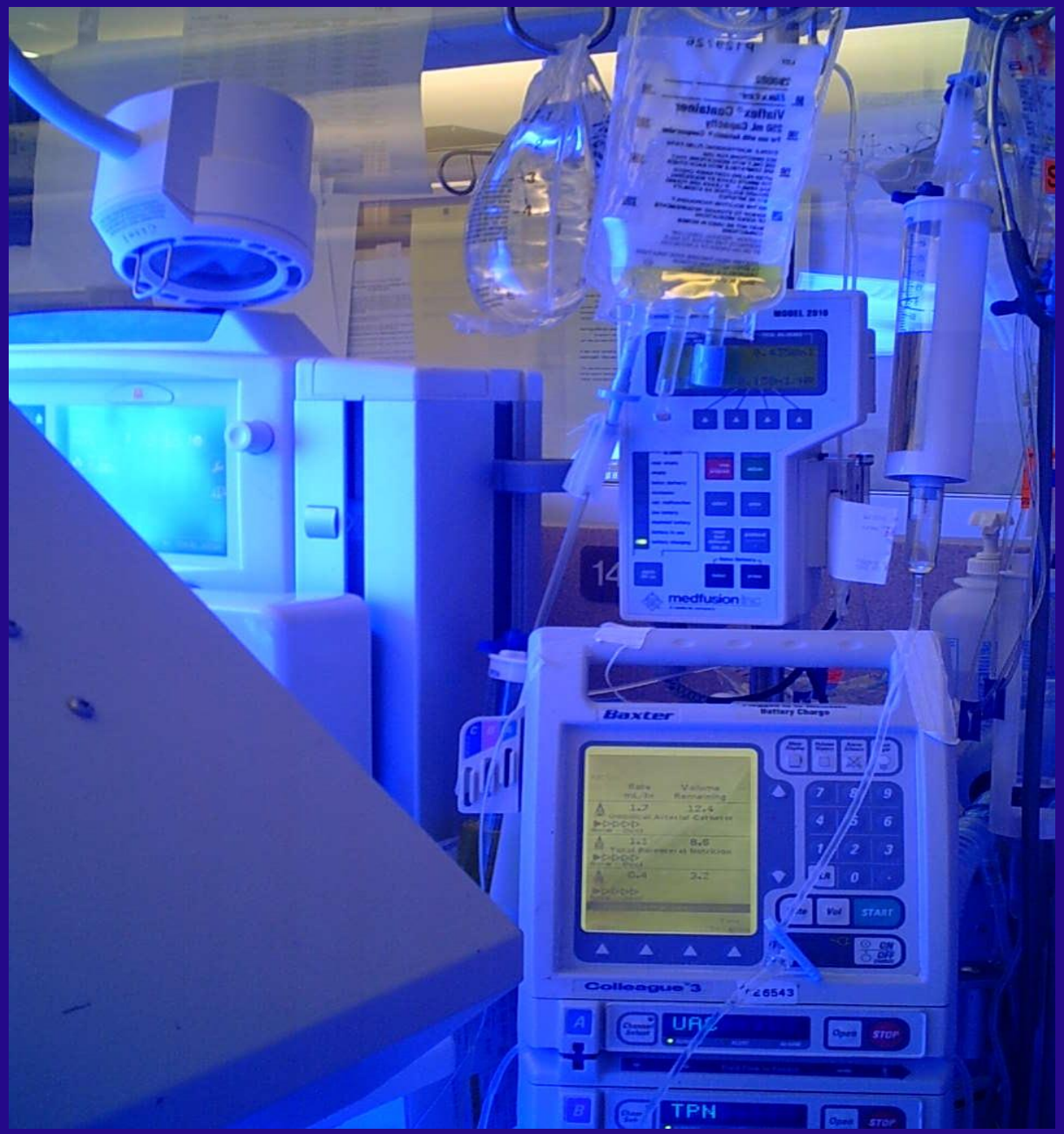
Accrete LBM

Prevent PGF

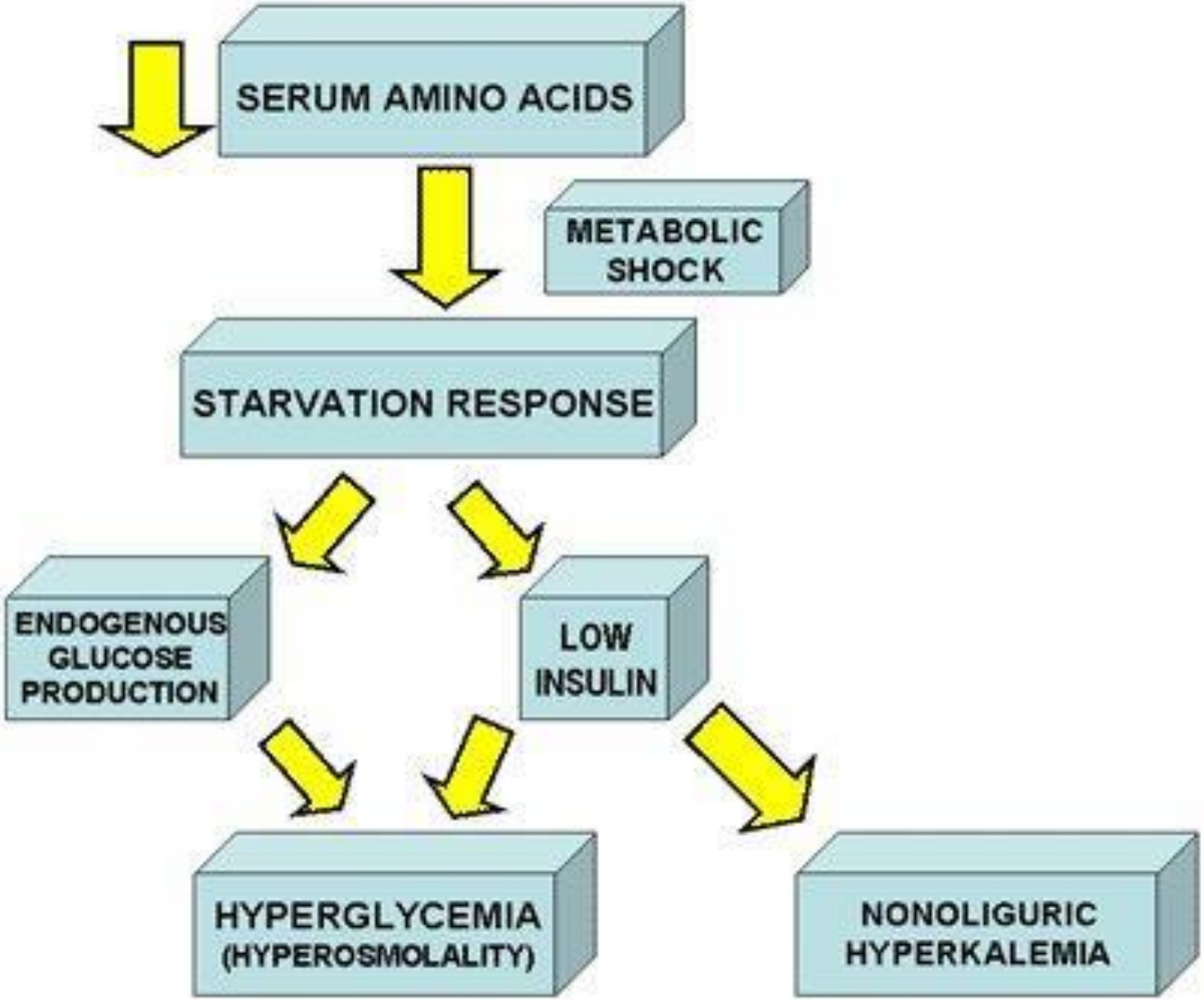
Decrease Morbidities (Gluc/K)

Optimize Neurodevt

Synergy with early enteral and in Transition to Human Milk



METABOLIC EMERGENCY



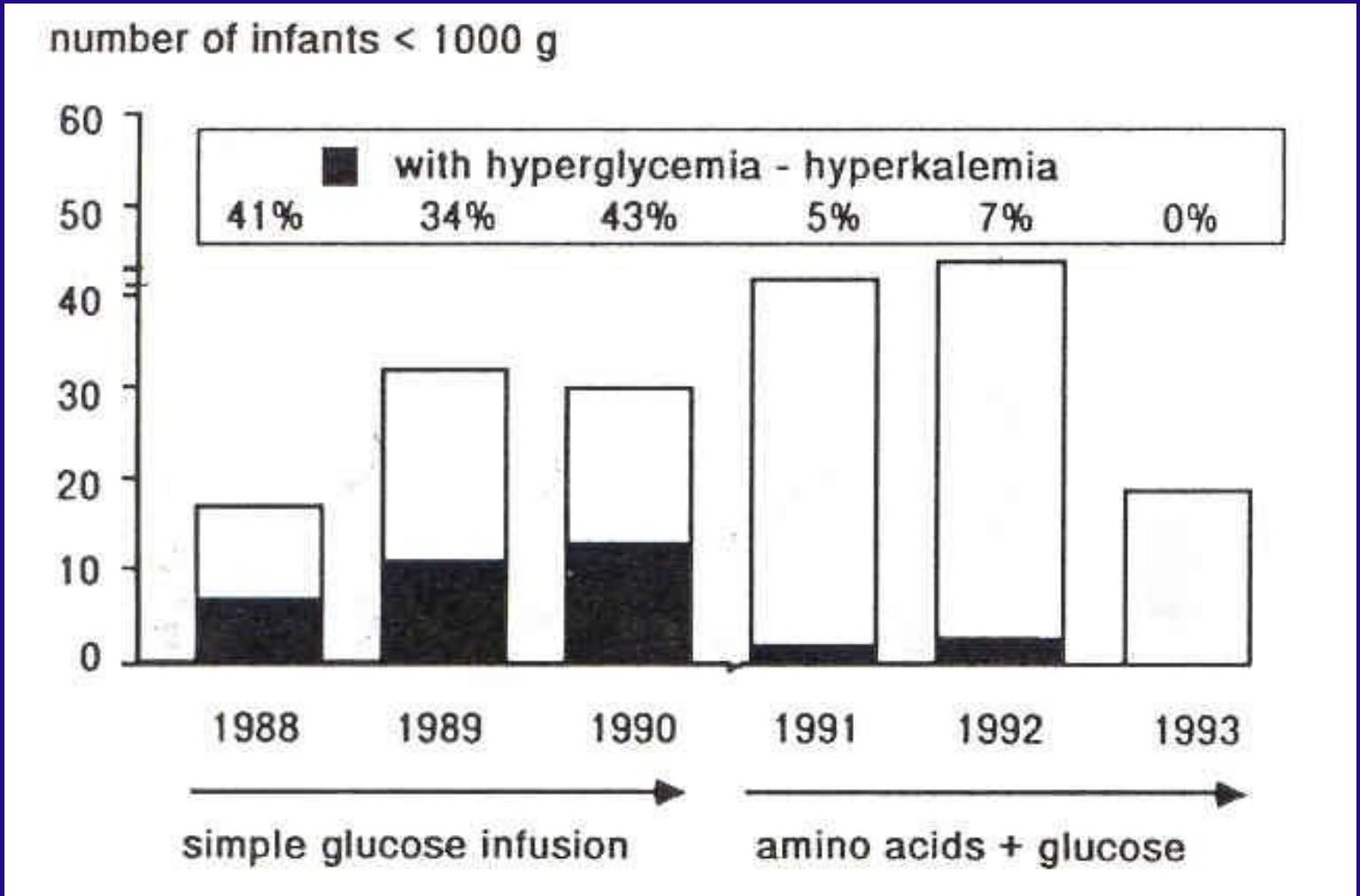
Louisville Early TPN Experience
TPN-related data ELBW

	2000-01	2002-04	2006-07	p
Age @ TPNi	**22.4±22.3**	**9.5±12.2**	**4.6±6.3**	**<0.001**
Days TPN	25.8±12.4	31.5±26.9	25.2±21.3	NS
Total intake* (cc/k/d)	141.5±32.6	150.1±31.3	129.3±31.3	0.018
Total kcal/k/d*	41.4±10.2	45.5±9.7	56.5±13.4	<0.001
Total Protein* g/k/d	1.2±0.4 1	1.8±0.6 2	3.0±0.7 3	<0.001
Insulin	8.6%	3.2%	5.0%	NS
Age @ nadir	**4.9±3.4**	**4.4±6.2**	**2.9±3.2**	**0.044**
% wt change	**-14.0±7.7**	**-10.6±6.2**	**-8.8±5.9**	**0.001**
RTBW	13.9±6.3	10.7±5.7	8.3±5.0	<0.001
$EUGR_W$ @ d/c	**57.1%**	**34.7%**	**25.0%**	**0.004**
$EUGR_{HC}$ @ d/c	10.0%	6.1%	10.0%	NS

*first five days (average)

Radmacher P and Adamkin DH J of Peri 2009

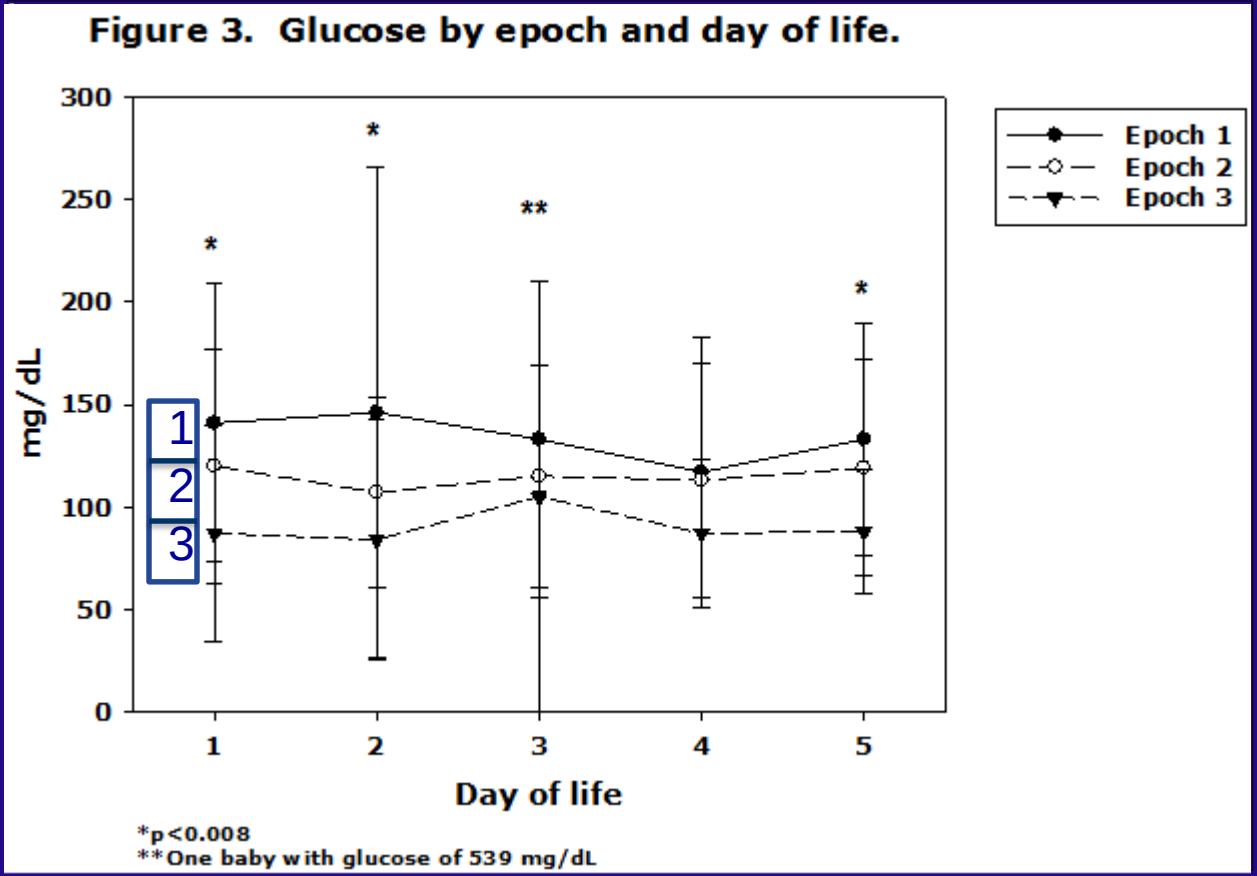
ELBW INFANTS WITH HYPERGLYCEMIA-HYPERKALEMIA IN THE FIRST WEEK OF LIFE



Micheli et al. Sem Neo Nutr/Met, 1994.

Louisville TPN Experience
Glucose by epoch and day of life

Improved glucose tolerance with higher protein dose



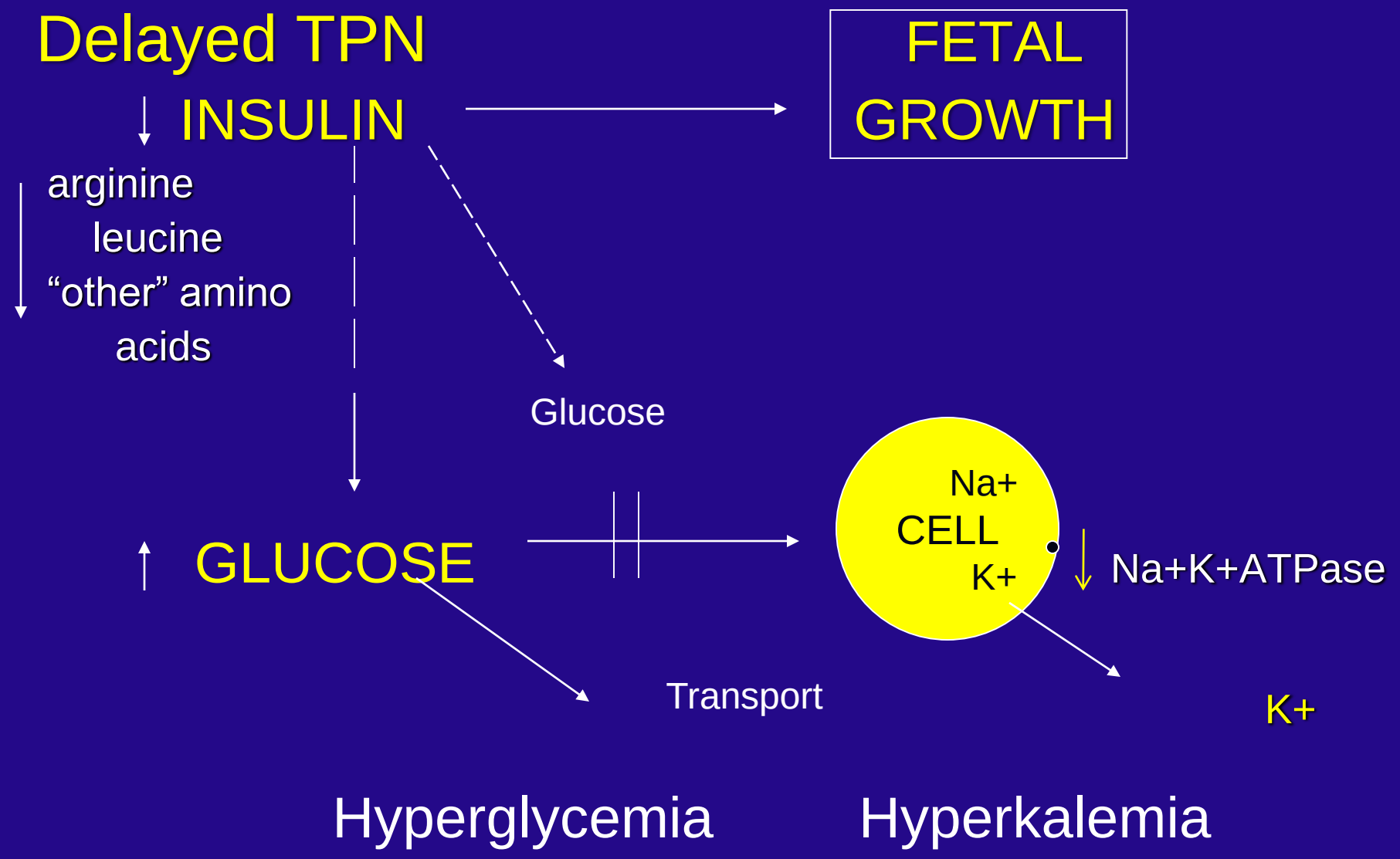
Protein 1.2 g/k/d epoch 1

1.8 g/k/d epoch 2

3.0 g/k/d epoch 3

Radmacher P and Adamkin DH J of Peri 2009

EARLY ADMINISTRATION of AMINO ACIDS



Protein Dose in Stock TPN (g/k/d)

AA	60ml/k/d	80ml/k/d
2%	1.2	1.6
4%	2.4	3.2
5%	3.0	4.0

- If you start with 5% AA you may not be able to increase the fluid rate!
- Additional fluids can be co-infused if glucose and/or electrolyte requirements change
- Can be made from leftover solution at compounding pharmacy and store at room temp for up to one week.

Recommendations Early Amino Acids and Benefits for VLBW

1) Immediate initiation within the first two hours of life.

2) Dosage 2.5 to 3.0 g/k/d initial solution (stock solution)

3) Advance to 3.5-4.0 g/k/d

- Promote growth
- Prevent hyperglycemia and non-oliguric hyperkalemia
- Maintain 1g/k/d TPN protein when fortified breast milk feeds @ 100 -110ml/k/d)
- Neurocognitive benefit

Feeding Milestones to Prevent Growth Failure in ELBW-VLBW

- 1st trophic feed <3 days
- Duration of trophic feeds (10-20ml/k/d) for 2- 5 days dependent on degree of immaturity, tolerance to feeds and clinical condition
- Increments in feeding volume advances after trophic @20-30ml/k/d depending on GA and tolerance
- Target 120ml/k/d with Gavage feeds by 14-21 days
- First Oral feed at 34 weeks or less
- Oral feeds of at least 120ml/k/d at 36- 38 weeks PMA
- Ad lib feeds or > 150 ml/k/d by discharge

modified from Jadcherla et al JPEN 2015

NEC

Concerns about NEC continue to Influence nutrition management decisions in the NICU

Minimal Enteral Nutrition and Feeding Schedule

Kosair Children's Hospital NICU | Progressive Enteral Feeding Schedule | 20 mL/k/d advancement

Date initiated:_____ Birth weight: _____

Day	Date	Time of feedings	Enteral (mL/k/d)	Weight (kg)	Vol each feeding	Feeding density	Type of milk or fortification*
1	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	Trophic	BW	1 mL	20	Colostrum/MBM/DHM
2	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	Trophic	BW	1 mL	20	Colostrum/MBM/DHM
3	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	20	BW	Wt x 2.5 = _____mL	20	Colostrum/MBM/DHM
4	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	40	BW	Wt x 5 = _____mL	20	Colostrum/MBM/DHM
5	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	60	BW	Wt x 7.5 = _____mL	20	MBM/DHM
6	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	80	BW	Wt x 10 = _____mL	20	MBM/DHM
7	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	100	BW	Wt x 12.5 = _____mL	24	MBM/DHM
8	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	120	BW	Wt x 15 = _____mL	24	MBM/DHM
9	/ /	Times: ◻_____ ◻_____ ◻_____ ◻_____ q 3 hrs ◻_____ ◻_____ ◻_____ ◻_____	140	BW	Wt x 17.5 = _____mL	24	MBM/DHM

*If colostrum/MBM/DHM is not available, use SSC.

Clinical Correlates of Trophic Effects of Human Milk

1. Fewer and lower volume residuals
2. Feeding advancement will be better tolerated and therefore reach full feeds sooner
3. Less episodes of abdominal distention
4. More rapid gastric emptying
5. Low susceptibility to NEC

Early Trophic feeding vs enteral fasting for Very preterm or VLBW infants (Cochrane)

9 trials n=754, Early trophic (up to 24ml/k/d) introduced < 96 hours continued at least one week vs Comparable Enteral fasting (few<1kg or SGA)

RESULTS

No evidence that early trophic affected feeding tolerance or growth rates. Meta analysis did not detect a statistically significant effect on incidence of NEC (RR 1.07 95%CI 0.67-1.70)

No evidence of important beneficial or harmful effects of early trophic feeds for very preterm or VLBW. Applicability of findings to extreme preterm or SGA is limited. (Morgan et al 2018)

Short vs Extended Duration of Trophic Feeding to Reduce Time to Achieve Full Enteral in EPT

N=192 EPT (23-28wks) Retrospective study. 2 Groups Short vs Extended Trophic Feedings. Short Trophic feeds < 3 days, <24ml/k/d. (More babies <750g in Extended group)

(Trophics initiated within 4 days in 85%)

RESULTS

1) Short duration was associated with decreased time to full enteral (mean -4.1 days) 12.5 days vs 9 days with adjustments for appropriate confounders
2) No increase risk of NEC and or death after achieving full feeds

ARE GASTRIC RESIDUALS OVERRATED?

- **Are Gastric residuals a surrogate for NEC or feeding intolerance?**
- **Are they developmental or physiologic and protective of the ELBW gut?**
- **Should we measure them??**

Impact of Routine Evaluation of GRV on the time to Achieve Full Enteral Feeding

- Practice Change in <34 weeks: Routine evaluation of GRV before each feed (n =239) vs Selective evaluation of GRV (n=233) 2 years after change from routine

RESULTS Selective vs Routine Eval of GRV

- Selective Pts weaned off of TPN 1 day sooner, achieved full feeds (150ml/k/d) 1 day earlier. Time to full oral and LOS were similar
- NEC low in both periods (1.7% selective, 3.3% historic)
- GA strongest predictor of time to full feeds
- Findings consistent with subgroup < 1500g

Riskin J Peds 2017

Gastric Residuals

- Don’t check them when on trophic feeds
- They do tend to rise just before diagnosis of NEC but were in the “acceptable range” and of themselves were not diagnostic (Cobb Peds 2004)
- They tend to decrease over time and may be used as a sign of improving feeding tolerance and guide feeding volumes
- No correlation with them and feeding outcomes

Slow Advances of Enteral feed volumes to Prevent NEC in VLBW (Cochrane) 2017

- Slow (up to 24 ml/k/d) v 30 to 40ml/k/d
- 10 trials, n=3753,(2804 from one large SIFT trial) stable AGA majority of infants
- 1/3 ELBW, 1/5 SGA or compromised in utero (AREDFV)

RESULTS

No effects on risk of NEC or All cause mortality

Sub group analyses ELBW or SGA or AREDV showed no evidence of effect on NEC or Death

Slow advance delayed establishment of full feeds by 1-5d

Borderline increased risk of invasive infection with slow

Oddie et al

From Parenteral to Enteral Nutrition: Approach for Evaluating PGF in Preterms

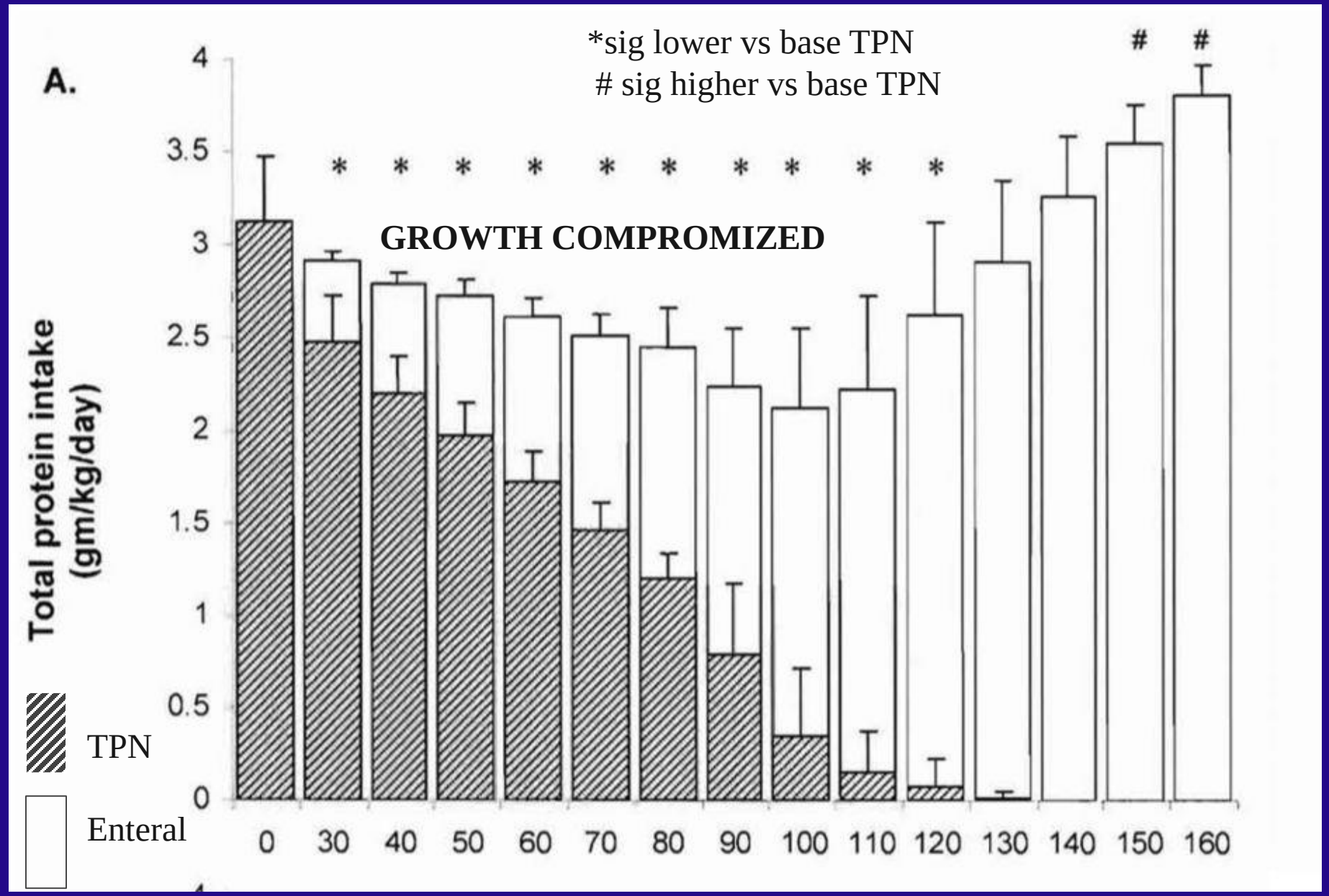
N=156 <32 weeks Chart review

3 Nutrition Phases

TPN / Transition/ Full Enteral

49%PGF

Milller JPEN 2013



Volume of enteral feeds ml/k/d

Miller M et al. JPEN 2013;38:489-497

How to Transition (eg)

Human Milk Feeds		@ 100 mL/kg		@ 110 mL/kg		@ 120 mL/kg		@ 130 mL/kg		@ 140 mL/kg		@ 150 mL/kg		@ 160 mL/kg		@ 170 mL/kg		@ 180 mL/kg	
Breast Milk																			
Breast Milk (Plain)		0.9	1.4	1.0	1.5	1.1	1.7	1.2	1.8	1.3	2.0	1.4	2.1	1.4	2.2	1.5	2.4	1.6	2.5
Breast Milk w/Prolacta (Human)																			
BM24/PL	(80% BM + 20% PL+4)	1.9	2.3	2.1	2.6	2.3	2.8	2.5	3.0	2.7	3.3	2.9	3.5	3.1	3.7	3.3	4.0	3.5	4.2
BM26/PL	(70% BM + 30% PL+6)	2.4	2.8	2.7	3.1	2.9	3.3	3.2	3.6	3.4	3.9	3.6	4.2	3.9	4.5	4.1	4.7	4.4	5.0
BM28/PL	(60% BM + 40% PL+8)	2.9	3.2	3.2	3.6	3.5	3.9	3.8	4.2	4.1	4.5	4.4	4.9	4.7	5.2	5.0	5.5	5.3	5.8
BM30/PL	(50% BM + 50% PL+10)	3.5	3.7	3.8	4.1	4.1	4.4	4.5	4.8	4.8	5.2	5.2	5.6	5.5	5.9	5.9	6.3	6.2	6.7
Breast Milk w/Enfamil HMF-AL (Bovine)																			
BM22/EHMF	(50 MBM + 1 pack HMF)	1.9	2.4	2.1	2.6	2.3	2.8	2.5	3.1	2.7	3.3	2.9	3.5	3.1	3.8	3.2	4.0	3.4	4.2
BM24/EHMF	(25 MBM + 1 pack HMF)	2.6	3.0	2.8	3.3	3.1	3.6	3.4	3.9	3.6	4.2	3.9	4.5	4.1	4.8	4.4	5.1	4.6	5.4
Breast Milk w/Similac HMF-HPCL (Bovine)																			
BM22/SHMF	(50 MBM + 1 pack HMF)	1.8	2.3	2.0	2.5	2.2	2.7	2.4	2.9	2.5	3.2	2.7	3.4	2.9	3.6	3.1	3.8	3.3	4.1
BM24/SHMF	(25 MBM + 1 pack HMF)	2.4	2.8	2.7	3.1	2.9	3.4	3.1	3.7	3.4	4.0	3.6	4.2	3.9	4.5	4.1	4.8	4.4	5.1
Breast Milk w/30 kcal/oz Formula (Bovine)																			
BM22	(80% BM + 20% SSC30)	1.3	1.7	1.5	1.9	1.6	2.1	1.7	2.2	1.8	2.4	2.0	2.6	2.1	2.8	2.2	2.9	2.4	3.1
BM24	(60% BM + 40% SSC30)	1.7	2.0	1.9	2.2	2.1	2.4	2.3	2.7	2.4	2.9	2.6	3.1	2.8	3.3	3.0	3.5	3.1	3.7
BM27	(30% BM + 70% SSC30)	2.4	2.5	2.6	2.8	2.8	3.0	3.1	3.3	3.3	3.5	3.6	3.8	3.8	4.0	4.0	4.3	4.3	4.5
Premature Formula (Regular or High Protein)																			
24 Calorie		2.4	2.8	2.6	3.0	2.9	3.3	3.1	3.6	3.4	3.9	3.6	4.1	3.8	4.4	4.1	4.7	4.3	5.0
27 Calorie	(50% 24 Calorie + 50% 30 Calorie)	2.7	2.9	3.0	3.2	3.2	3.5	3.5	3.7	3.8	4.0	4.1	4.3	4.3	4.6	4.6	4.9	4.9	5.2
30 Calorie		3.0		3.3		3.6		3.9		4.2		4.5		4.8		5.1		5.4	
Hypoallergenic Formulas																			
Extensively Hydrolyzed 24 Calorie		2.2		2.5		2.7		2.9		3.1		3.4		3.6		3.8		4.0	
Elemental 24 Calorie (all brands)		2.2	2.5	2.4	2.7	2.7	3.0	2.9	3.2	3.1	3.5	3.3	3.7	3.6	4.0	3.8	4.2	4.0	4.5

3.5 – 4 g/kg/day (recommended) – 2.8 g/kg/day (enteral) = 0.7 – 1.2 g/kg/day (TPN)

Goals for Protein and Energy for TPN and Transition to Full Enteral for ELBW

CALORIES	80-100 cal/k/d
PROTEIN	3.5-4.0g/k/d

TWO TRANSITION STRATEGIES to PREVENT POSTNATAL GROWTH FAILURE in ELBW INFANTS

1. Continue TPN Protein until Enteral Feeds reach 120ml/k/d
2. Fortify Concentrated Human Milk fortifier at 40ml/k/d and Concentrated Bovine fortifier at 80ml/k/d
3. Calculate Protein to reach 4g/k/d when transitioning from TPN to Human milk feedings