Children's Hospital
London Health Sciences Centre

Nutritional Considerations for the Human Milk Fed Infant: Size Matters!

Cindy Ulrich, RD
Doris Yuen, RD, MD, PhD, FRCPC

Neonatal Intensive Care Unit
October 3, 2011

Overview

- Nutritional Consequences of Premature Birth
- Nutrition & Growth Goals at Discharge
- Post discharge Supplementation of Human Milk for at Risk Infants – Evidence and Practice
- Micronutrients of Particular Concern at Discharge in the Human Milk Fed Preterm
- Case Discussions
- Summary/Conclusions

Clinical Consequences of Preterm Birth

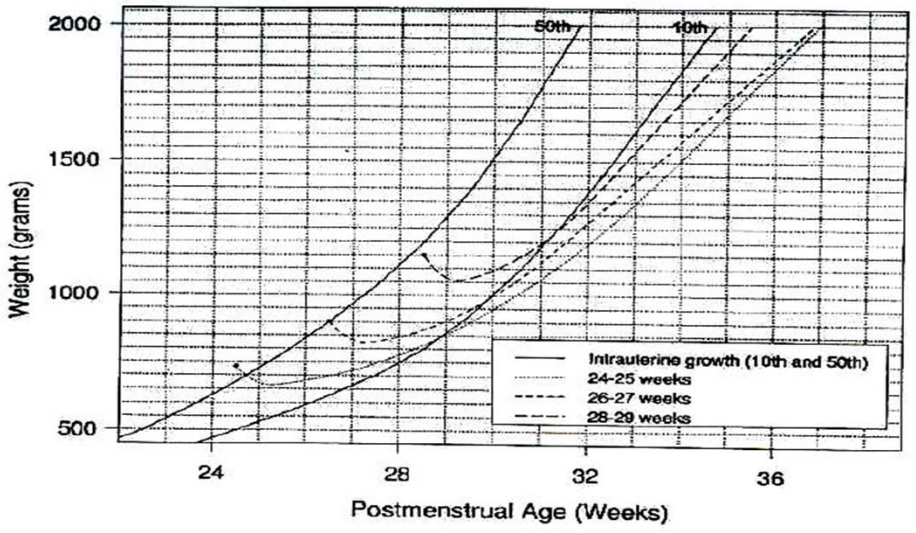
- Limited body stores of all nutrients[1]
- GOAL: intrauterine rates of nutrient accretion and growth[3]
- Growth: very high requirements for all nutrients (esp. protein) [2]
- Full parenteral nutrition unable to suppress proteolysis[2]
- Regulatory mechanisms of insulin response are not able to affect proteolysis
- REALITY:
  - delay in provision of nutrition support
  - limitations in nutrient delivery with TPN, HMF and formulas

  → poor growth & significant nutrient deficits at discharge [3-5]

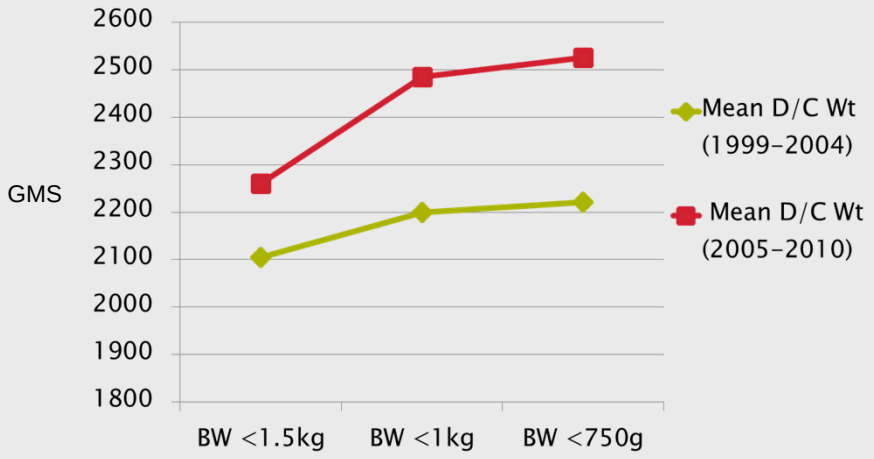
1. Zeigler E et al Growth 1976;40:329-341
2. Denne SC et al J Clin Invest 1996;97:746-754
3. AAP Committee on Nutrition 2003; 23-54
4. Ehrenkranz RA et al Pediatr 1999;104:280-289
5. Embleton NE et al Pediatr 2001;107:270-3

Growth of Hospitalized VLBW Infants

Ehrenkranz RA et al Pediatr 1999;104:280-9 [4]



Weight at Discharge
VLBW Infants Receiving Human Milk

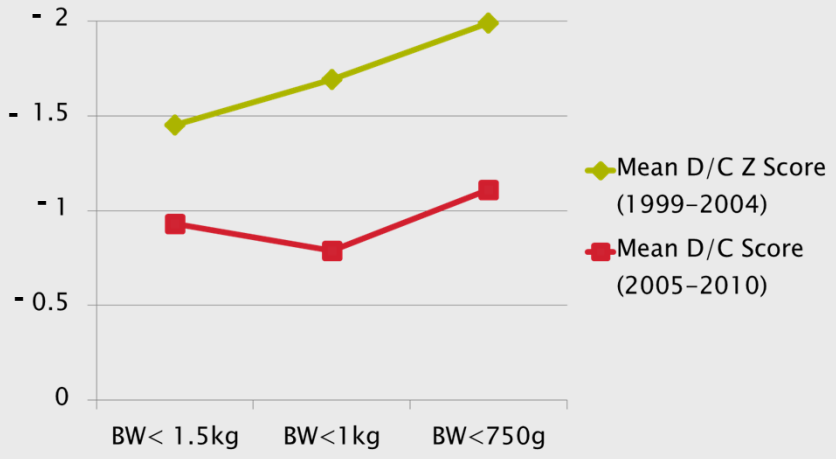


NICU, St. Joseph's Healthcare, London

Children's Hospital
London Health Sciences Centre

4

Z Score at Discharge
VLBW Infants Receiving Human Milk



NICU, St. Joseph's Healthcare, London

Children's Hospital
London Health Sciences Centre

5

Estimated Enteral Protein and Energy Requirements[6]

Body Weight (g)	500–700	700–900	900–1200	1200–1500	1500–1800	1800–2100
Fetal Wt Gain (g/kg/d)	21	20	19	18	16	14
Protein Needs (g/kg/d)	4	4	4	3.9	3.6	3.4
Energy Needs (cal/kg/d)	105	105	110	127	128	131
Protein: Energy (g/100cal)	3.8	3.7	3.4	3.1	2.8	2.8

6. Zeigler E JPGN 2007;45:S170–174

Children's Hospital London Health Sciences Centre

6

Preterm Protein & Energy Requirements for Catch-up Growth[7]

Post-Natal Age	26–30 weeks		30–36 weeks		36–40 weeks	
Catch-up Growth Required?	No	Yes	No	Yes	No	Yes
Protein (g/kg/day)	3.8–4.2	4.4	3.4–3.6	3.6–4.0	2.8–3.3	3.0–3.4
Energy (cal/kg/day)	126–140	133	120–128	120–133	108–133	107–131
Protein: Energy Ratio g/100cal	3.0	3.3	2.8	3.0	2.4–2.6	2.6–2.8

7.Rigo et al. 2006 J Pediatr 149: s80–8

Children's Hospital London Health Sciences Centre

7

Consequences of Inadequate Growth

Growth velocity is correlated to developmental outcomes

- Ereknkranz et al [8]
  - N=495
  - BW 501-1000g
  - CP, MDI and PDI<70 increased in groups with slower growth velocity at18-22 months corrected age
- Sices et al[9]
  - N=154
  - Mean BW 768±140g
  - 18% growth failure to 20 months corrected age
- growth failure (-0.67 z score) between 0-4 mo and 8-20 mo correlated with poor PDI

8. Erhenkranz RA et al Pediatr 2006;117:1253-61
9. Sices L et al Pediater Child Health 2007;12:22-28

Children's Hospital
London Health Sciences Centre

Consequences of Rapid Growth Including Catch-up Growth

Barker Hypothesis[10]-

- poor fetal nutrition with postnatal high CHO/low protein & fat -> detrimental effects on adult health
- Relatively few studies/inconsistent results[11]
- SGA preterm & term infants -> higher risk than AGA preterm
- Both extremes of intake may have adverse long-term adverse health outcomes[12]
- effects small compared to other risk factors-genetic and environmental/lifestyle factors[11,12]

Consensus: maximize nutrition support in first year when most catch-up is likely to occur with potential for favorably affecting developmental outcomes[12,13]

10. Barker DJ et al 1993 Lancet;341:938-941
11. Euser AM et al 2005 AJCN;81:480-7
12. Greer F Semin Perinatol 2007;31:89-95
13. Tsang R et al 2005 Nutrient Needs of the Preterm Infant

Children's Hospital
London Health Sciences Centre

Goals for Growth:
Preterm Infants at Discharge from Hospital

GOAL for nutritional management:

"**to achieve a body composition and rate of growth of a term infant of the same post-natal age**" [12]

Confounders to Achieving this Goal:

- Increasing survival of smallest, sickest infants
- Earlier hospital discharge (35-36wks)
- Smallest infants at significant risk for
  - growth failure, developmental delay, infection and re-hospitalization
- Co-morbidities associated with prematurity (respiratory, GI, neurologic)) affect nutrient requirements and method(s) of nutrient delivery[14]

12. Greer F Semin Perinatol 2007;31:89-95
14. Lemons J et al Pediatr 2001;107:e1-e8

Children's Hospital
London Health Sciences Centre

10

Intrauterine & Post-natal Growth Chart[15]

- Most recent
  - Canadian intrauterine weight data for weight combined CDC growth data to 50 weeks (WHO in draft)
- Use for preterm infants to 40 weeks corrected age
  - WT increase15-16 g/kg/day
  - HC increase 0.5-1.0cm/wk
  - LT increase 0.9-1cm/wk
  - Greater increases anticipated if catch-up growth required

    ? catch-up →>5-10th %ile vs. return to birth %ile

http://members.ca/growthchart
15.Fenton TR Pediatrics 2003;10:3-13

Children's Hospital
London Health Sciences Centre

11

Post-Natal Growth Charts- WHO Charts[16]

- 2010 adapted for Canada from WHO Child Growth Standards
- Use in preterm infants after term corrected age (>40wks)
  - WT increase 30-40g/day (e.g. girls vs. boys 0-2mos)
  - HC increase 0.5cm/wk (e.g. girls & boys 0-2mos)
  - LT increase 1.0cm/wk (e.g. girls & boys 0-2mos)
  - Greater increases for catch-up growth

www.dietitians.ca/growthcharts

16. WHO 2006 http://www.who.int/childgrowth/en

Children's Hospital London Health Sciences Centre

Nutrition Recommendation for Preterm Infants at Discharge

- CPS 1995[17]
  - assume no in-hospital deficits- same requirements as for term
- AAP 2003[3]
  - insufficient evidence upon which to base specific recommendations
- Tsang 2005[13] - only published consensus statement of experts
- ESPHGAN 2006[18]
  - -position paper on Feeding PT Infants Post-D/C
- DRI's 2005,2010(VitD and Ca)- for term[19]
- No official recommendation for most nutrient intakes
  - gradual transition from preterm to term requirements recommended,
    - based on achievement of term CA and/or catch-up growth

17. CPS Nutrition Committee Can Med Assoc J 1995;152:1765-85
18. ESPGHAN Committee on Nutrition JPGN 2006; 42:596-603
19. http://hc-sc.gc.ca/fn-an/nutrition/reference/dri_rep-rap_anref-list/index- eng.php

Children's Hospital London Health Sciences Centre

"General" Consensus of Recent Publications[12,13,18]

Goal for entire 1st year of life

- achieve body composition & rate of growth of a normal fetus of the same post-menstrual age
- Specific nutrient data lacking
  - safe assumption that needs for catch-up growth are higher compared to term
  - Protein intake continues to be rate-limiting nutrient for lean tissue growth
  - Ca, PO_4, Vit A increased needs post-discharge
    - *based on normalization of serum levels and improved bone mineralization in studies continuing in hospital preterm formulas in the early post-discharge period*

Children's Hospital London Health Sciences Centre

14

Consensus Targets for Stable Growing and Post-Discharge Preterm Infants[13,19]

Nutrient	Stable/growing Target – Preterm Infants	Post-discharge Target – Preterm Infants	DRI's-AI's Term Infants
Volume mL/kg/d	120-200	**135-220**	700ml/d
Energy Kcal/kg/d	110-150	**120-130**	72-108
Protein g/kg/d	3.4-4.4	**2.5-3.5**	1.5
Ca mmol/kg/d	2.5-5.5	**3.7-4.4**	5 mmol/day
P mmol/kg/d	2-4.5	**2.9-3.4**	3.9 mmol/day
Vit D IU/d	400	**400**	400
Fe mg/kg/d	2-4	**2-4**	0

Children's Hospital London Health Sciences Centre

15

Human Milk for Preterm Infants at Discharge

- Human milk provides many benefits for PT infant [20,21]
  - Host defense, Neurodevelopment, GI, Nutrition
- HM fed PT infants show slower growth vs. formula fed PT [20,21]
  - exclusive human milk intake of >180ml/kg/day[22] required to achieve growth rate of 15g/kg/day
  - fortification often required to meet requirements for adequate growth/catch-up growth
- Many unable to exclusively breastfeed at discharge:
  - body size, physiologic immaturity, co-morbidities, requirements, etc.[22]

20. O'Connor et al JPGN 2003;37:437-46
21. Schanler et al Pediatr 1999;103:1150-7
22. Pediatric Nutrition Practice Group ADA 2009;p160-186

Nutritional Limitations in Use of Human Milk for Preterm Infants[23]

- Low protein density-stage of lactation
- Low mineral density (Ca, P04)
- Variability in composition (fat)
- Restricted milk intakes
- Availability

- Note preterm nutritional needs higher than at any other time in life

23. Schanler R Am J Clin Nutr 2007;85:625S-628S

Fortification of Human Milk at Discharge[24, 25]

- Study patients
  - BW 750–1800g
  - Human Milk fed at D/C
- Study Groups
  - plain HM
  - ½ feeds HMF 1:25ml from d/c to 12 weeks
- Results
  - HMF group: >LT , >WT, >HC (<1250g BW)
  - Fortification no effect on duration of breastfeeding
  - Follow up study -> sustained results at 12mos CA

24. O'Connor DL et al Pediatrics 2008;121:766–776
25. Aimone A et al JPGN 2009;49:456466

Fortification of Human Milk at Discharge[26]

- Study Patients
  - BW 535–2255g
  - Human Milk fed at D/C
- Study Groups
  - Plain HM (n=102)
  - HMF: 5 packets in 20–50ml HM (1.375g protein & 17.5cal/day) (N=105) to 4 mos corrected age, given as one supplemental bottle feed daily
- Results
  - HMF group: no differences in anthropometrics to12mos CA
- **Main limitation**: very low level of nutrient supplementation

26. Zachariassen G et al Pediatrics 2011 127:e995–1003

Fortification of Human Milk at Discharge[27,28]

- 2010 Systematic Review: Multi-nutrient fortification of human milk for preterm infants following hospital discharge[27]
  - Limited to O'Connor et al[24]
  - Conclusion: limited evidence exists to provide multi-nutrient fortification to HM fed preterm infants post-discharge
- 2007 Systematic Review
  - Conclusion: cannot recommend nutrient enriched post-discharge formulas over term formulas despite a significant difference in linear growth in favour of PDF[28]

27. McCormick et al Cochrane Database of Systematic Reviews 2010
28. Henderson G et al Cochrane Database of Systematic Reviews 2007

Children's Hospital
London Health Sciences Centre

20

Fortification of Human Milk for Preterm Infants after Discharge – Recommendations for Practice[13,18,22,27]

1. Continuing HM encouraged as first choice
   - Wide variability in practice based on limited evidence
2. Use of multi-nutrient fortifier for at risk infants
   - Use of in-hospital fortification may be problematic
   - Preterm Discharge Formulas can be used to fortify HM
     - *-> 24, 27, 30 cal/oz*
     - *generally poor sources of protein, calcium & PO_4*
   - No evidence for use of PDF fortification
     - *reserved for the larger, healthier infants-who require energy dense vs nutrient dense fortified HM*

Children's Hospital
London Health Sciences Centre

21

Comparison of Nutrition Targets & Various Human Milk Feeding Regimes

Nutrient	Stable/ growing Target	Post-discharge Target	HM Alone	HM + 1:25HMF	HM + 1:50HMF	HM+PDF To 24cal/oz	HM: PDF 1:1
Volume mL/kg/d	120-200	135-220	175	150	165	150	165
Energy Kcal/kg/d	110-150	120-130	122	120	119	122	119
Protein g/kg/d	3.4-4.4	2.5-3.5	1.6	2.9	2.2	1.9	2.5
Ca mmol /kg/d	2.5-5.5	3.7-4.4	1.2	4.9	3.1	1.6	2.3
P mmol /kg/d	2-4.5	2.9-3.4	0.9	3.6	2.2	1.1	1.7
Vit D IU/d	400	400	4	411	216	36	95
Fe mg /kg/d	2-4	2-4	trace	0.6	0.3	0.4	1.1

for a 2kg infant at Discharge (~120kcal/kg/d)[22]

Children's Hospital London Health Sciences Centre

22

Discharge Nutrition Goals for the Breastfeeding Mother and her Preterm Baby [22]

1. Promote adequate weight gain to include catch-up growth
2. Ensure adequate delivery of protein, Ca, PO_4, vitamin D, Fe
3. Maintain or increase mother's milk volume
4. Maintain or improve feedings at the breast
   - Limit bottle feeding
5. Limit volume of supplemental formula feeds to that needed to achieve goals 1 and 2

Children's Hospital London Health Sciences Centre

23

Best Predictors of Breastfeeding Success in the Preterm Infant [29]

1. milk supply at discharge $\geq$750ml/day
2. prenatal intention to breastfeed
3. pumping initiation within hours post-delivery
4. discharge plan for *eventual* breast transition
5. early follow -up post discharge

29. www.cpqcc.org

Children's Hospital
London Health Sciences Centre

Micronutrients for Human Milk Fed Preterm Infants at Discharge[13,22]

Nutrient:	Discharge Requirement:
Iron	2-4mg/kg/day (to 1 yr)
Vitamin D	400 IU/day (to 1 yr)
Ca	3.7-4.4mmol/kg/day
PO4	2.9-3.4mmol/kg/day
Vitamin A	1400 IU/day (to 1 yr)
Zinc	1-2mg/kg/day (to 1 yr)

NOTE:

- Limited quantities in unfortified human milk
  - Assume trace Fe & Vit D, 203 IU Vit A/100ml HM[13]
  - Assume need for Ca, PO_4 supplementation until normal serum AlkPhos, PO_4[13]
- High requirements/minimal body stores [1]

Children's Hospital
London Health Sciences Centre

Suggested Vitamin & Mineral Supplements for a 2 kg Infant at Discharge[22]

Feeding	Micro nutrient Less Than Requirement	Supplement Example
Exclusive Human Milk	All fat soluble vitamins and most minerals including Ca, P04, Zn & Fe	**Tri-vi-sol 1ml/day** (1400IU VitA,400IU VitD,30mgVitC/mL) **Fer-in-sol 0.5-1mL/day** 15mg elemental Fe/mL (2-4mg/kg/day up to Maximum reasonable dose of 15mg/day)
Fortified Human Milk 1pkt:25ml	Iron if fortifier does not contain Fe (example: Similac HMF)	**Fer-in-sol 0.5-1mL/day** 15mg elemental Fe/mL (2-4mg/kg/day up to Maximum reasonable dose of 15mg/day)
Fortified Human Milk 1pkt:50ml	Some fat soluble Vitamin, Iron if fortifier does not contain Fe (example: Similac HMF)	**Fer-in-sol 0.5-1mL/day** 15mg elemental Fe/mL (2-4mg/kg/day up to Maximum reasonable dose of 15mg/day)
Human Milk Enriched With PDF to 24cal/oz	All fat soluble vitamins and most minerals including Ca, P04, Zn & Fe	**Tri-vi-sol 1ml/day** (1400IU VitA,400IU VitD,30mgVitC/mL) **Fer-in-sol 0.5-1mL/day** 15mg elemental Fe/mL (2-4mg/kg/day up to Maximum reasonable dose of 15mg/day)
1:1 Human Milk :PDF 22cal/oz	All fat soluble vitamins and most minerals including Ca, P04, Zn & Fe	**Tri-vi-sol 1ml/day** (1400IU VitA,400IU VitD,30mgVitC/mL) **Fer-in-sol 0.5-1mL/day** 15mg elemental Fe/mL (2-4mg/kg/day up to Maximum reasonable dose of 15mg/day)

Children's Hospital
London Health Sciences Centre

26

Case Example 1

- 31+3 wk GA male → Discharged @ 36+2 wks
- Prematurity, Mild Respiratory Distress, Feeds/Growth
- BW 1223g (10th) → D/C WT 1890g (<3rd)
- BLT 40cm (10-15th) → D/C LT 43cm (3rd)
- BHC 27cm (10th) → D/C HC 32cm (25th)
- excellent milk supply (300ml/pump;>1.5L/day)
  - breastfed a previous term infant x12mos
- Uneventful feeding course:
  - Immediate TPN
  - day 1 -> lipids, initial feeds
  - day 5 -> full TPN & lipids (3.7g protein/kg/d; 95cal/kg/d)
  - day 11 -> full volume enteral feeds (1 HMF:50ml HM)
  - day 12 -> full fortified feeds (1 HMF:25ml HM)

Children's Hospital
London Health Sciences Centre

27

Case Example 1 – Cont'd

- last 4-5 days prior to discharge -> transition to full breastfeeds ->drop in WT gain from 15g/kg/day to 7g/kg/day (<3rd)
  - INTAKE: 150ml/kg/day (285ml/day) (wk 4 preterm milk)
    ~105cal/kg/day & ~2.1g protein/kg/day

DISCHARGE FEEDING PLAN :

1. 5-7 breastfeeds/day
2. 2-3 fortified (HMF 1:25) feeds added at discharge
3. Daily supplements: Trivisol 1.0 ml, Ferinsol 0.5 ml
   - 400 IU Vit D, 1400 IU/d Vit A, 2-4mg/kg/day
4. Iron Haberman/slow flow nipple required R/T strength of suck vs. coordination of swallow : breathe

NUTRITION FOLLOW-UP PLAN:

1-2 weeks post-discharge in preterm breastfeeding clinic

Children's Hospital
London Health Sciences Centre

28

Comparison of Nutrition Targets & Various Human Milk Feeding Regimes

Nutrient	Stable/ growing Target	Post-discharge Target	HM Alone	HM + 1:25HMF	HM + 1:50HMF	HM+PDF To 24cal/oz	HM: PDF 1:1
Volume mL/kg/d	120-200	135-220	175	150	165	150	165
Energy Kcal/kg/d	110-150	120-130	122	120	119	122	119
Protein g/kg/d	3.4-4.4	2.5-3.5	1.6	2.9	2.2	1.9	2.5
Ca mmol /kg/d	2.5-5.5	3.7-4.4	1.2	4.9	3.1	1.6	2.3
P mmol /kg/d	2-4.5	2.9-3.4	0.9	3.6	2.2	1.1	1.7
Vit D IU/d	400	400	4	411	216	36	95
Fe mg /kg/d	2-4	2-4	trace	0.6	0.3	0.4	1.1

for a 2 kg infant at discharge (~120kcal/kg/d)[22]

Children's Hospital
London Health Sciences Centre

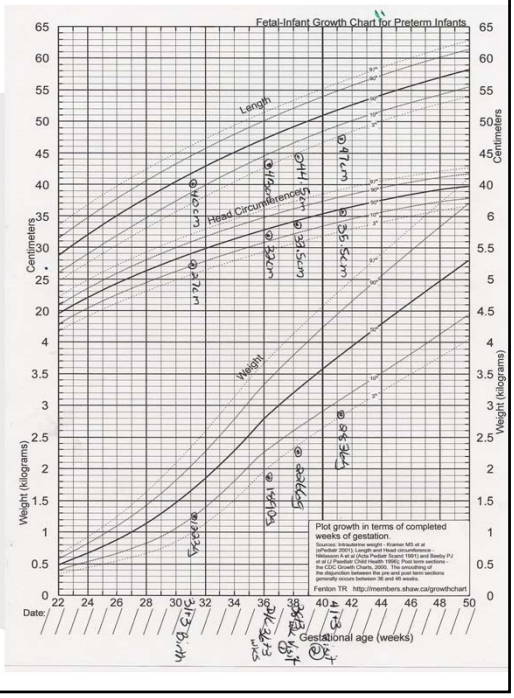
29

Fenton Growth Data
Case 1

Visit 1:
2 fortified bottles, breast x 7
- ➢WT gain 12g/kg/d (27g/day)
- ➢HC gain 0.75cm/wk
- ➢LT gain 0.75cm/wk

Plan:
1. Continue 2 fortified bottles/d + demand breastfeeding
2. Breast + 1-2 pumps/day

Visit 2:
Demand breastfeeding
~ 9-10 feeds/day (last 1/52)
- ➢WT gain 27g/day
- ➢HC gain 0.7cm/wk
- ➢LT gain 0.8cm/wk

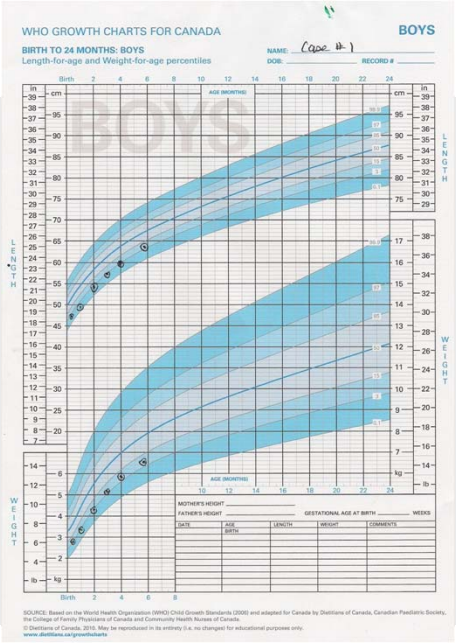


Children's Hospital
London Health Sciences Centre

WHO Growth Data
Case 1

Plan:
- Continue Breast on demand
- Continue 1ml/day Tri-vi-sol
- Increase Fer-in-sol to 0.7ml/day
  = 3.7mg/kg/day Fe
- Wean pumping gradually over next 1-2 weeks

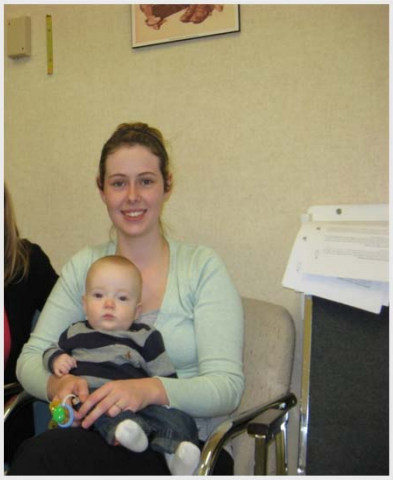
Subsequent Visits :
- •Full demand breast feeding with stable growth
- •Fer-in-sol to maximum reasonable dose of 1.0 ml/day (15 mg Fe/day)
- •1 Pediatric D Drop/day
  - replace Tri-vi-sol @ ≥4kg

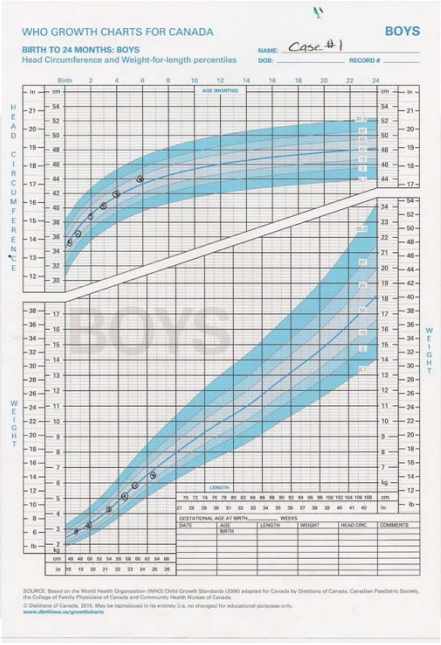


Children's Hospital
London Health Sciences Centre

31

WHO Growth Data
Case 1





Children's Hospital
London Health Sciences Centre

32

Case Example 2

- 31+4 wks male → discharged at 35+4wks
  - BW 1925g (75th) → D/C WT 2460g (≥25th)
  - BLT 43cm (50th) → D/C LT 48cm (≥50th)
  - BHC 29.25cm (50th) → D/C HC 31.5cm (≥25th)
- **At Discharge :**
  - Demand breastfeeding: transferring 180-200ml/kg/day
    - ~500ml/day, ~120cal/kg/day ,~3.2g protein/kg/day
  - Mom had excellent milk volumes ≥1L/day
    - Continued to pump 60-100ml pc Breastfeeds at discharge
  - Weight gain ~14g/kg/day
  - Daily supplements to meet A, D & Fe needs
    - Tri-vi-sol 1.0ml, Fer-in-sol 0.5 ml

Children's Hospital
London Health Sciences Centre

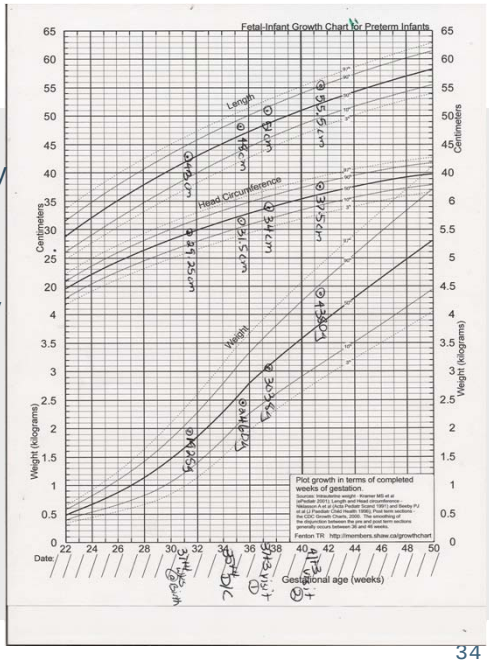
33

Fenton Growth Data
Case 2

Visit 1:
Demand breastfeeding 8-10 x's/day
- ➢WT gain 15g/kg/d (44g/day)
- ➢HC gain 1.4 cm/wk
- ➢LT gain 1.6 cm/wk

Mom weaned pumping to once/day for comfort

Plan:
- Continue breast on demand
- Continue 1 ml/day Tri-vi-sol, increase Fer-in-sol to 0.7ml/day
  = 2.5 mg/kg/day Fe
- D/C pumping gradually over next week

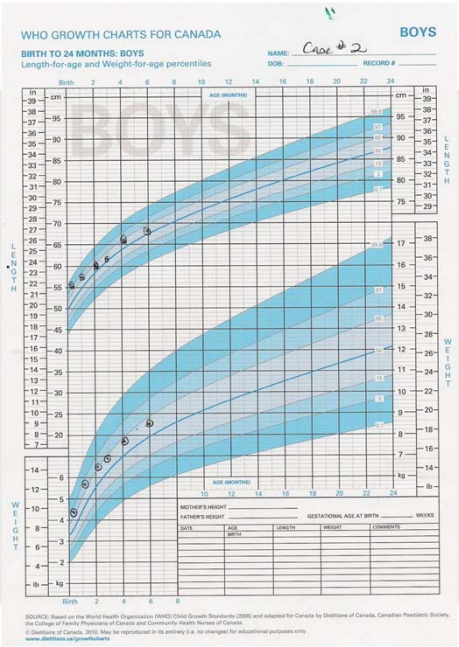


Children's Hospital
London Health Sciences Centre

34

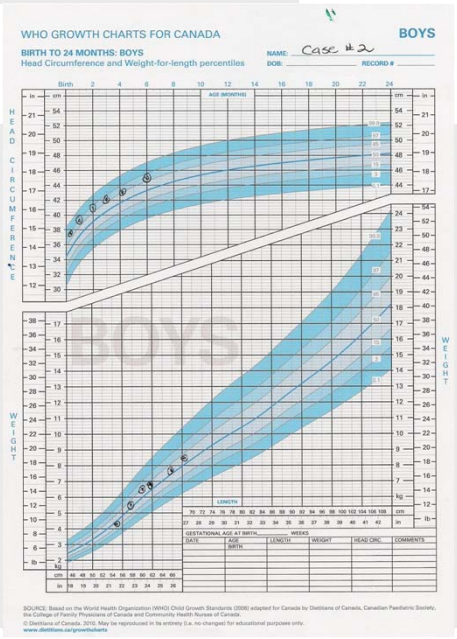
WHO Growth Data
Case 2

Subsequent Visits :
- Full demand breast feeding with stable growth
- Fer-in-sol to maximum reasonable dose of 1.0 ml/day (15mg Fe/day)
- 1 Pediatric D Drop/day
  - replace Tri-vi-sol @ ≥4kg
- Continue to 1 year CA



Children's Hospital
London Health Sciences Centre

WHO Growth Data
Case 2



Case Example 3

- 29+4 wk GA female → Discharged @ 39+1 wks
- R/O Sepsis @ birth, RDS, PDA, Feeds/Growth
  - BW 1075g (20th) → D/C WT 2846g (≥10th)
  - BLT 39cm (50th) → D/C LT 50cm (≤50th)
  - BHC 26cm (20th) → D/C HC 35cm (50th)
- Mom has reduced milk supply (400-700ml/day);
  - Domperidone increased to 20mg QID TID at discharge
  - pumping 7-8 times/24hr
- Maternal Hx.:1st baby, underlying renal disease, is a RN (adult), high anxiety re: preterm birth

Case Example 3 – Cont'd

- Eventful feeding course for management of PDA:
  - Immediate -> TPN
  - Day 1 -> lipids, initial feeds
  - Day 20 -> full volume enteral feeds (1 HMF:50ml HM)
  - Day 24 -> full fortified feeds (1HMF:20ml HM for increased protein needs of ELBW (1kg BW))
- Discharge:
  - Good WT gain @ 12g/kg/day on HMF 1:25ml HM
  - slow flow nipple
  - tires after 50ml of feeding q 3hr (tachypnea,supplemental O_2 D/C at 36 weeks)
  - ~140ml/kg/day, ~110cal/kg/day, ~2.8g/kg/day (wk 9 milk)
  - Poor transfer @ breast per ac/pc breast scale of < 20ml

Case Example 3 – Cont'd

DISCHARGE FEEDING PLAN :

- fortified (HMF 1:25) feeds by bottle at discharge with plan for mom to wean to ½ fortified feeds at home and start Tri-vi-sol 0.5ml/day
- Practice at breast 1-2 times/day with full/part top-up by bottle (unfortified)
- Ferinsol 0.7ml daily (Fe 3-4mg/kg/day (ELBW))
- Continued pumping 7-8 times/day

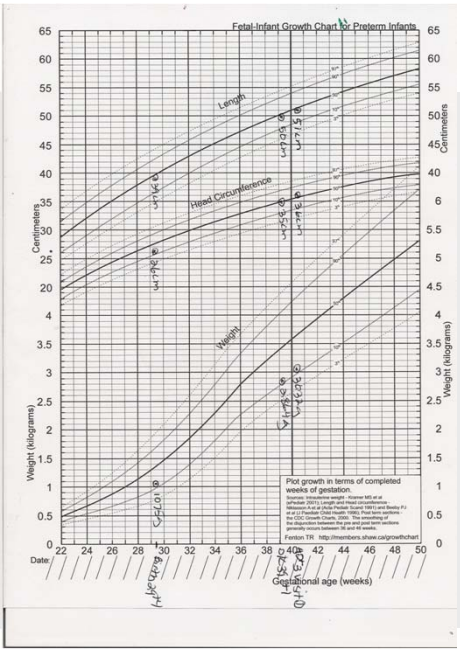
NUTRITION FOLLOW-UP PLAN:

- 1-2 weeks post-discharge in preterm breastfeeding clinic

Fenton Growth Data
Case 3

Visit 1:
3 fort /3 unfort bottles/day
Breast x 2/day (1hr/session/ no top-up)
Pumped volumes ~ 600ml/day
➢WT gain 19g/day
➢HC gain 0.8cm/wk
➢LT gain 0.8cm/wk

Plan:
- increase to 5 fortified bottles/day until HMF supply out (next 2 weeks)
- increase Breast to 3x/ day
- continue 6-7 pumps /day

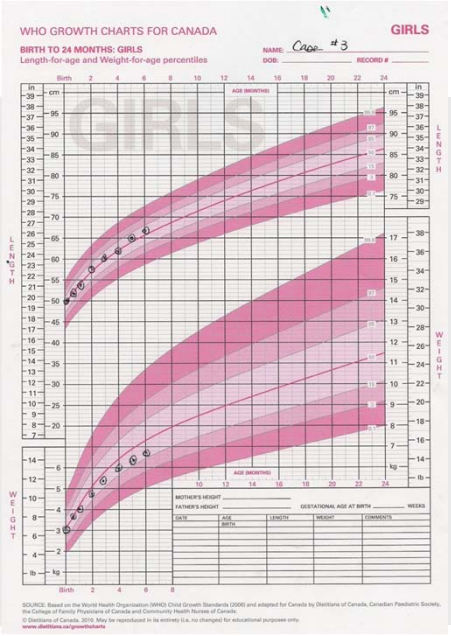


Children's Hospital
London Health Sciences Centre

WHO Growth Data
Case 3

Visit 2:
3 Breast/day (no top-up)
5 fortified bottles/day
~500ml/d pumped + Breastfeeds
➢WT gain 44g/day
➢HC gain 0.7cm/wk
➢LT gain 0.8cm/wk

Plan:
•AC/PC scale for Breast
•Preterm discharge formula
1 tsp/100ml HM if bottles(24cal/oz)
•increase in Breast to ~650ml/d -> -
→180ml/kg/d of unfortified HM
•Tri-vi-sol to 1ml/d (@ D/C HMF)
•Fer-in-sol to 1ml/d (4 mg Fe/kg/d)



Children's Hospital
London Health Sciences Centre

WHO Growth Data Case 3

Visit 3:

Transition to full demand breast

9-10x's /day; 60-80ml/feed using AC/PC weigh scale

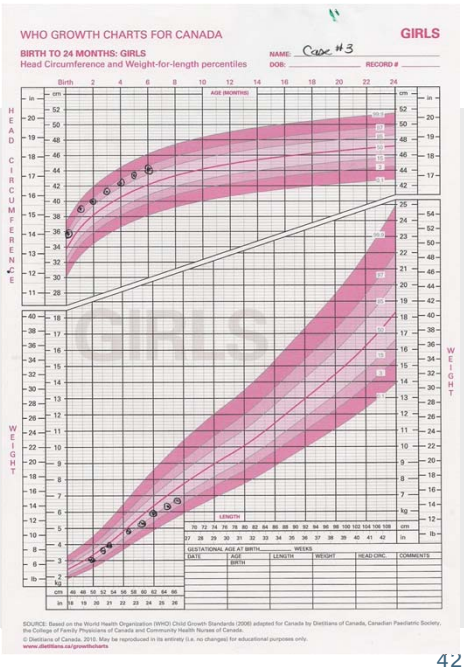
- ➢WT gain 24g/day
- ➢HC gain 0.9cm/wk
- ➢LT gain 1.0cm/wk

Plan:

- D/C AC/PC scale for breastfeeds
- D/C Tri-vi-sol, start 1 Ped D Drop/day with wt ~4kg
- continue 1ml/d Fer-in-sol

Subsequent Visits :

- Full Breast with slight fall off in WT but stable HC, LT



Summary

- Majority of preterm infants continue to be at nutritional risk at the time of hospital discharge
- Goal for preterm infant growth post-discharge:
  - achieve a body composition and rate of growth of a normal fetus of the same post-menstrual age during the entire 1st year of life
- Human milk continues to be the preferred choice for feeding for all infants
- Multi-nutrient fortification of HM may be required in specific infants to achieve growth and body composition goals
- Specific vitamin and mineral supplementation is important in this population

References and Resources

1. Ziegler EE, O'Donnell AM, Nelson SE, et al. Body composition of the reference fetus. Growth 1976;40:329-41.
2. Denne SC, Karn CA, Ahlrichs JA et al. Proteolysis and phenylalanine hydroxylation in response to parenteral nutrition in extremely premature and normal newborns. J Clin Invest 1996; 97:746-754.
3. Kleinman R. American Academy of Pediatrics. Pediatric Nutrition Handbook. 5th Edition. Elk Grove Village, Ill. American Academy of Pediatrics, 2004 pp23-54.
4. Ehrenkranz RA, Younes N, Lemons JA, *et al.* Longitudinal growth of hospitalized very low birth weight infants. Pediatrics 1999; 104:280-289.
5. Embleton NE, Pang N, Cooke RJ. Postnatal malnutrition and growth retardation: An inevitable consequence of current recommendations in preterm infants? Pediatrics. 2001;107:270-3.
6. Zeigler EE. Protein Requirements of Very low Birth Weight Infants. JPGN 2007;45:S170-S174.
7. Rigo J, Senterre J. Nutritional needs of premature infants: current issues. J Pediatr 2006;149:s80-8.
8. Ehrenkranz RA, Dusick AM, Vohr BR et al. Growth in the neonatal intensive care unit influences neurodevelopmental and growth outcomes of extremely low birth weight infants. Pediatrics 2006;117:1253-61.
9. Sices L, Wilson-Costello D et al. Post-discharge growth failure among extremely low birth weight infants: Correlates and consequences. Pediatr Child Health 2007;12:22-28.

References and Resources

10. Barker DJP, Gluckman PD, Godfrey KM, Harding JE, Owen JA, Robinson JS. Fetal nutrition and cardiovascular disease in adult life. Lancet 1993;341: 938-41.
11. Euser AM, Finken MJ, Keijzer-Veen MG, Hille ET, Wit JM, Dekker FW. Associations between prenatal and infancy weight gain and BMI, fat mass, and fat distribution in young adulthood: a prospective cohort study in males and females born very preterm. Am J Clin Nutr 2005;81:480-7.
12. Greer FR. Post-discharge nutrition: what does the evidence support? Semin Perinatol. 2007;31:89-95.
13. Tsang R, Uauy R, Koletzko B, Zlotkin S, eds. Nutrition of the Preterm Infant. Scientific Basis and Practical Guidelines. Cincinnati, OH: Digital Educational Publishing; 2005.
14. Lemons J.A., Bauer C.R., Oh W., et al: Very low birth weight outcomes of The National Institute of Child Health and Human Development Neonatal Network Research. January 1995 through December Pediatrics 2001; 107(1):E1-E8.
15. Fenton TR A new growth chart for preterm babies: Babson and Benda's chart updated with recent data and a new format. BMC Pediatrics 2003;10:3-13.
16. The WHO Child Growth Standards. World Health Organization. <http://www.who.int/childgrowth/en/> (Accessed on September 27, 2010).
17. Nutrition Committee of the Canadian Paediatric Society. Nutrient needs and feeding of premature infants. Can Med Assoc J 1995; 152:1765-85.

References and Resources

18. ESPGHAN Committee on Nutrition: Medical position paper: Feeding preterm infants after hospital discharge. JPGN 2006;42:596-603.
19. http://hc-sc.gc.ca/fn-an/nutrition/reference/dri_rep-rap_anref-list/index- eng.php (accessed September 24, 2010).
20. O'Connor D, Jacobs J, Hall RT, et al. Growth and development of premature infants fed predominantly human milk, predominantly premature infant formula, or a combination of human milk and premature formula. JPGN 2003;37:437-46.
21. Schanler RJ, Shulman RJ, Lau C. Feeding strategies for premature infants: Beneficial outcomes of feeding fortified human milk versus preterm formula. Pediatrics 1999;103:1150-7.
22. Pediatric Nutrition Practice Group American Dietetic Association. ADA Pocket Guide to Neonatal Nutrition. Chicago, Ill. 2009 pp160-186.
23. Schanler RJ Evaluation of the evidence to support current recommendations to meet the needs of premature infants: the role of human milk. Am J Clin Nutr 2007;85:625S-628S
24. O'Connor DL , Khan, S et al P Growth and nutrient intakes of human milk-fed preterm infants provided with extra energy and nutrients after hospital discharge. Pediatrics 2008;121:766-776.
25. Aimone A, Rovet J et al. Growth and body composition of human milk-fed premature infants provided with extra energy and nutrients early after hospital discharge: 1 year follow-up. JPGN 2009;49:456466.
26. Zachariassen G et al. Nutrient enrichment of mother's milk and growth of very preterm infants after hospital discharge. Pediatrics 2011 127:e995-1003.

References and Resources

27. McCormick F, Henderson G et al. Multi-nutrient fortification of human breast milk for preterm infants following hospital discharge. Cochrane Database of Systematic Reviews 2010, Issue 7.
28. Henderson G, Fahey R, McGuire W. Nutrient enriched formula versus human breast milk for preterm infants following hospital discharge. Cochrane Database of Systematic Reviews 2007, Issue 4.
29. California Perinatal Quality Care Collaborative. Nutritional support of the very low birth weight infant Part I & II . www.cpqcc.org (accessed September 27, 2010)