HEALTH HOLDING

HAFER ALBATIN HEALTH CLUSTER
MATERNITY AND CHILDREN HOSPITAL

Department:	Neonatal Intensive Care Unit (NICU)		
Document:	Departmental Policy and Procedure		
Title:	Follow up of Growth of Preterm Infant		
Applies To:	All NICU Staff		
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1. PURPOSE:

1.1 To achieve a growth rate similar to that of the intrauterine fetus of the same gestational age.

1.2 Weight gain, head circumference, and linear growth all correlate with long term outcomes in preterm infants. Studies showed that the pattern of growth of prematurely born infants exerts a significant, and independent, effect on neurodevelopmental status and growth outcome at 18 to 22 months corrected age.

1.3 Numerous articles demonstrate that infants born prematurely are at high risk for poor extra-uterine growth (weight, length, and head circumference) when compared with estimates of growth that would have occurred had the infants remained in utero.

1.4 Implementation of standardized feeding regimens in NICUs has been shown to result in a decline in the incidence of NEC.

2. DEFINITIONS:

2.1 Growth status is assessed at birth by the assessments of weight, length, and head circumference on fetal growth charts.

2.2 Plotting growth on standardized growth charts gives a measure of both growth velocity and the deviation from fetal growth.

2.3 Improved postnatal catch-up linear growth in very low birth weight infants is associated with improved cognitive and motor scores and lower rates of cerebral palsy at 2 years corrected age. Weight gain, head circumference, and linear growth all correlate with long-term outcomes in preterm infants.

2.4 Monitoring postnatal growth in NICU by the use of growth velocity alone without visualizing the pattern of growth on growth charts can lead to delayed diagnosis and treatment of growth failure and worse long-term outcome.

2.5 Extrauterine growth restriction (EUGR) is poor growth in NICU. It is defined as a growth measurement (weight, length, or head circumference) that is < 10th percentile of the expected intrauterine growth for the postmenstrual age (PMA) at the time of discharge (36 or 40 weeks PMA) (Appendices 7.2 and 7.3). It can be caused by:

2.5.1 The major factor is likely the development of significant protein and energy deficits during the first several weeks of life, which prove difficult to reverse and have long-lasting effects, including short stature and poor neurodevelopmental outcomes.

2.5.2 Inflammations: Degree of illness and inflammation has been shown to be negatively associated with the degree of catch-up growth in weight, length, and body fat free mass (FFM). This associations with illness implicate inflammatory cytokine activation in the etiology of reduced linear and FFM growth rate.

2.5.3 Early aggressive TPN and enteral nutritional support has been shown reduce the incidence of EUGR by improving growth; achieving earlier nutritional milestones, reducing the incidence of BPD, NEC, and late-onset infection; mediating the severity of critical illness; and reducing the length of hospital stay.

3. POLICY:

3.1 The admitting physicians assess intrauterine fetal growth by plotting weight, length and head circumference of Fenton growth charts.

3.2 The assigned staffs are responsible for daily measurements of weight, head circumference and follow up feeding protocol and so on.

4. PROCEDURE:

4.1 Plot the infant on Fenton preterm growth charts for boys and girls (Appendices 7.4 and7. 5). Plot the weight daily and head circumference and length every week. This gives a measure of both growth velocity and the deviation from fetal growth. Suggested targets for growth includes:

4.1.1 **Weight :**

4.1.1.1 Weight represents the balance between energy intake and expenditure.

4.1.1.2 Growth velocity is calculated for the period between the times that the infant regained birth weight and when that infant was discharged. The currently acceptable weight-gain velocity in the preterm infant is 15 to 18 grams/kg/day (from return to birth weight), which approximates the weight gain of the fetus during the second through third trimester. However, higher velocities (20-30 g/kg/day) may be needed for extremely low birth weight infants to regain their birth percentile by term, likely because of the need for catch-up growth after nutritional deficits in the first weeks of life.

4.1.1.3 Weight gain is associated with neurodevelopmental outcomes.

4.1.1.4 Weight gain alone does not give a complete picture of the overall nutritional state of the infant, and can be confounded by non-nutritional weight gain (e.g. edema).

4.1.2 **Head Circumference**:

4.1.2.1 During the third trimester, the brain is undergoing tremendous changes characterized by increasing dendritic complexity and synaptic connectivity, which are reflected by increases in brain volume and surface area. In the absence of hydrocephalus, head circumference indexes the brain's growth and correlates with brain volume.

4.1.2.2 The growth velocity of head circumference that mimics the fetus during the third trimester, and thus goal for growth of the preterm infant, is approximately 1cm/week (0.9-1.1 cm/week).

4.1.2.3 MRI findings in preterm infants who develop microcephaly by term corrected age show significant losses in deep nuclear gray matter (indicating neuronal loss, architecture, or both) compared with preterm infants with normal percentile.

4.1.2.4 Stunting of head growth in both the neonatal and post discharge periods is associated with poorer neurodevelopmental outcomes.

4.1.3 **Length** :

4.1.3.1 Linear growth represents lean body mass and protein accretion and also indexes organ growth and development, including the brain.

4.1.3.2 Intrauterine linear-growth velocity is approximately 1 cm/week, and therefore is the goal that can be followed.

4.1.3.3 There is increasing evidence that linear growth suppression is associated with poorer cognitive outcomes.

4.1.3.4 Lower calorie and protein intakes during hospitalization are associated with prolonged suppression of linear growth.

4.1.3.5 In addition, inflammation, which increases protein breakdown, is associated with reduced length percentile up to 24 months corrected age in preterm infants.

4.1.3.6 Aim at optimizing protein delivery with adequate energy support and reducing inflammation to decrease protein breakdown to potentially improve neurodevelopmental outcomes.

4.1.4 **Crossing percentiles** for any measurement (losing or gaining) suggest abnormal growth e.g. an infant with a head circumference at birth that is at the 50th percentile who leaves the NICU with a head circumference below the l0th percentile (poor head growth) is at serious risk for neurodevelopmental problems. If the same infant has a head circumference above the 90th percentile at discharge, hydrocephalus or other causes for abnormalities should be considered.

4.1.5 **Monitor** how far a given infant is falling behind or whose growth status is decreasing from birth percentiles, and adjust the nutritional approach accordingly, and may:

- 4.1.5.1 Assess for a medical cause e.g. acidosis, urinary tract infection.
- 4.1.5.2 Increase the feeding volume or caloric concentration.
- 4.1.5.3 Add breast milk fortification.
- 4.1.5.4 Consult dietician to add calories.
- 4.1.5.5 In this setting, the precise percentile measurement is less important than the pattern of growth over time.

4.1.6 **When to start feeding**: Start feeding as early as the first day when there are no contraindications such as the following

- 4.1.6.1 Hemodynamic instability, needs volume expansion, high inotropic support, has hemodynamically significant PDA.
- 4.1.6.2 Significant hypoxic episodes, Apgar score of less than 3 at 5 minutes of age with significant metabolic acidosis.
- 4.1.6.3 Abnormal GI examination or dysfunction e.g. suspected GI anomaly, Ileus, Grossly bloody stool, Necrotizing enterocolitis (NEC), bilious gastric aspirate despite appropriate position of oro-gastric tube, exchange blood transfusion.

4.1.7 **Feeding method**:

- 4.1.7.1 Should be individualized based on gestational age, clinical condition, and feeding tolerance e.g. related to the development and coordination of suck-swallow-breathe patterns, gastric motility, and emptying.
- 4.1.7.2 Swallowing is first detected at 11 weeks' gestation and the sucking reflex is first observed at 24 weeks' gestation. However, a coordinated suck-swallow is not present until 32 to 34 weeks' gestation and even then, it is immature; it matures by postnatal age. Swallowing must be coordinated with respiration.
- 4.1.7.3 Start infants less than 34 weeks' gestation, by orogastric, intermittent, tube feeding by gravity as most do not yet have the ability to coordinate suck-swallow-breathe pattern.
- 4.1.7.4 Transition to breast/bottle-feedings is a gradual process:
  - 4.1.7.4.1 Infants who are approximately 33 to 34 weeks gestation, who have coordinated suck-swallow-breathe patterns and respiratory rates less than 60 per minute, are appropriate to have a trial of oral feeding.
  - 4.1.7.4.2 Encourage non-nutritive attempts at the pacifier or breast before 33 to 34 weeks, if tolerated around 32 weeks.

4.1.8 **Type of starting milk:**

- 4.1.8.1 Start trophic feeding by colostrum/preterm milk within the first 48 hours of life if clinically stable and advance to full feed according to the guidelines and tolerance.
- 4.1.8.2 In instances where the supply of maternal milk is insufficient volume, full-strength 20 kcal/ fluid ounce formula may be used and changed to preterm formula after feeding is tolerated.

4.1.9 **Method of advancing feeding**:

- 4.1.9.1 The implementation of standardized feeding regimens has been shown to result in a decline in the incidence of NEC.
- 4.1.9.2 Follow the feeding protocol tables of the Saudi Neonatology Society (appendices 7.6) for neonates with birth weight of less the 750 grams up to 2 kg.
- 4.1.9.3 Meta-analyses by Cochrane did not show statistically significant effects on the risk of NEC between slow and faster advancement of feeding, or that delaying enteral feeding of the VLBW infants beyond 4 days after birth reduces the risk of NEC. Also early trophic feeding did not lead to a significant effect on the incidence of NEC.

4.1.10 **Enteral feeding goals:**

- 4.1.10.1 Ensure that the transition from intrauterine to extrauterine environment occurs with minimal disruption in nutrition support by utilizing early ,aggressive parenteral(TPN) and enteral nutritional strategies:

4.1.10.1.1 Postnatal growth begins with a period of weight loss, primarily through the loss of extracellular fluid. Historically, in preterm infants, this postnatal weight loss can be as much as 15% of birth weight with the nadir by 4 to 6 postnatal days and a regain to birth weight by 14 to 21 days. This pattern can be attenuated in most preterm infants with optimized early nutrition. The goal is to limit the degree and duration of initial weight loss in preterm infants and to facilitate regain of birth weight within 7 to 10 postnatal days by providing proper nutrition.

4.1.10.2 Provide nutrient intake that permit the rate of postnatal growth and composition of weight gain to approximate that of a normal fetus of the same post menstrual age.

4.1.10.2.1 Fluids as per daily requirements.

4.1.10.2.2 Calories:

4.1.10.2.2.1 Improved energy intake during hospitalization is associated with increased free fat mass accretion (FFM) at 4 months corrected age, and improved linear growth out to 24 months corrected age.

4.1.10.2.2.2 Preterm infants in a thermoneutral environment require approximately 60 kcal/kg/day for maintenance of body weight assuming adequate protein is provided. Additional calories are needed for growth, with the smallest neonates tending to demonstrate the greatest need, because their rate of growth is highest.

4.1.10.2.2.3 A range of 110 to 135 kcal/ kg/ day is recommended.

4.1.10.2.2.4 Infants with severe and or prolonged illness frequently require a range of 130 to 150 kcal/kg/day.

4.1.10.2.3 Protein:

4.1.10.2.3.1 Protein plays an important role in the developing brain, and is necessary for normal neurogenesis, dendritic arborization, synaptogenesis, and myelin production, as well as for cell signalling in the form of growth factors and neurotransmitters.

4.1.10.2.3.2 Recent studies have consistently shown improved neurodevelopment in infants receiving more aggressive protein supplementation during hospitalization, and these findings are lasting.

4.1.10.2.3.3 Administration of protein should begin within the first few hours of life and rapidly advanced to 3gm/kg/day via parenteral nutrition.

4.1.10.2.3.4 Add breast milk fortifier to infants receiving breast milk feeds who were < 1500 grams birth weight after they have reached at least 100 ml/kg/day or full enteral feeding volumes as follows:

4.1.10.2.3.5 One packet of human milk fortifier added to 50 cc of breast milk creates - 22 kcal / 30 ml milk.

4.1.10.2.3.6 One packet of human milk fortifier added to 25 cc of breast milk creates 24 kcal / 30 ml milk.

4.1.10.2.3.7 Follow manufacturer's recommendations.

4.1.10.2.3.8 Fortification should continue until the infant reaches at least 2.0 kg or is established at breastfeeding. Fortification may be used for longer periods of time in nutritionally compromised infants.

4.1.10.2.3.9 Human Breast Milk Fortifier also increases calcium and phosphorous intake.

4.1.11 **Iron supplementation:** Preterm infants need a supplement of 4 to 4.5 mg/kg of dietary iron to prevent late anemia.

4.1.11.1 Iron-fortified formulas and iron-fortified HMF provide approximately 2.2 mg/kg/day when delivered at a rate of 150 ml/kg/day.

4.1.11.2 In addition, give 2 to 3 mg/kg/day for VLBW infants of supplemental iron.

4.1.11.3 Start iron supplements when the preterm infant is tolerating full enteral volumes of Feedings.

4.1.12 **Vitamin D and bone minerals:**

4.1.12.1 When infants tolerate full enteral feeds, give 400 IU/ day of vitamin D, up to a maximum of 1000 IU/ day.

4.1.12.2 Elevations of serum alkaline phosphatase activity (APA) and clinical rickets are uncommon in the first 4 weeks after birth at any gestational age.

4.1.12.3 Screen the serum APA and serum phosphorus at 4 to 6 weeks after birth in VLBW infants followed by biweekly monitoring.

4.1.12.4 Management of enterally fed preterm infants with radiologic evidence of rickets (poorly defined terms include osteopenia or biochemical rickets):

4.1.12.5 Maximize nutrient intake of human milk fortifier or preterm formula. If unable to tolerate, then add elemental calcium and phosphorus as tolerated.

4.1.12.6 Begin with 20 mg/kg per day of elemental calcium and 10 -20 mg/kg per day elemental phosphorus and increasing, as tolerated, usually to a maximum of 70 - 80 mg/kg per day of elemental calcium and 40 - 50 mg/kg per day elemental phosphorus.

4.1.12.7 Assess for cholestasis and renal disease as these infants are at risk for bone loss.

4.1.12.8 Recheck radiographs for evidence of rickets at 5 to 6 week intervals until resolved.

4.1.12.9 Limit use of steroids and furosemide, as clinically feasible.

4.1.13 Ensure that 25 IU of vitamin E be administered with appropriate intake of folate and vitamin B12.

4.1.14 **Feeding post discharge:**

4.1.14.1 Continue breast feeding for breastfed infants.

4.1.14.2 If formula-fed, may give post-discharge formula with high contents of protein, minerals and trace elements as well as a long chain polyunsaturated fatty acid supply, at least until a post-conceptional age of 40 weeks, but possibly until about 52 weeks post-conceptional age.

4.1.14.3 Continued growth monitoring is required to adapt feeding choices to the needs of individual infants and to avoid underfeeding or overfeeding.

5. MATERIAL AND EQUIPMENT:

5.1 Growth charts
5.2 Feeding protocol
5.3 Measuring tape
5.4 Weighing machine

6. RESPONSIBILITIES:

6.1 Physician
6.2 Nurse

7. APPENDICES:

7.1 Postnatal growth pattern of infant born at 26 weeks
7.2 The complex interactions between nutrition, inflammation, linear growth, and development.
7.3 Extra-uterine Growth Restriction (EUGR)
7.4 Plot growth of Preterm Infants on Fenton Preterm Growth Charts (girls)

7.5 Plot growth of Preterm Infants on Fenton Preterm Growth Charts (boys)
7.6 Feeding protocol table of Saudi Neonatology Society

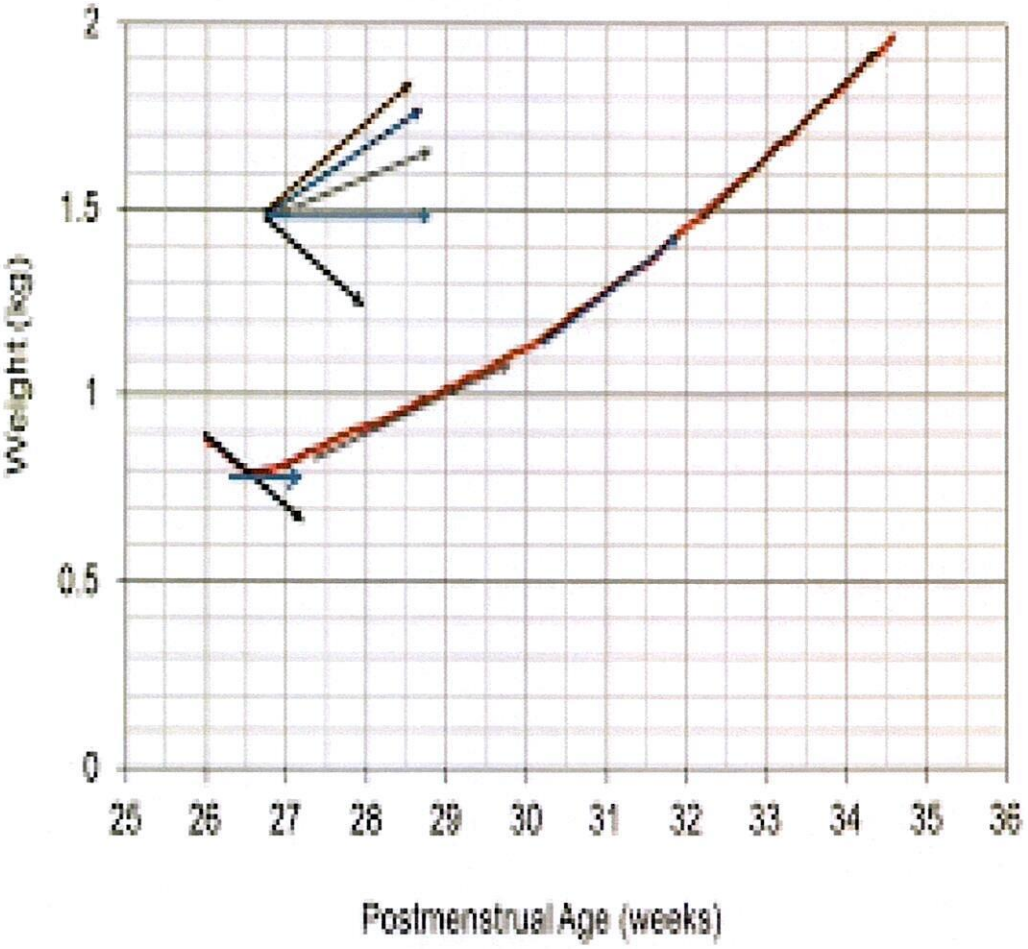
8. REFERENCES:

8.1 Clark RH et al., Assessment of Neonatal Growth in Prematurely Born Infants. Clinical Perinatology 41 (2014)295-307
8.2 Pfister KM et al. Linear Growth and Neurodevelopmental Outcomes. Clinical. Perinatology. 41 (2014) 309-321
8.3 American Academy of Pediatrics. Clinical Report. Calcium and Vitamin D Requirements of Enterally Fed Preterm Infants. Pediatrics Vol. I3I, No. 5, 2013
8.4 Saudi Neonatology Society. Guidelines for enteral feeding of preterm infants in Saudi Arabia. 2011
8.5 Morgan J et al., Delayed introduction of progressive enteral feeds to prevent necrotising enterocolitis in very low birth weight infants. The Cochrane database of systematic reviews Volume 12, 2014.
8.6 Morgan J et al., Slow advancement of enteral feed volumes to prevent necrotising enterocolitis in very low birth weight infants. The Cochrane database of systematic reviews Volume 10, 2015.
8.7 David h et al., Nutrition and Selected Disorders of the Gastrointestinal Tract. Nutrition for the high risk infant. Klaus & Fanaroff Care of the high risk infant. 6s edition 2013; I5I

9. APPROVALS:

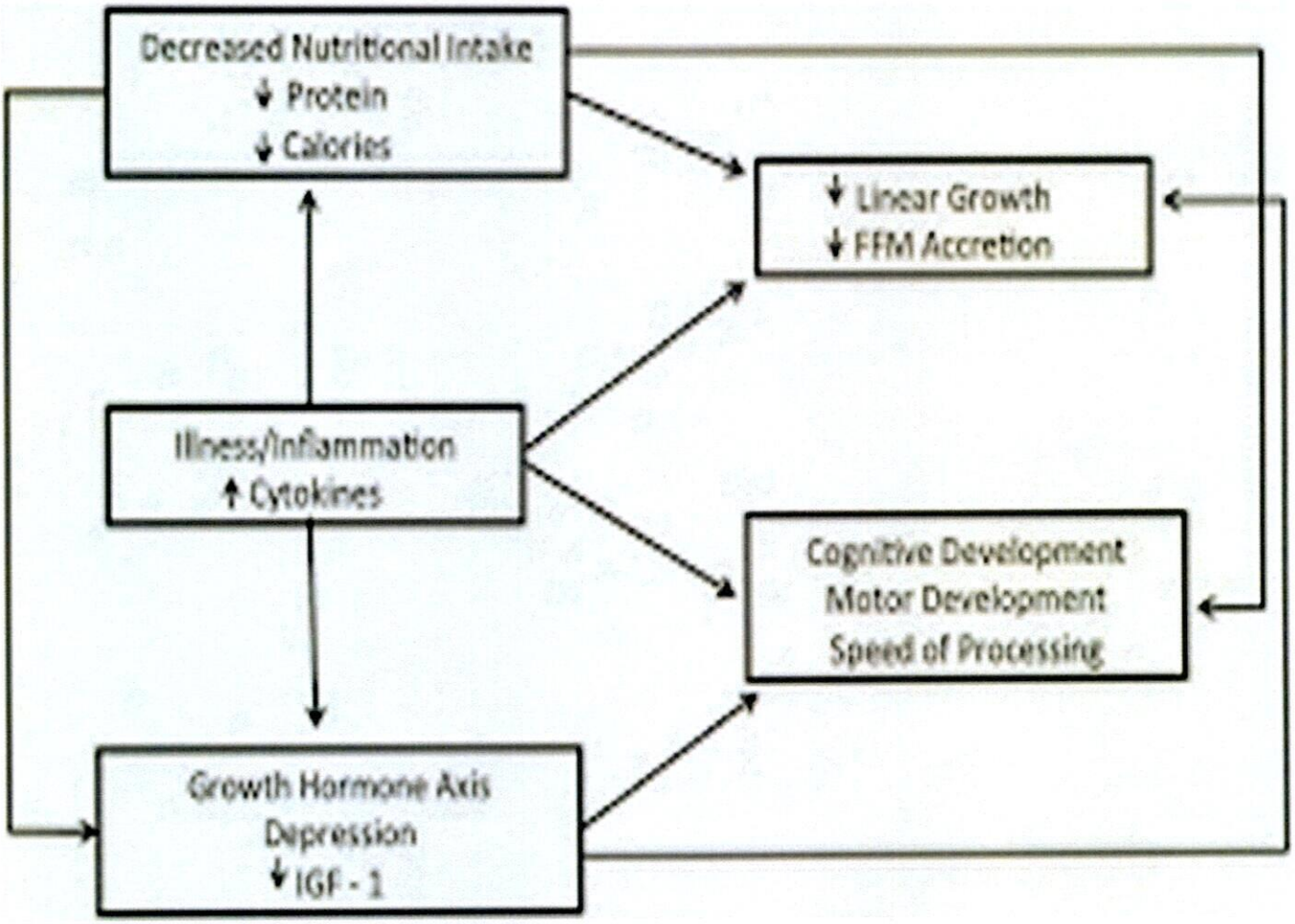
	Name	Title	Signature	Date
Prepared by:	Ms. Afrah Saud Al Shammari	NICU Head Nurse		January 05, 2025
Prepared by:	Dr. Falah Nabhan Al Shammari	NICU Quality Coordinator		January 05, 2025
Reviewed by:	Mr. Sabah Turayhib Al - Harbi	Director of Nursing		January 07, 2025
Reviewed by:	Dr. Sarhan Hamdan Al Shammari	NICU Head of the Department		January 08, 2025
Reviewed by:	Mr. Abdulellah Ayed Al Mutairi	QM&PS Director		January 09, 2025
Reviewed by:	Dr. Tamer Mohamed Naguib	Medical Director		January 12, 2025
Approved by:	Mr. Fahad Hazam Al - Shammari	Hospital Director		January 19, 2025

Appendices 7.1Postnatal growth pattern of infant born at 26 weeks:



- **Postnatal growth pattern of an infant born at 26 weeks' estimated gestational age based on observation made in 1000 inborn infants who survived to be discharged.**
- **Note that growth velocity continues to accelerate through term gestation.**
- **Growth velocity changes following birth for an infant born at 26 weeks estimated gestational age:**
- **0 to 5 days (black);**
- **5 to l0 days (light blue);**
- **10 to 28 days (light grey);**
- **28 to 42 days (deep blue);**
- **42 to 56 days (brown).**
- **Healthy newborn infants regain their birth weight within the first 2 weeks. (Data from the Pediatrix Clinical Data Warehouse 2009-2010.)**

Appendices 7.2 The complex interactions between nutrition, inflammation, linear growth, and development:



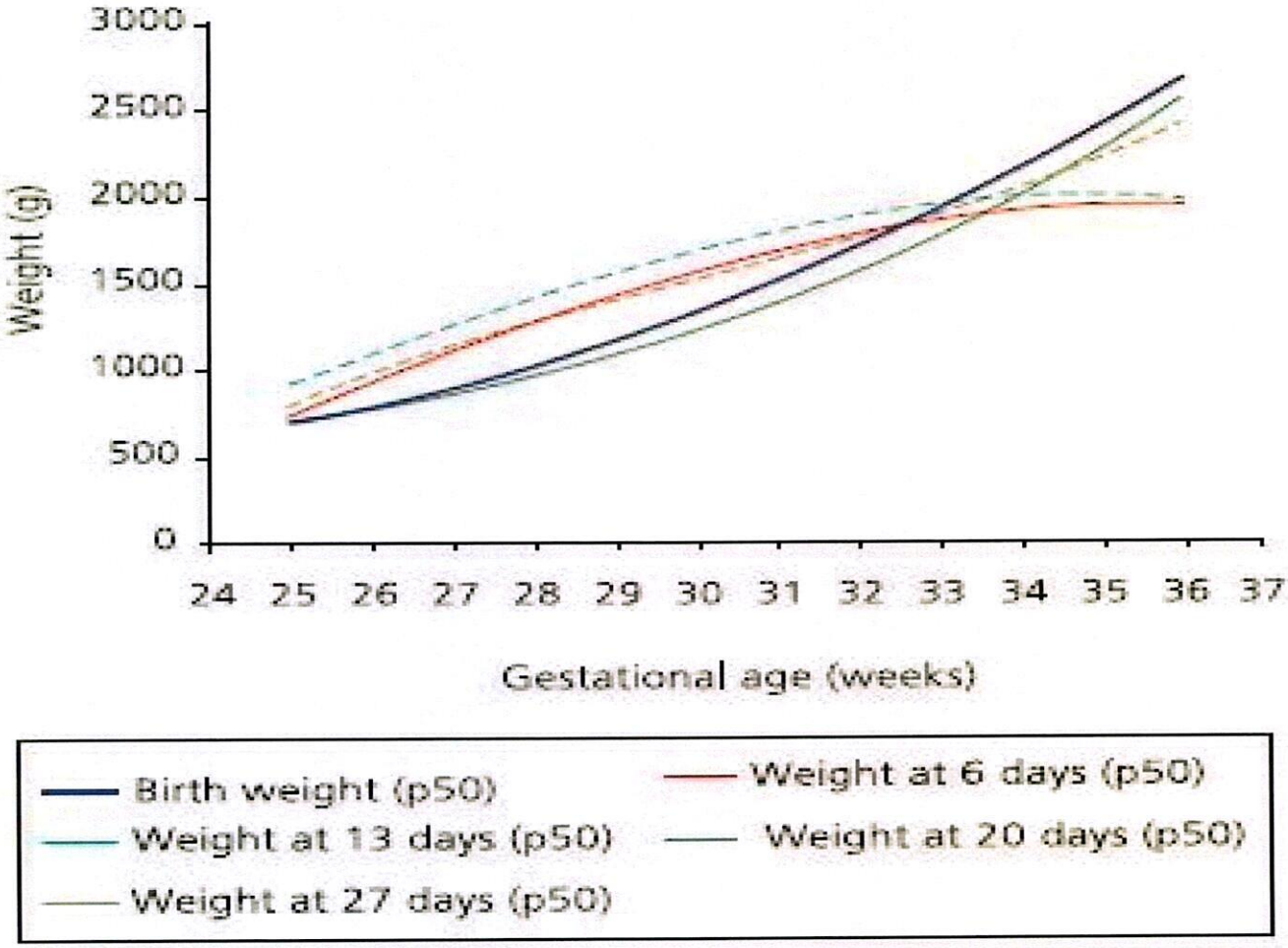
FFM, fat-free mass

IGF-1, insulin like growth factor 1.

FFM, fat-free mass;

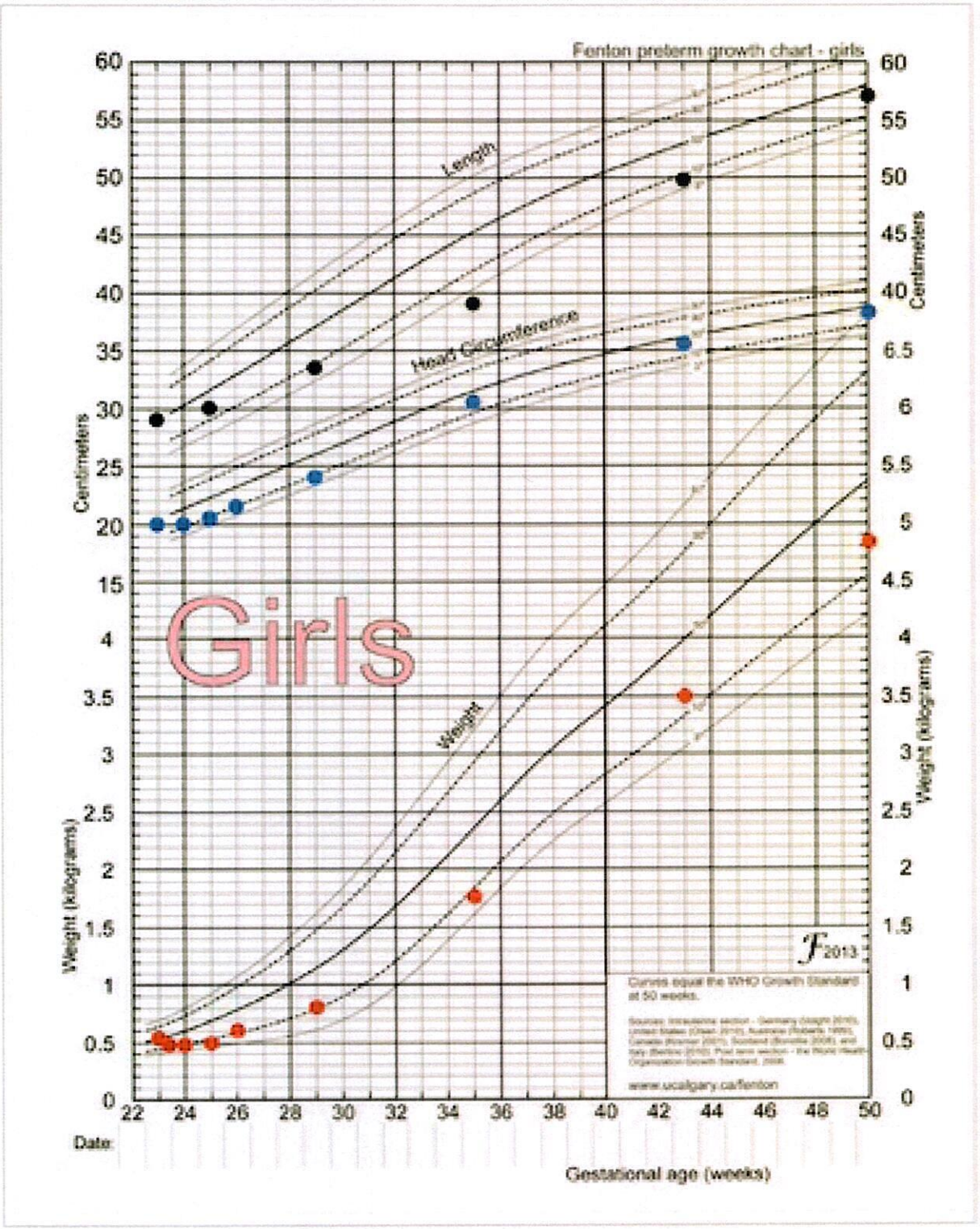
IGF-1, insulin like growth factor 1

Appendices 7.3 Extra-uterine Growth Restriction (EUGR):

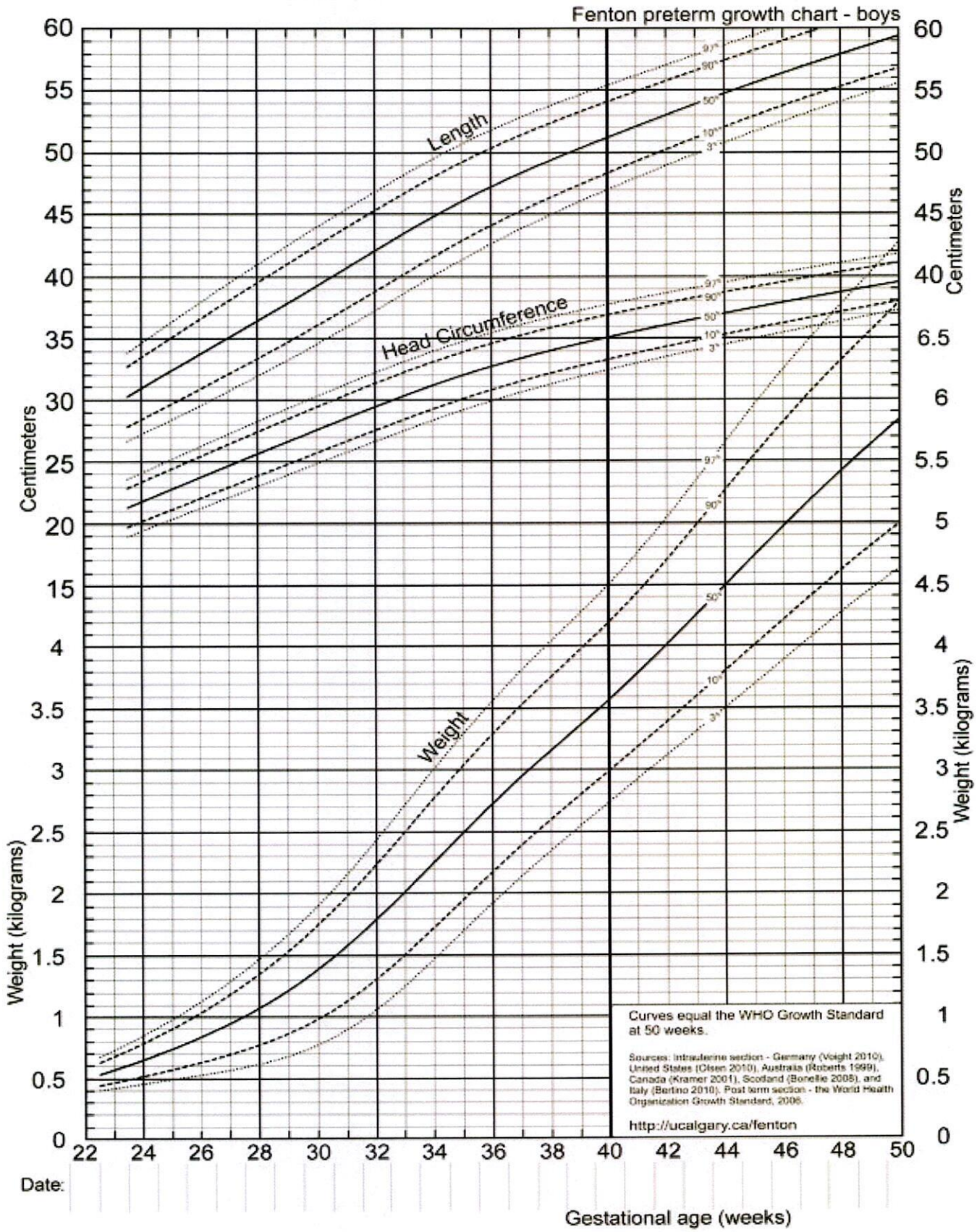


Median weight change per week on premature infants' first 27 days after birth according to gestational age at birth

Appendices 7.4 growth of preterm infants on fenton growth charts(girls):



Appendices 7.5 growth of preterm infants on fenton growth charts(males):



Feeding Protocol for infant < 750 gram

Type of Formula	Day of Feeding	Feeding Volume (Q4 hours)					
EBM/ Preterm Milk Formula	1	1	1	1	1	1	1
EBM/ Preterm Milk Formula	2	1	1	1	1	1	1
EBM/ Preterm Milk Formula	3	1	1	1	1	1	1

Minimal Enteral Feeding (MEF)

Type of Formula	Day of Feeding	Feeding Volume (Q2 hours)											
EBM/Preterm Milk Formula	4	1	1	1	1	1	1	1	1	1	1	1	1
EBM/Preterm Milk Formula	5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2
EBM/Preterm Milk Formula	6	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	3	3
EBM/Preterm Milk Formula	7	3.5	3.5	3.5	3.5	3.5	3.5	4	4	4	4	4	4
EBM/Preterm Milk Formula	8	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	5
EBM/Preterm Milk Formula	9	5.5	5.5	5.5	5.5	5.5	5.5	6	6	6	6	6	6
EBM/Preterm Milk Formula	10	6.5	6.5	6.5	6.5	6.5	6.5	7	7	7	7	7	7
EBM/Preterm Milk Formula	11	7.5	7.5	7.5	7.5	7.5	7.5	8	8	8	8	8	8
EBM/Preterm Milk Formula	12	8.5	8.5	8.5	8.5	8.5	8.5	9	9	9	9	9	9
EBM/Preterm Milk Formula	13	9.5	9.5	9.5	9.5	9.5	9.5	10	10	10	10	10	10

Feeding Protocol for infant 750- 999 gram

Type of Formula	Day of Feeding	Feeding Volume (Q4 hours)					
EBM/Preterm Milk Formula	1	1	1	1	1	1	1
EBM/Preterm Milk Formula	2	1	1	1	1	1	1
EBM/Preterm Milk Formula	3	1	1	1	1	1	1

Minimal Enteral Feeding (MEF)

Type of Formula	Day of Feeding	Feeding Volume (Q2 hours)											
EBM/Preterm Milk Formula	4	1	1	1	1	1	1	1	1	1	1	1	1
EBM/Preterm Milk Formula	5	2	2	2	2	2	2	2	2	2	2	2	2
EBM/Preterm Milk Formula	6	3	3	3	3	3	3	4	4	4	4	4	4
EBM/Preterm Milk Formula	7	5	5	5	5	5	5	6	6	6	6	6	6
EBM/Preterm Milk Formula	8	7	7	7	7	7	7	8	8	8	8	8	8
EBM/Preterm Milk Formula	9	9	9	9	9	9	9	10	10	10	10	10	10
EBM/Preterm Milk Formula	10	11	11	11	11	11	11	12	12	12	12	12	12
EBM/Preterm Milk Formula	11	13	13	13	13	13	13	14	14	14	14	14	14

Feeding Protocol for infant 1000- 1249 gram

Type of Formula	Day of Feeding	Feeding Volume (Q2 hours)											
EBM/Preterm Milk Formula	1	1	1	1	1	1	1	1	1	1	1	1	1
EBM/Preterm Milk Formula	2	2	2	2	2	2	2	3	3	3	3	3	3
EBM/Preterm Milk Formula	3	4	4	4	4	4	4	5	5	5	5	5	5
EBM/Preterm Milk Formula	4	6	6	6	6	6	6	7	7	7	7	7	7
EBM/Preterm Milk Formula	5	8	8	8	8	8	8	9	9	9	9	9	9
EBM/Preterm Milk Formula	6	10	10	10	10	10	10	11	11	11	11	11	11
EBM/Preterm Milk Formula	7	12	12	12	12	12	12	13	13	13	13	13	13
EBM/Preterm Milk Formula	8	14	14	14	14	14	14	15	15	15	15	15	15
EBM/Preterm Milk Formula	9	16	16	16	16	16	16	17	17	17	17	17	17

Feeding Protocol for infant 1250 - 1499 gram

Type of Formula	Day of Feeding	Feeding Volume (Q3 hr)							
EBM/Preterm Milk Formula	1	1	1	1	1	1	1	1	1
EBM/Preterm Milk Formula	2	2	2	3	3	4	4	5	5
EBM/Preterm Milk Formula	3	6	6	7	7	8	8	9	9
EBM/Preterm Milk Formula	4	10	10	11	11	12	12	13	13
EBM/Preterm Milk Formula	5	14	14	15	15	16	16	17	18
EBM/Preterm Milk Formula	6	19	19	20	20	21	21	22	22
EBM/Preterm Milk Formula	7	23	23	24	24	25	25	26	26
EBM/Preterm Milk Formula	8	27	27	28	28	29	29	30	30

Feeding Protocol for infant 1500 -1749 gram

Type of Formula	Day of Feeding	Feeding Volume (Q3 hr)							
EBM/Preterm Milk Formula	1	2	2	2	2	2	2	2	2
EBM/Preterm Milk Formula	2	3	3	4	4	5	5	6	6
EBM/Preterm Milk Formula	3	7	7	8	8	9	9	10	10
EBM/Preterm Milk Formula	4	11	11	12	12	13	13	14	14
EBM/Preterm Milk Formula	5	15	15	16	16	17	17	18	18
EBM/Preterm Milk Formula	6	19	19	20	20	21	21	22	22
EBM/Preterm Milk Formula	7	23	23	24	24	25	25	26	26
EBM/Preterm Milk Formula	8	27	27	28	28	29	29	30	30
EBM/Preterm Milk Formula	9	31	31	32	32	33	33	34	34