Tara K. Bastek, MD, MPH, and Karen M. Varga, RD, LDN, CNSC

Preterm Nutrition Through Discharge: A Case-Based Challenge

Pediatric Nutrition
CONTINUING EDUCATION FOR CLINICIANS
pnce.org

ANNENBERG CENTER FOR HEALTH SCIENCES
AT EISENHOWER
Imparting knowledge. Improving patient care.

This activity is supported by an educational grant from
Mead Johnson Nutrition.

Presenters

Tara K.

BASTEK, MD, MPH

Neonatologist
Chair, Ethics Committee
WakeMed Health and Hospitals
Raleigh, North Carolina

Karen M.

VARGA, RD, LDN, CNSC

Pediatric/Neonatal Registered Dietitian
WakeMed Health and Hospitals
Raleigh, North Carolina

Faculty Disclosures

Tara K. Bastek, MD, MPH

Speakers Bureau	Mead Johnson Nutrition
Consultant/Speaker	CAE Healthcare

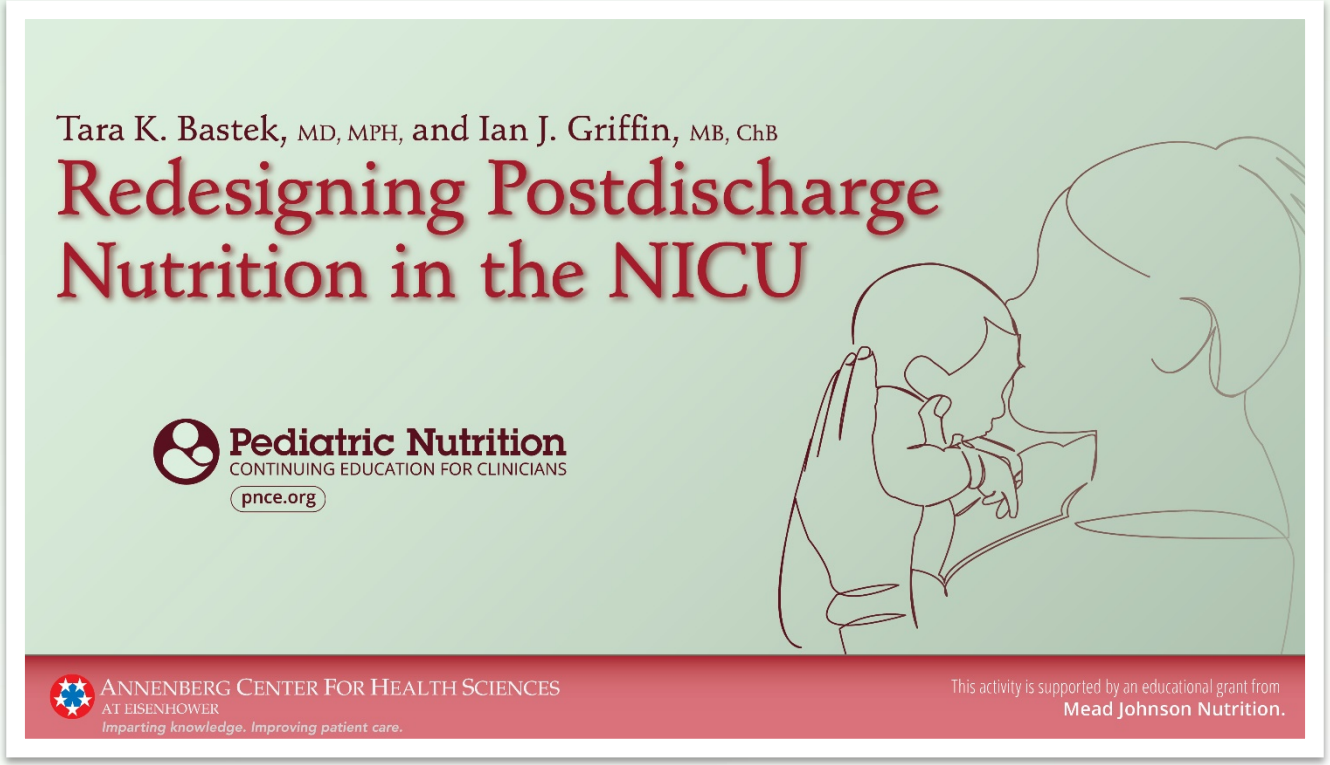
Karen M. Varga, RD, LDN, CNSC

Speakers Bureau	Reckitt/Mead Johnson Nutrition

Learning Objectives

- Link nutrient intake recommendations to the expected growth for preterm infants
- Apply the latest evidence supporting preterm infant convalescent and discharge nutrition
- Recommend novel approaches to convalescent and discharge feeds when a preterm infant is designated as at risk for growth failure or micronutrient deficiencies
- Customize nutritional interventions to help close the growth failure gap in the NICU and at discharge

Recommended for Foundational Knowledge



Tara K.
BASTEK, MD, MPH

and

Ian J.
GRIFFIN, MB, CHB

Director, Clinical and Translational Research
Mid-Atlantic Neonatal Associates
Biomedical Research Institute of New Jersey
Morristown, New Jersey

Trends of Preterm Infants In the NICU

- Preterm birth affects 1 of every 10 infants in the US
- 3,500–4,000 infants born at 22–27 weeks GA in US
- Rates decreased from 2007 to 2014; however, preterm birth rate rose for the fourth straight year in 2018
- Trends in Care Practices, Morbidity, and Mortality in Extremely Preterm Neonates, 1993–2012 [1]
  - Retrospective cohort study, N=154,233 neonates
  - Survival to discharge without comorbidities improving at 25–28 weeks
  - Percentage of babies with comorbidities at 22–24 weeks GA is **not trending down**

GA, gestational age; NICU, neonatal intensive care unit.

1. Stoll BJ, et al. *JAMA*. 2015 8;314:1039-51.

Extrauterine Growth Restriction Is Common

Inadequate extrauterine growth results from

- Increased metabolic demand
- Poor early metabolic tolerance
- Poor feeding tolerance
- Infections
- Respiratory distress
- Pharmacologic effects
- Inadequate nutritional supply

Potential consequences of inadequate growth

Impaired neurodevelopment

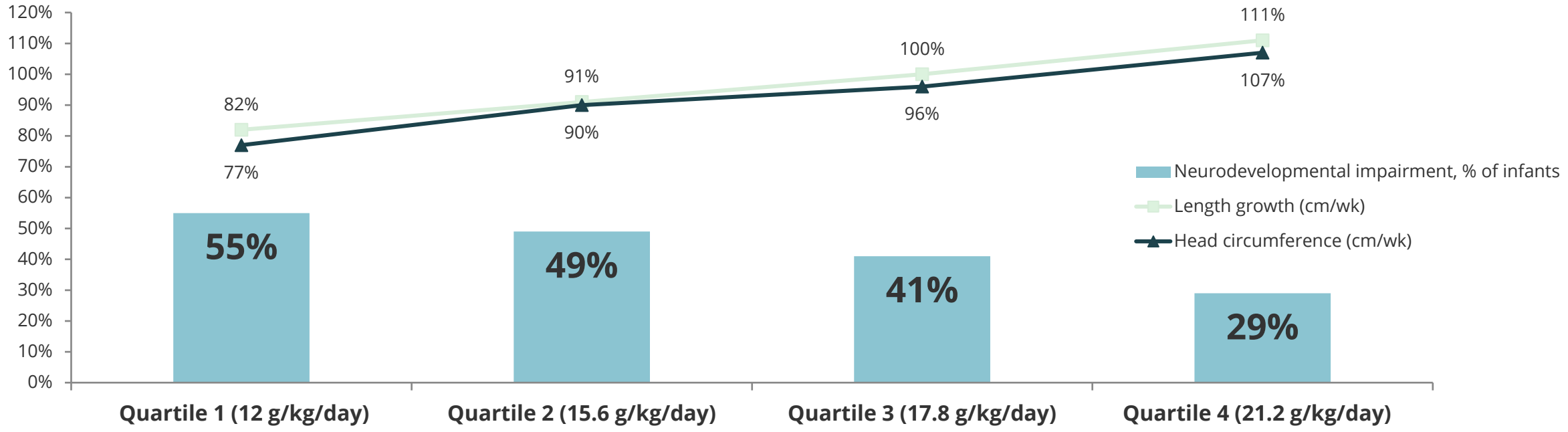
Delayed cognitive development

Delayed growth

Lapillonne A et al. *J Pediatr.* 2013;162:S7-S16.

Faster Growth Linked to Better Neurodevelopmental Outcomes

Figure. **Neurodevelopmental impairment decreases when growth velocity increases**



Neurodevelopmental impairment defined as the presence of any of the following: cerebral palsy, MDI <70, PDI <70, deaf/hearing loss requiring amplification in both ears or bilaterally blind.

MDI, mental development index; PDI, physical development index.

Ehrenkranz RA et al. *Pediatrics*. 2006;117(4):1253-1261.

Evidence of the importance of growth in the NICU to help prevent growth restriction

	Q1 (n=124)	Q2 (n=122)	Q3 (n=123)	Q4 (n=121)	*P*
Weight gain mean (SD) g/kg/d	12.0 (2.1)	15.6 (0.8)	17.8 (0.8)	21.2 (2.0)	
Normal neurologic exams	70	77	76	86	<.01
Q1 vs Q4 equates 2.53x risk of NDI					
CP, %	21	13	13	6	<.01
MDI <70,%	39	37	34	21	<.01
PDI <70,%	35	32	18	14	<.001
Weight <10 percentile, %	58	61	51	46	.03
Length <10 percentile, %	47	43	29	28	<.001
HC <10% percentile, %	31	18	18	22	.098
Rehospitalization, %	63	60	50	45	<.01

HC, head circumference; MDI, Mental Developmental Index; NDI, neurodevelopmental impairment; PDI, Psychomotor Developmental Index.

Cohort of over 400 extremely low birth weight (ELBW) infants looking at developmental outcome and growth at 18-22 months of age.

Ehrenkranz RA, *Pediatrics*. 2006;117:1253-1257.

"Preterm Birth is a Nutritional Emergency."

–Hay 2018

- **NICUs *must* focus on nutrition** because intake in the NICU affects growth and long-term health
- Easy to blame other diseases on a lack of growth, but **poor nutrition is the driver of many morbidities**
- Protocols are needed to guide nutrition
- Highly variable nutritional practices in busy NICUs can produce variable growth outcomes

Hay WW Jr. *Pediatr Gastroenterol Hepatol Nutr*. 2018;21:234-247.

Nutrient Intake Recommendations

"From the start of care, we implement recommendations from the experts."

–Tara K. Bastek, MD, MPH

Optimal Macronutrients and Micronutrients

- Preterm infants have altered body composition (eg, less muscle mass, more fat mass) compared to term
- Protein and energy needs are greater
- **LC-PUFAs** (including DHA & ARA) support neurodevelopment and immune system development
- Preterm infants require increased intake of vitamins and minerals compared with their term counterparts
- Low iron stores—associated with poor neurodevelopment outcomes [1],[2]

ARA, arachidonic acid; DHA, docosahexaenoic acid; LC-PUFA, long chain polyunsaturated fatty acids.

1. Young BE, et al. *Curr Pediatr Rep.* 2013;1:247-256.
2. Baker RD, et al. *Pediatrics.* 2010;126:1040-1050.

Recommended Intakes of Select Micronutrients

	Per kg body weight per day	Per 100 Cal
Calcium, mg	120–200	109–182
Phosphate, mg	60–140	55–127
Sodium, mg	69–115	63–105
Iron, mg	2–3	1.8–2.7
Zinc, mg	1.4–2.5	1.3–2.3
Vitamin D, IU	400–1,000 [a] (per day)	100–350 [b]

a. Total IU/day from milk and supplement
b. From milk only

Global expert recommendations made by Koletzko et al 2014 [1] for select micronutrients.

1. Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.

Recommended Intakes

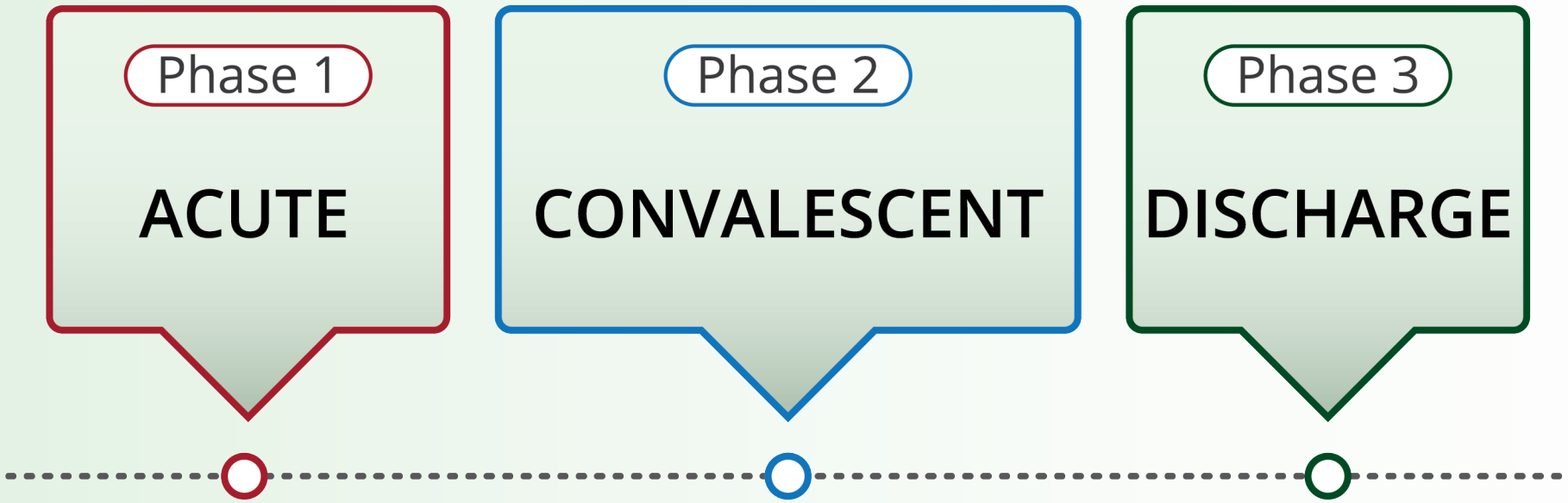
	Per kg body weight per day	Per 100 Cal
Fluids, mL	135–200	
Energy, Cal	110–130	
Protein, g	3.5–4.5	3.2–4.1
Lipids, g	4.8–6.6	4.4–6.0
DHA, mg	18–60	16.4–55
ARA, mg	18–45	16.4–41
Carbohydrate, g	11.6–13.2	10.5–12

ARA, arachidonic acid; DHA docosahexaenoic acid.

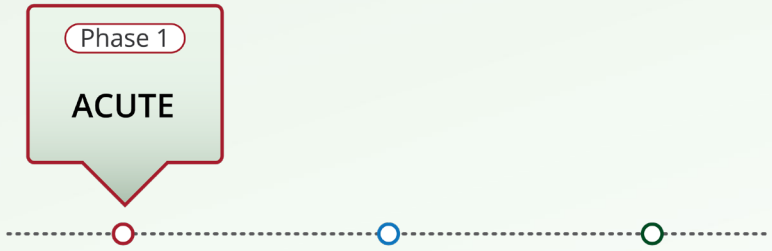
- Compared with Tsang et al 2005 [1] recommendations (3.0–3.6 g/kg/day), Koletzko et al 2014 [2] recommends increased protein intake at 3.5–4.5 g/kg/day
- DHA intake of 18–60 mg/kg/day compared with 12–30 mg/kg/day intake recommended by ESPGHAN 2010 [3]

1. Tsang RC, et al. Digital Educational Publishing, Inc. 2005.
2. Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.
3. Braegger C, et al. *J Pediatr Gastroenterol Nutr.* 2010;51:110-22.

Feeding Methods in 3 Phases



Phase 1: Acute Feeding Phase

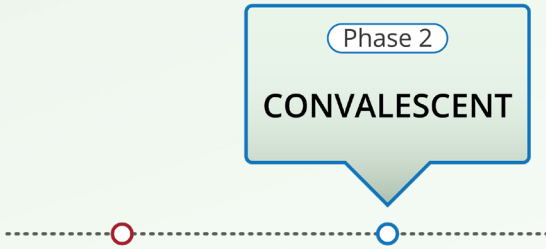


- **Acute** (parenteral nutrition) TPN IV nutritional feeds
  - Amino acid infusion mixtures important for parenteral nutrition
- Most growth failure occurs during transition phase to enteral feeds [1]
- This phase determines how well the baby can use nutrition and micronutrients for growth vs survival [1]
- TPN Protocols beneficial—safety, adherence, best practice [2]
- Careful monitoring is key to optimize nutrition for individual patients

TPN, total parenteral nutrition.

1. Hay WW Jr. *Pediatr Gastroenterol Hepatol Nutr.* 2018;21:234-247.
2. Adamkin DH,et al. *J Neonatal Perinatal Med*. 2014;7(3):157-164

Phase 2: Convalescent Phase



- **Convalescent phase** defined as period during which preterm is feeding and growing
- **“Transition nursery”** and **“feeder grow”** stage
- Tempting to become complacent with infants in this stage
- Long periods of time
- Volume and composition is under provider’s control

Improved growth in this phase can mitigate the effects of poorer growth earlier.

Roggero P, et al. *Nutrients*. 2020;12:1857. Adamkin DH, et al. *J Neonatal Perinatal Med*. 2014;7:157-164.

Challenge Question #1

What is an appropriate growth velocity for a baby in the convalescent phase in the NICU (<36 weeks)?

Breastmilk Production Support

- Benefits of human milk
  - Immune protection
  - Influences preterm gut microbiota and intestinal maturation
- Breastmilk is optimal for all infants but requires supplementation to produce and sustain growth in preterm infants
  - Feeding methods include NG tube, breast, or bottle feed
  - Qualified and extended lactation support is required for mothers with frequent follow-up

NG, nasogastric.

1. Lapillonne A et al. *J Pediatr Gastroenterol Nutr.* 2019;69:259-270.
2. Collado MC, et al. *Pediatr Res.* 2015;77:726-731.
3. Miller J, et al. *Nutrients*. 2018;10:707.

Phase 3: Discharge—Post-NICU Recovery

- Healing period continues. Nutrition monitoring still vital!
- Nutritional volume is prescribed by provider in charge of composition
- Meeting nutritional goals while being mindful of important changes

If you don't do well in the previous 2 phases, baby will fall behind in Phase 3.

Nutritional Evaluation Prior to Discharge

- Develop feeding plan prior to discharge, consider the following:
  - Has the preterm infant had poor weight gain during NICU stay?
  - Is the preterm infant's discharge weight <10th percentile?
  - Is the preterm infant at higher nutrition risk due to BW <1000 g or on prolonged PN during NICU course?
- Confirm appropriate growth is demonstrated based on discharge feeding regimen
- Important to ask:
  - Can the preterm infant ingest the proper amount of human milk or formula for continued growth and development?
  - Does human milk fortifier or formula include all key nutrients for continued growth and development?
- Discharge and higher calories

Individualized Fortification Flexibility

- Common approach of "standard" discharge feeds:
  - Baby needs 22 or 24 cal/feeding (fortified BM or straight mix formula)
  - Not very flexible for family needs; likely to fall short nutritionally
- "Individualized" fortification allows flexibility to get total calories needed in 24-hr period
- The additives/fortification/products used may be standard (or few in number/variety), but the feeding plan is individualized, *logistically*

"Individualized" Fortification
For some, this could mean 24 cal feeds 8/day
For others it might be 2 or 3 or 4 breastfeeds a day, and 24 or 27 cal/feeds for the rest
Others may include mom's milk for 5 to 6 feeds/day and 4–6oz of 30 cal/feeds for the other 2 feeds

A Word About Growth Curves

Growth Charts vs Target Goals

- Growth charts preferred to show patterns over time; illustrates growth failure and/or recovery during NICU course and long-term growth trajectory for catch-up growth
- Targets goals—variable depending on parameters
  - Change with corrected gestational age vs chronological age
  - Change with different growth trajectories (eg, whether 90th or 10th centile)
- Important to use growth charts in combination as preterm infants transition from NICU to home and new growth goals are established

Challenge Question #2

When do you transition from using preterm growth charts to WHO growth charts?

Growth Charts

High-quality neonatal growth charts that use advanced mathematical modeling. Although, we still don't know what is "optimal."

Olsen (developed from NICU growth data) Bertino (developed from 'ideal' growth data)	Up to 36 weeks GA	• Assess for GA, SGA, LGA • Not recommended for growth monitoring for preterm >36 wks
Fenton	Between 23–50 weeks correct age (10 weeks post-term)	• Best growth chart to assess longitudinal growth in preterm infants over this period • Validated as a growth monitoring tool in preterm infants • Definitions of poor growth are strongly related to long-term outcomes
World Health Organization	Term birth to 24 months	• Separate male and female curves • Very large international sample size • Widely used

SGA, small for gestational age; LGA, large for gestational age.

Griffin IJ. Growth management in preterm infants. UpToDate.com. Last updated: Jun 17, 2020.
Fenton TR, et al. *J Pediatr*. 2018;196:77-83. WHO growth standards: https://www.who.int/tools/child-growth-standards/standards

What to Measure: Pros and Cons and Target Goals

	Pros	Cons	Target [1]
Weight	• Easy to do • Done daily • Easy to see trends • Cleary associated with short- and long-term outcomes	• Affected by fluid status • Diuretics • Only reflects short period of time	• 23–36 weeks: 15–20 g/kg/d • >36 weeks: 20–35 g/d (girls) 23–43 g/d (boys)
Length	"Real" growth	• Hard to do • Inaccurate	• ~1 cm/wk
Head circumference	• Strongly related to developmental outcome • Easy to do	• Confounded by change in head shape	• ~1 cm/wk

1. Fenton TR, et al. *BMC Pediatr*. 2013 20;13:59

WHO Growth Velocity Standards (in grams)

Age	Boys		Girls	
1-month increments	Median change at 50th percentile	Daily Rate	Median change at 50th percentile	Daily Rate
0–4 wks	1023	34.1	879	29
4 wks–2 mo	1196	40	1011	34
2–3 mo	815	27	718	24
3–4 mo	617	21	585	20
4–5 mo	522	17	489	16
5–6 mo	422	14	401	13
6–7 mo	357	12	344	11
7–8 mo	316	11	311	10
8–9 mo	285	10	273	9
9–10 mo	259	9	245	8
10–11 mo	243	8	233	8
11–12 mo	239	8	232	8

WHO growth standards: https://www.who.int/tools/child-growth-standards/standards

Case Study “Ava”

Background		
Born at 30w5d	**DOB 9/17/2020**	
Birth weight	745 g	(2%, Z-score -2.00) [a]
Birth length	34 cm	(2%, Z-score -2.11)
Birth HC	22.8 cm	(0.05%, Z-score -3.32)
Born to 21-yr old G1P1 via c/s due to recurrent decelerations in the setting of intermittent reverse and absent end diastolic flow on US		
Pregnancy complicated by known IUGR, anxiety, tobacco dependence, palpitations, hx of chlamydia		
Feeding plan per mother is breastfeeding		
Mom signed consent for donor milk		

a. Fenton premature growth chart

Fenton TR, Kim JK. *BMC Pediatr*. 2013;13:59.

A

Ava

Nutrition Progression: Phase 1 & 2

Phase 1:

- Feeds began on DOL 1, per high-risk feeding protocol due to IUGR status
- Enteral feeds advanced per protocol and at goal on DOL 12
- IVF/TPN discontinued 9/30 with stable BG

Phase 2: DOL 12: Goal feeds MBM with liquid HMF 24 cal/oz at 150 mL/kg

Nutrient	Recommended	Provided—MBM w/LHMF 24
Energy, kcal/kg	110–130	**121**
Protein, g/kg	3.5–4.5	**3.9**
Vitamin D	400–1000	**610 (w/ supplementation)**
Iron	2–3	**3.3 (w/ supplementation)**
Calcium	120–200	**177**
Phos	60–140	**98**

BG, blood glucose; DOL, day of life; HMF, human milk formula; IUGR, Intrauterine growth restriction; IVF, intravenous fluids; LHMF, liquid human-milk fortifier; MBM, maternal breast milk; TPN, total parenteral nutrition.

Ava

Nutrition Progression: Phase 2 continued

- DOL 14: Additional vitamin D and iron supplements started
- DOL 23: Feedings changed to HP fortifier, as infant receiving mix of DM and MBM (likely receiving less protein than estimated)
- DOL 25: Modular fat supplement added to provide additional 10 kcal/kg
- Feeds adjusted to provide ~131 kcal/kg and 4–4.5 g/kg protein (Based on DBM vs MBM)
- DOL 48: (37w3d) feeds changed to preterm HP RTF 24 cal formula @ 160 mL/kg as mom no longer providing MBM

Average weight gain from DOL 10 to 36 weeks Gestational Age: 21.9 g/kg/d
Average weight gain from 36 weeks to discharge at 37w6d: 22 g/d

DOL, day of life; DBM, donor breast milk; HP, high protein; MBM, maternal breast milk; HP RTF, high-protein, ready-to-feed, preterm formula.

Phase 3: Discharge Nutrition Assessment

Discharged 11/6/2020	Weight 1770 grams (0.07%, Z-score—3.18 based on Fenton chart) at 37w6d and DOL 51
Discharge feedings	PRTF HP 24 cal po ad lib

- Plan for HP RTF 24 at home for ~4 weeks post discharge with follow-up in SICC
- Day prior to discharge baby took in 170 mL/kg HP RTF 24

Nutrient	Recommended	Provided—PRTF HP 24 at 170mL/kg
Energy, kcal/kg	110–130	**136**
Protein, g/kg	3.5–4.5 (2.8–3.2) [a]	**4.8**
Vitamin D	400–1000 (400) [a]	**722**
Iron	2–3 (2) [a]	**2.4**
Calcium	120–200 (70–140) [a]	**224**
Phos	60–140 (35–90) [a]	**122**

a. Estimated needs at discharge with no accumulated nutrient deficits (Uauy et al 2014 [1]; Agostoni et al 2010 [2])

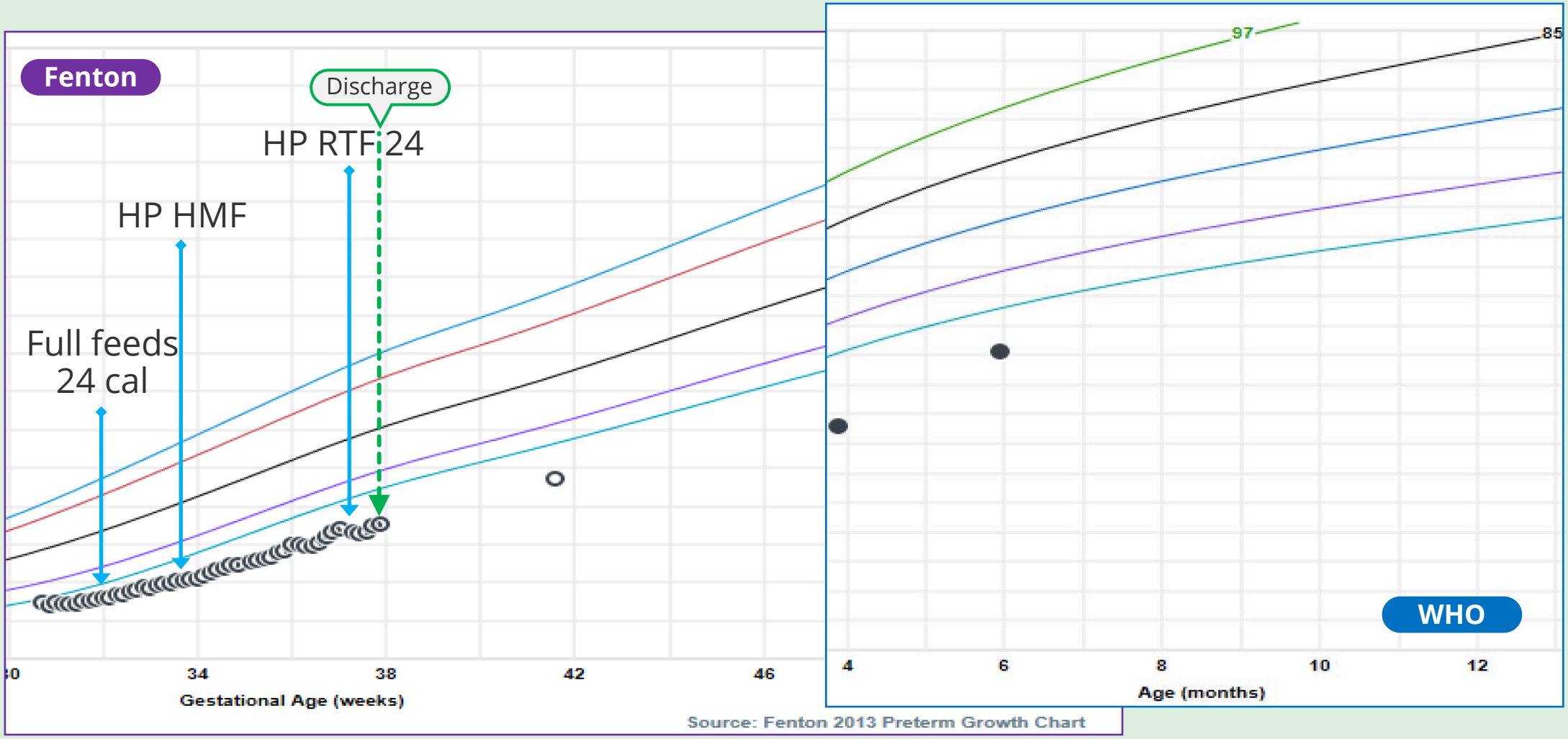
DM, donor milk; HP RTF, high-protein, ready-to-feed, preterm formula; MBM, maternal breast milk; SICC, Special Infant Care Clinic.

1. Uauy R, et al. *World Rev Nutr Diet.* 2014;110:4-10. 2. Agostoni C, et al. *J Pediatr Gastroenterol Nutr.* 2010;50:85-91.
3. Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

A

Ava

Case A—Combined



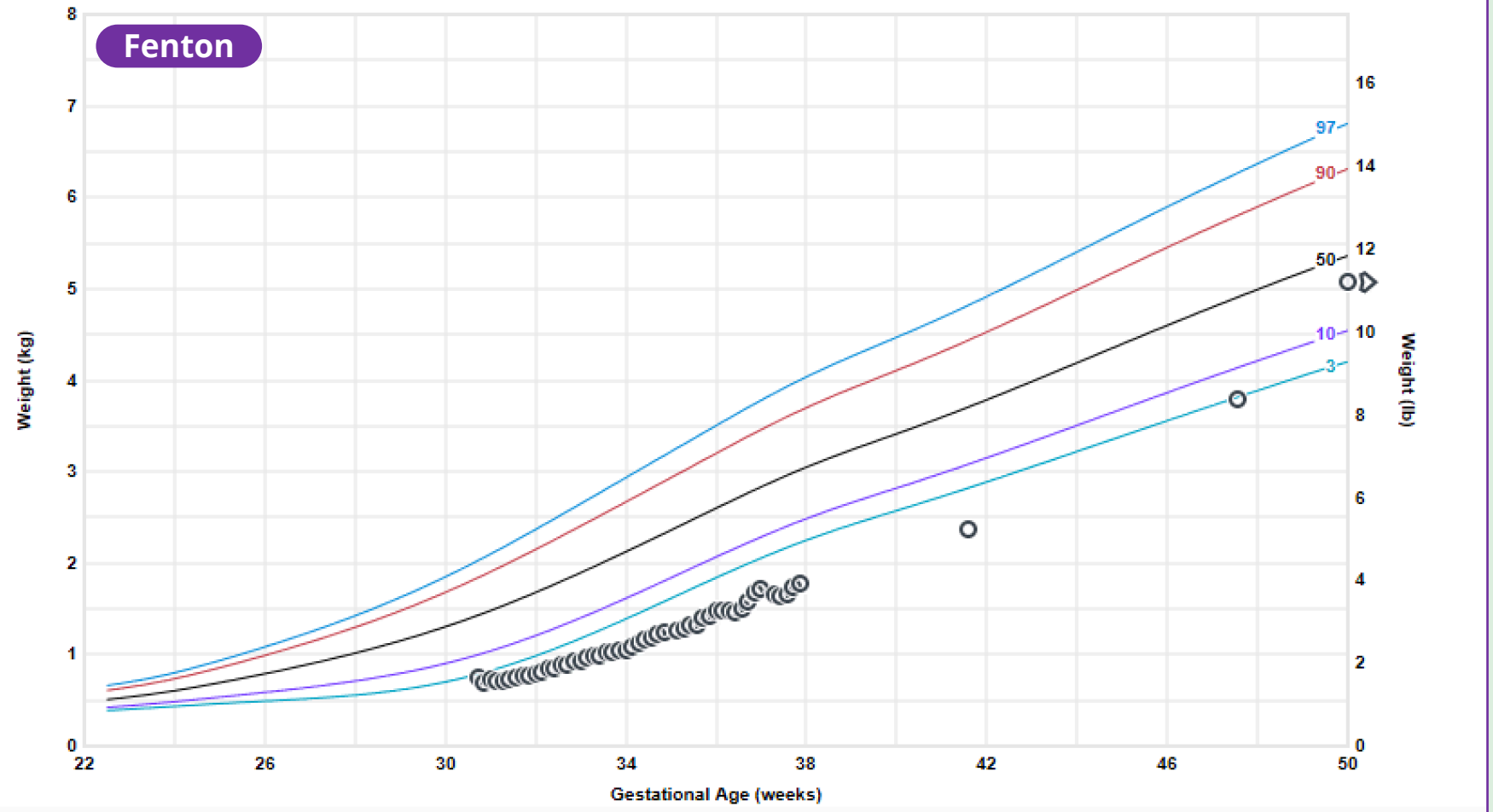
HP RTF, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.

A

Ava

Case A: Fenton Curve

Weight-for-age Percentiles (Premature girls, 22.5 to 50 weeks)

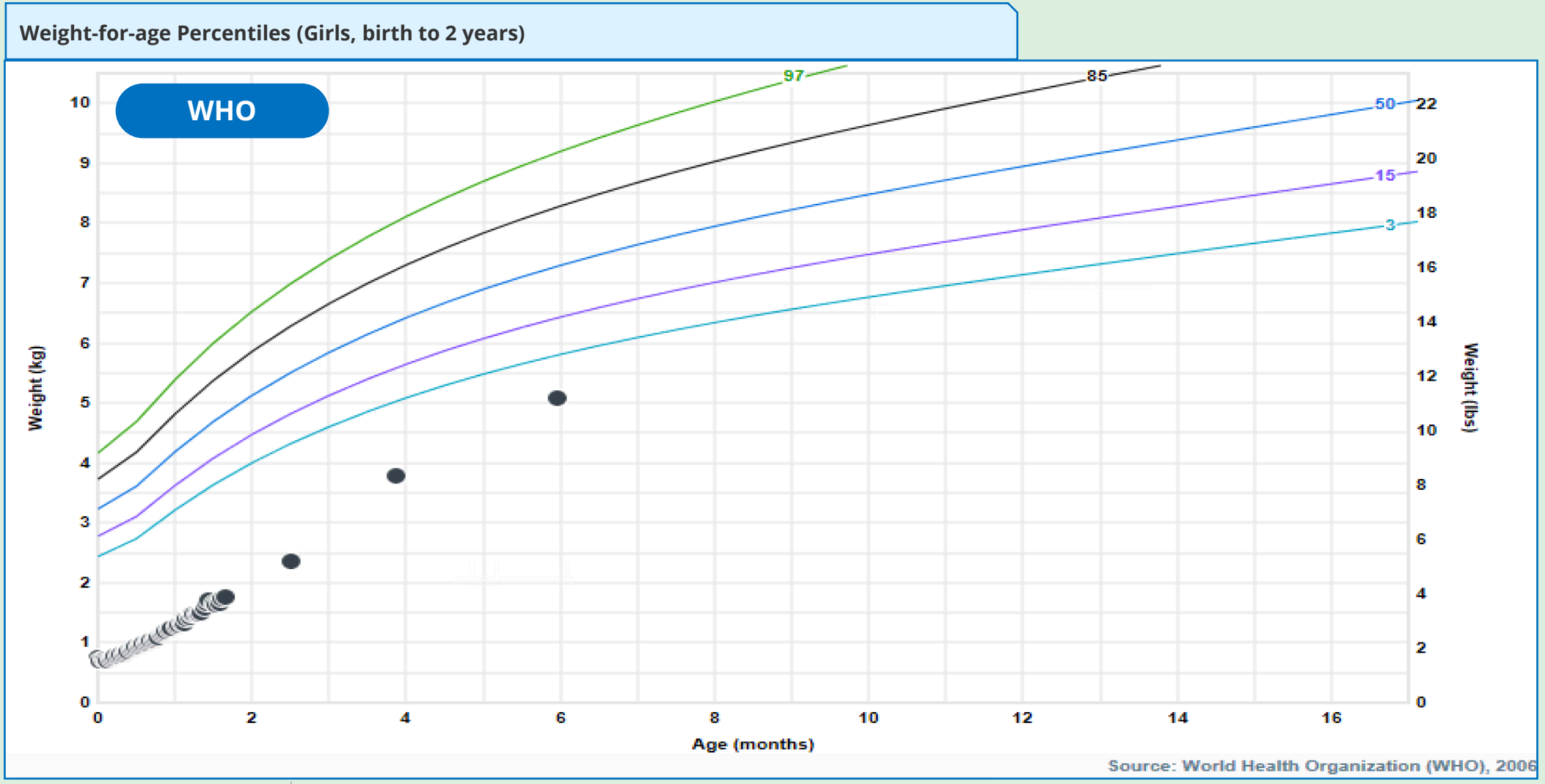


Source: Fenton 2013 Preterm Growth Chart

A

Ava

Case A: WHO Curve

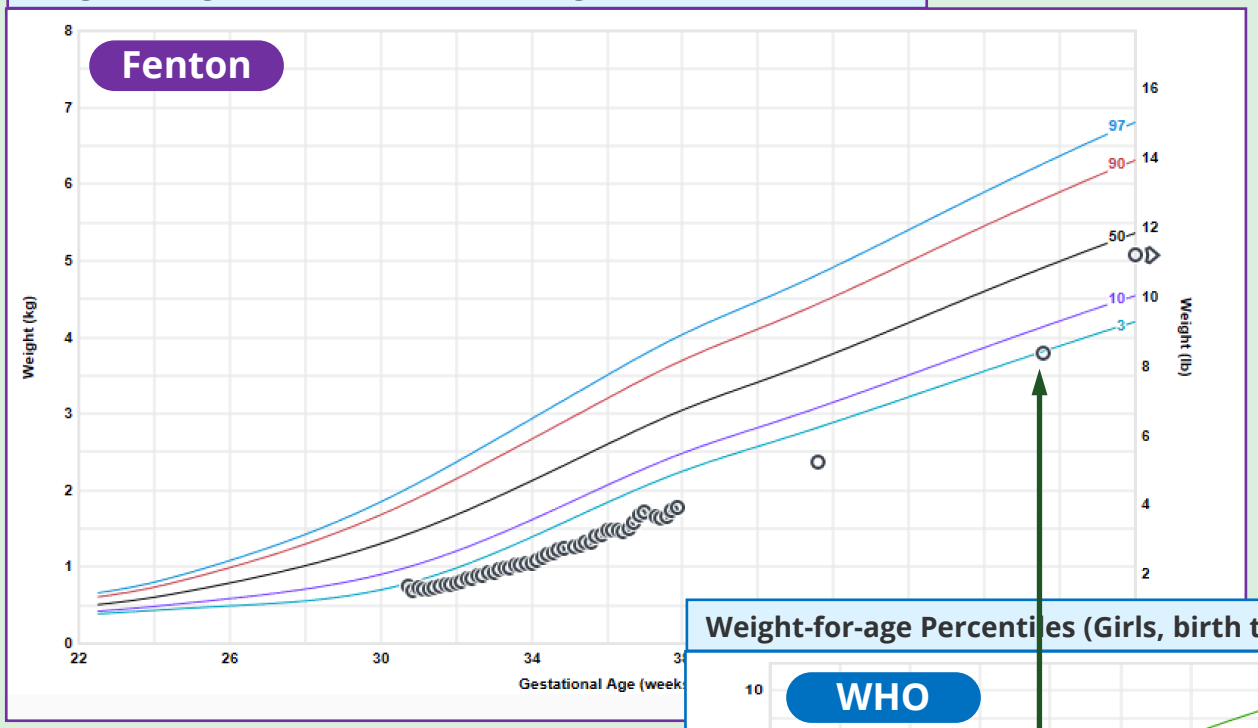


A

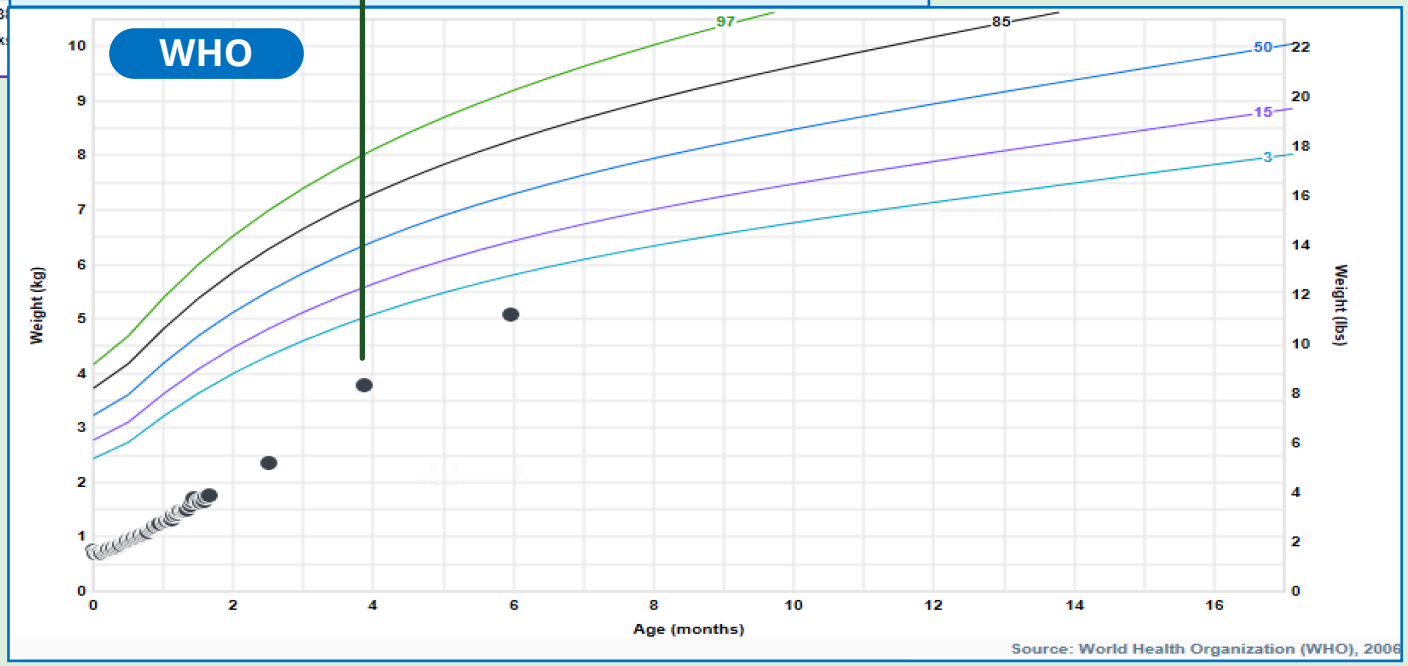
Ava

A

Weight-for-age Percentiles (Premature girls, 22.5 to 50 weeks)

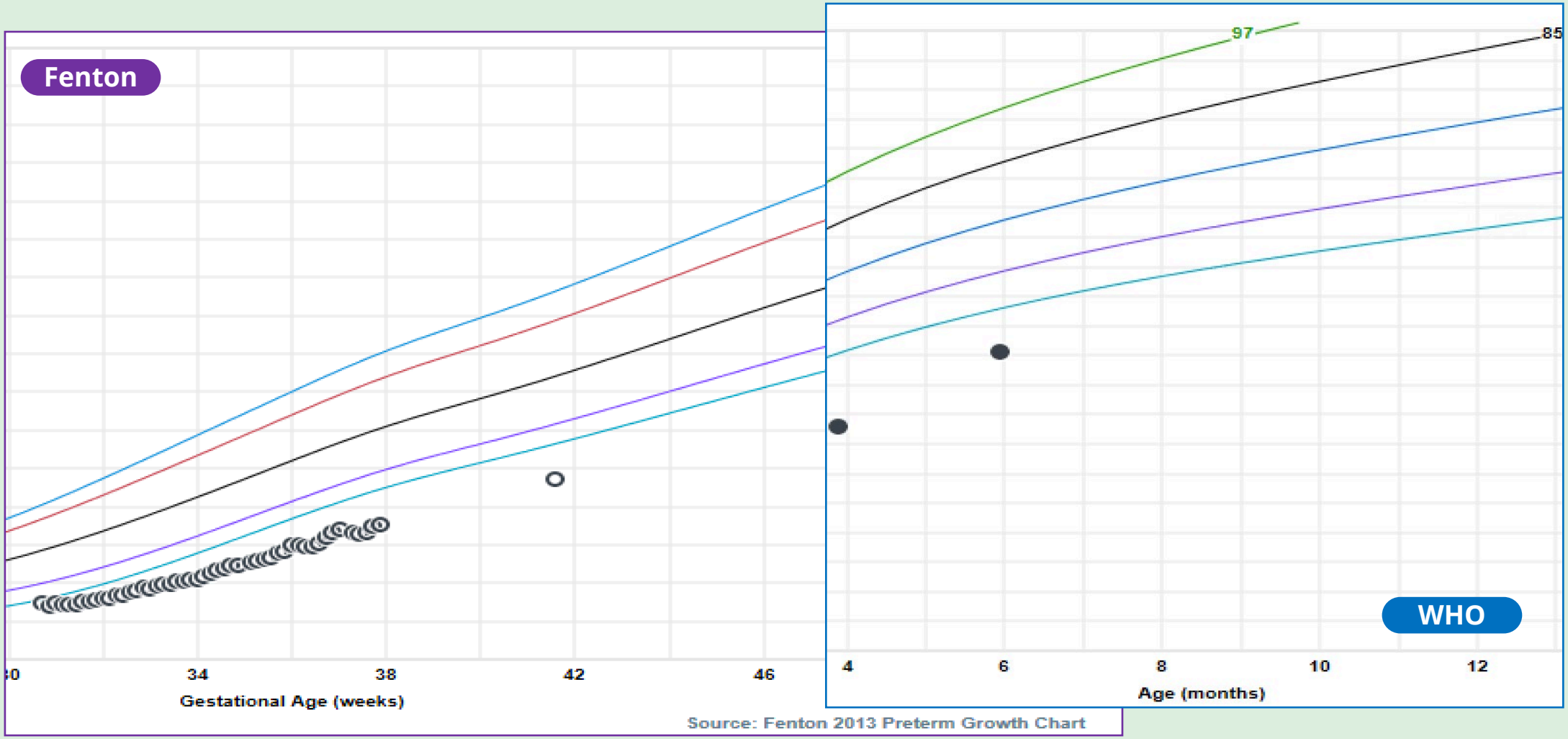


Weight-for-age Percentiles (Girls, birth to 2 years)



Ava

Case A—Combined



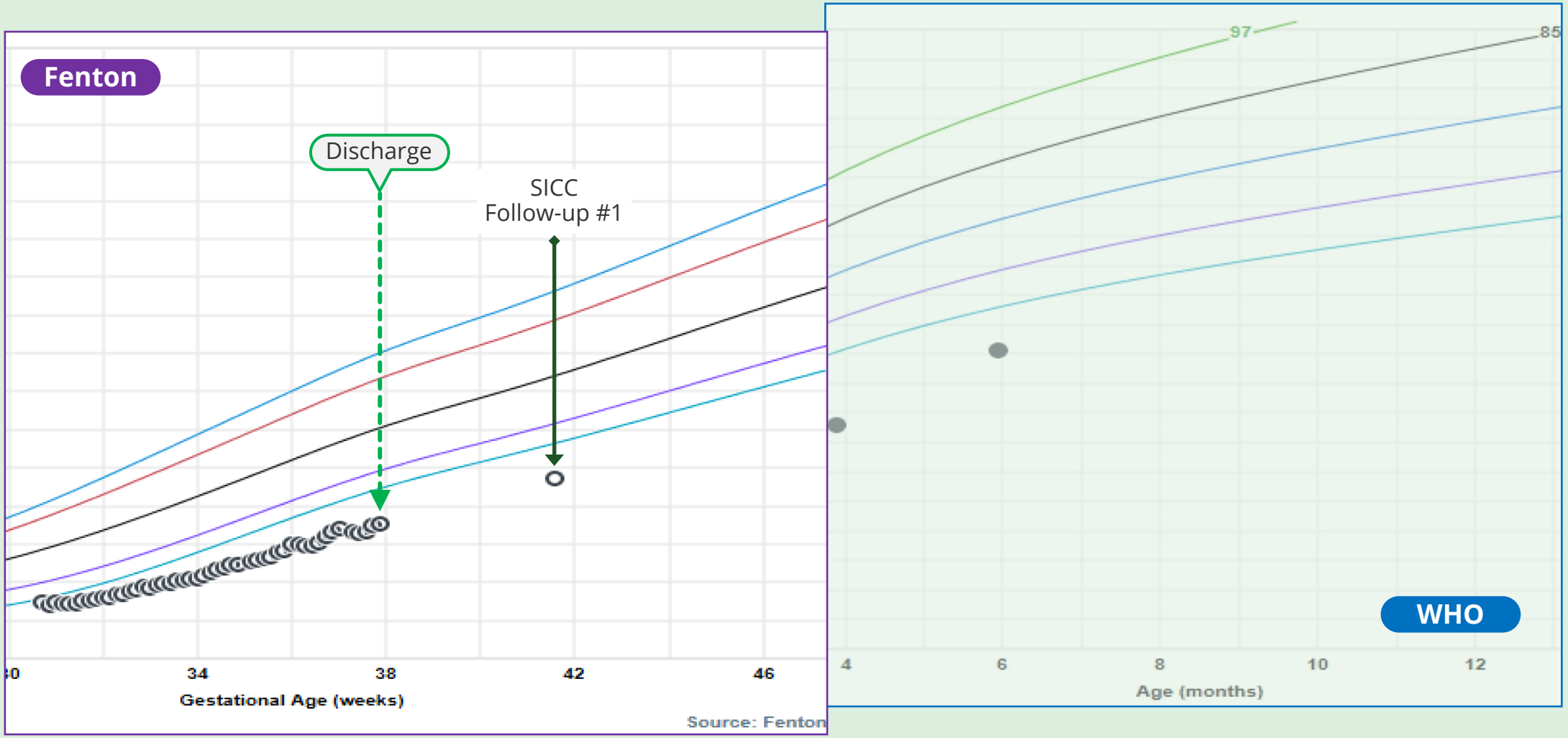
A

Ava

Audience Poll – Case A

Do you use the Fenton Growth Calculator (available on PediTools website) to determine goal growth rates?

Case A—Combined



SICC, Special Infant Care Clinic.

A

Ava

Phase 3: 1st Clinic Follow-Up Visit

Date: 12/2/2020 **PMA: 41w4d**

Weight: 2.362 kg (0%, Z-score: -3.07 based on Fenton Growth chart)
Growth velocity: 23 g/d on average since discharge (Goal 21 g/d on per Fenton Calculator [a])

- Feeds changed to preterm discharge powder formula 24 cal/oz po ad lib (taking ~170 mL/kg)

Nutrient	Recommended	Provided—PDF 24 at 170 mL/kg
Energy, kcal/kg	110–130	136
Protein, g/kg	3.5–4.5 (2.8–3.2) [b]	3.8
Vitamin D	400–1000 (400) [b]	441 (w/supplement)
Iron	2–3 (2) [b]	4.7 (w/supplement)
Calcium	120–200 (70–140) [b]	163
Phos	60–140 (35–90) [b]	90

a. Growth Calculator available on Peditools.org
b. Estimated needs at discharge with no accumulated nutrient deficits

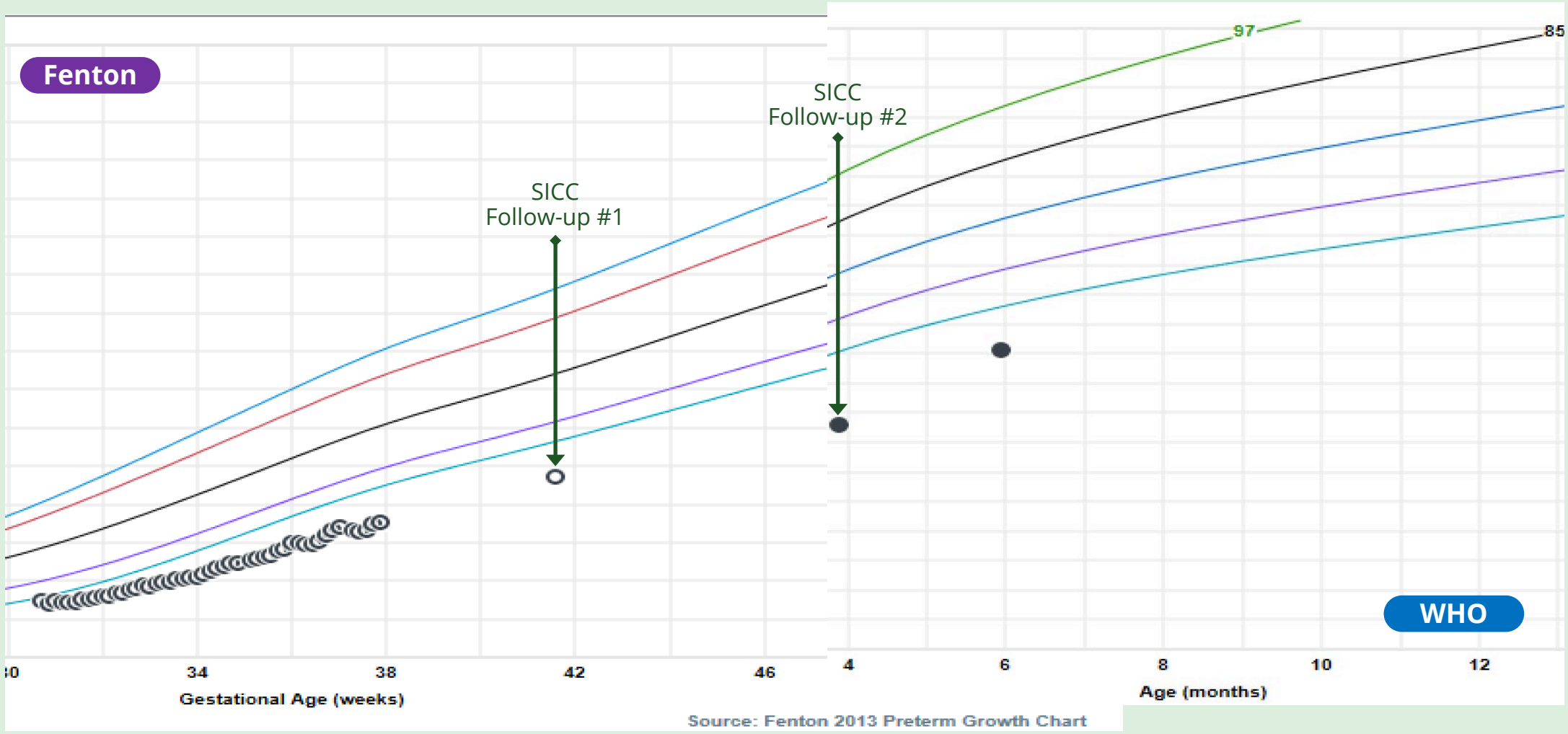
PDF, preterm discharge formula, PMA, postmenstrual age; SICC, Special Infant Care Clinic.

1. Uauy R, et al. *World Rev Nutr Diet.* 2014;110:4-10. 2. Agostoni C, et al. *J Pediatr Gastroenterol Nutr.* 2010;50:85-91.
3. Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

A

Ava

Case A—Combined



SICC, Special Infant Care Clinic.

A

Ava

Phase 3: 2nd Clinic Follow-Up Visit

Date: 1/13/21 **PMA: 47w4d**

Weight: 3.788 kg (3%, Z-score -1.94 based on Fenton Growth Chart)
Growth Velocity: 34 g/d (Goals: 23 g/d based on Fenton Calculator [a])

- C/O frequent spit-ups. Omeprazole started and changed to extensively hydrolyzed protein (EHP) formula 24 cal/oz po ad lib goal of ~19 oz per day for 150 mL/kg

Nutrient	Recommended	Provided—EHP formula 24 cal at 150 mL/kg
Energy, kcal/kg	110–130	**120**
Protein, g/kg	3.5–4.5 (2.8–3.2) [b]	**3.4**
Vitamin D	400–1000 (400) [b]	**427 (w/supplement)**
Iron	2–3 (2) [b]	**4.5 (w/supplement)**
Calcium	120–200 (70–140) [b]	**113**
Phos	60–140 (35–90) [b]	**52**

a. Fenton Growth Calculator available on Peditools.org
b. Estimated needs at discharge with no accumulated nutrient deficits

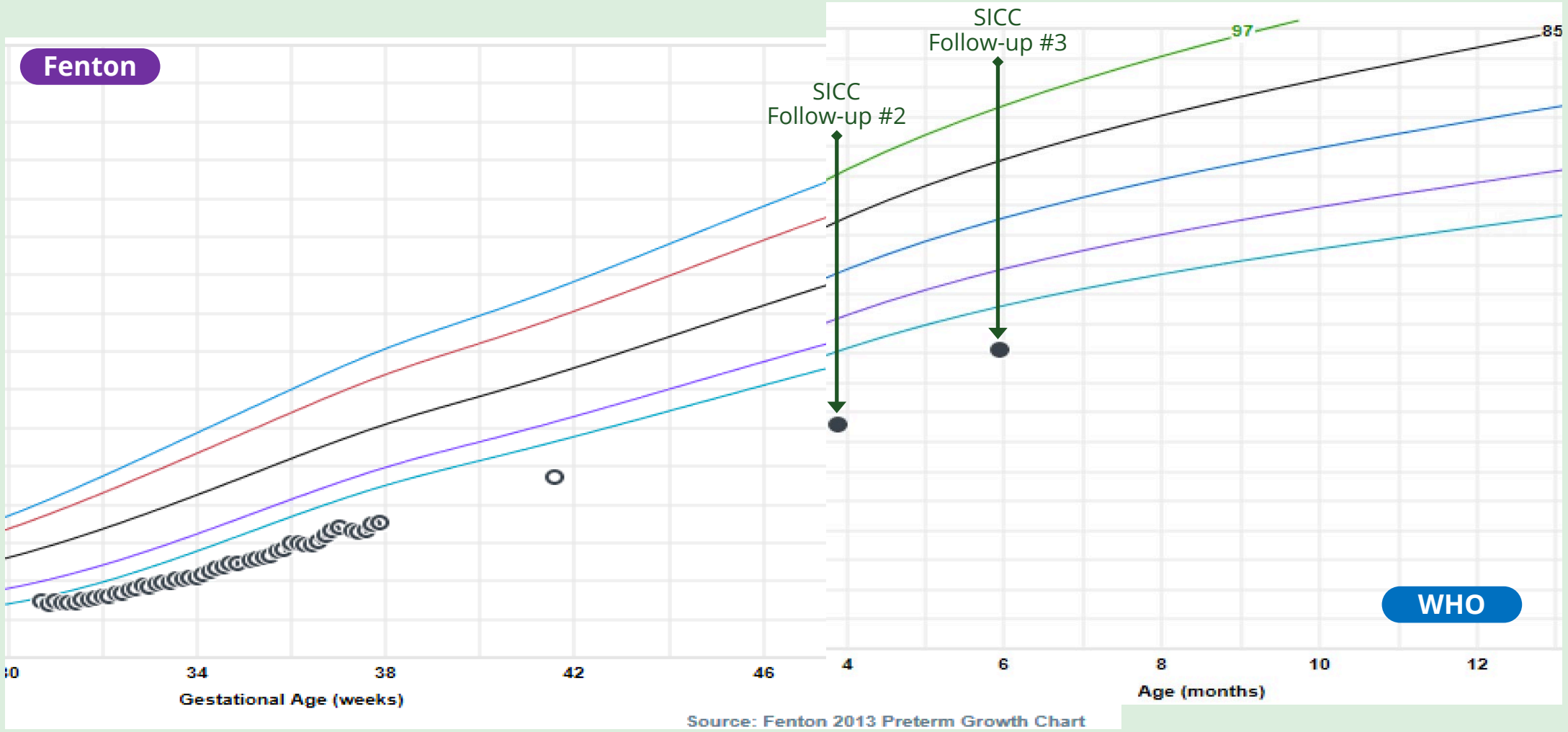
EHP, extensively hydrolyzed protein; PMA, postmenstrual age.

1. Uauy R, et al. *World Rev Nutr Diet.* 2014;110:4-10. 2. Agostoni C, et al. *J Pediatr Gastroenterol Nutr.* 2010;50:85-91.
3. Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

A

Ava

Case A—Combined



SICC, Special Infant Care Clinic.

A

Ava

Phase 3: 3rd Clinic Follow-Up Visit

Date: 3/17/21	CGA: 3 months 3 weeks

Weight: 5.072 kg (0%, Z-score: -3.94 based on WHO 0–2 yrs Girls, chronological age)
Growth velocity: 20 g/d (Goal 21 g/d based on WHO goal at CGA of 3–4 months)

- Infant tolerating hydrolyzed protein formula well
- Reflux is improved
- Meeting growth goals for continued catch up growth
- Plan to continue current formula po ad lib. Discuss start of solids 4–6 months corrected age

Nutrition Progression: Phase 3 Summary Table

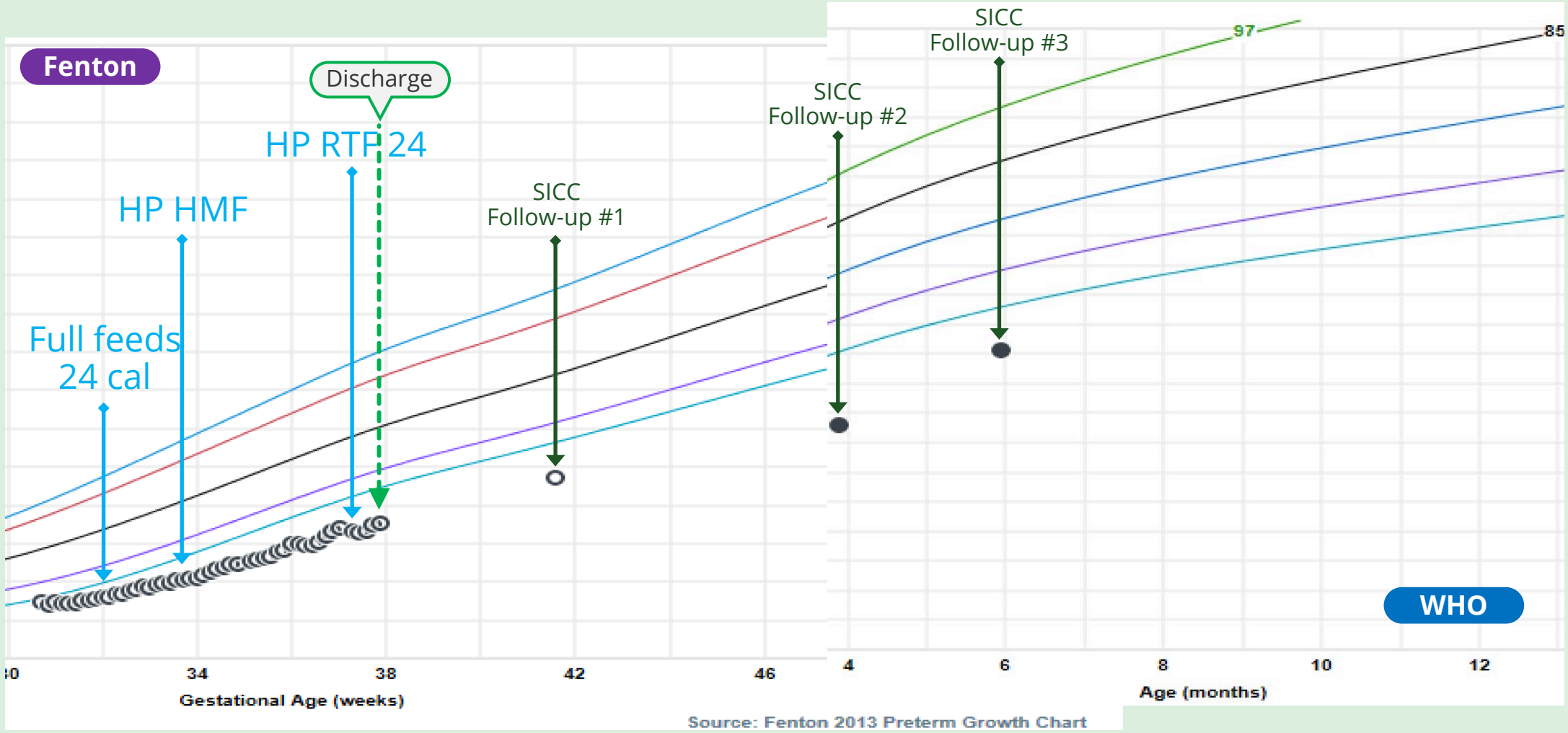
Dates	Gestational Age	Weights	Weight gain	Goals
9/27/2020–10/24/2020	32w1d (DOL 10)—36 weeks	810–1490 gram	21.9 g/kg/d on average	15–20 g/kg/d
10/24/2020–11/6/2020	36 weeks to discharge (37w6d)	1490–1770 gram	22 g/d	20–35 g/d 30.3 g/d per Fenton calculator
12/2/2020	Follow-up #1 (41w4d)	2.362 kg	23 g/d	20–35 g/d 21 g/d per Fenton calculator
1/13/2021	Follow-up #2 (47w4d)	3.788 kg	34 g/d	20–35 g/d 23 g/d per Fenton calculator
3/17/2021	Follow-up #3 (CGA 3 months 3 weeks)	5.072 kg	20 g/d	20 g/d based on WHO at CGA

CGA, corrected gestational age.

Fenton calculator can be found on peditools.org (also in EPIC, most electronic medical records)

Ava

Case A—Combined

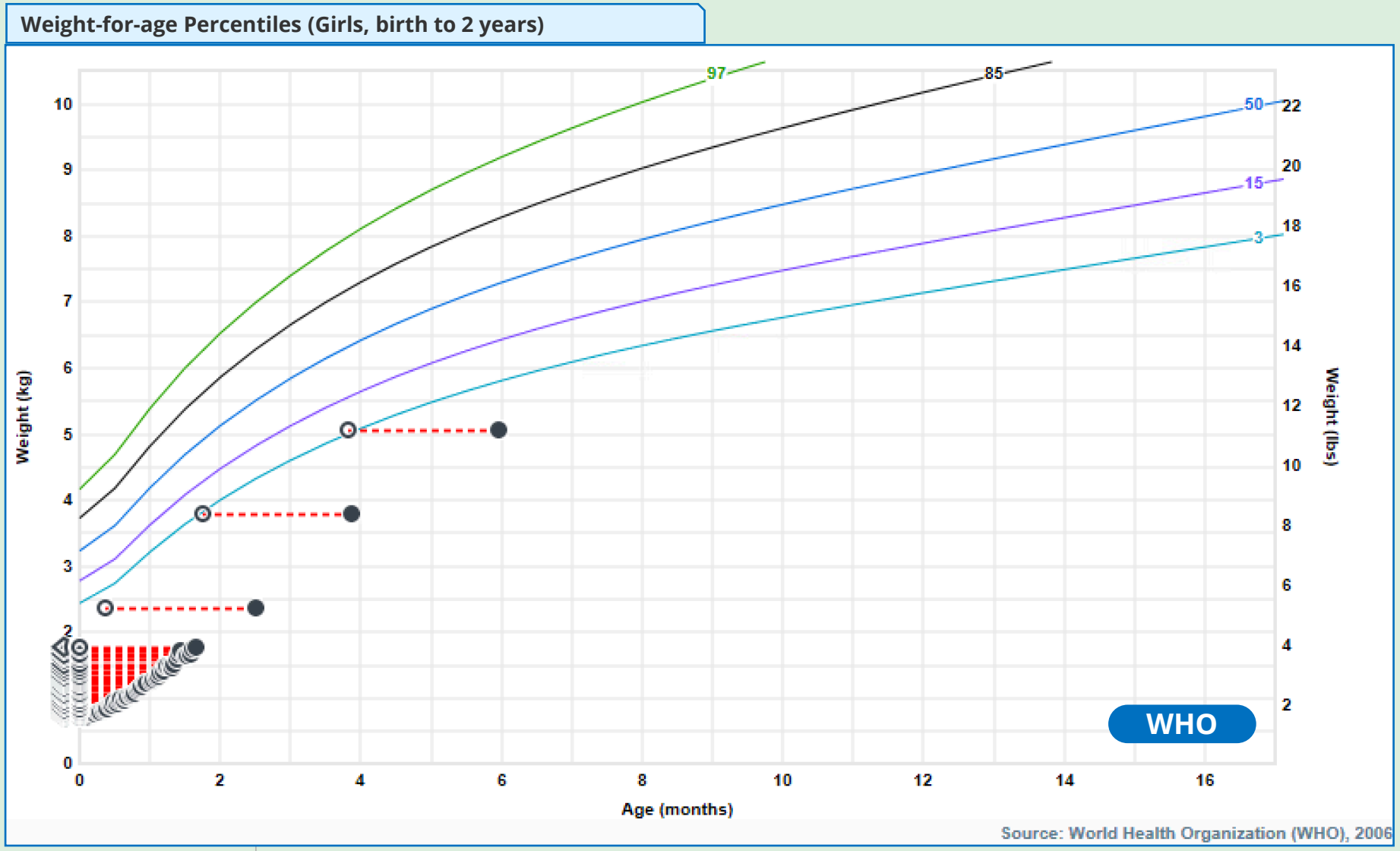


SICC, Special Infant Care Clinic.

A

Ava

Case A—WHO With Corrected Gestational Age



A

Ava

Case Study “Ava”: Managing Nutritional Deficits at Time of Discharge

Key Takeaway for baby who continued to have nutritional deficits at time of discharge:

- Use of more nutrient-dense formula for 4 weeks after discharge helped close nutrient gap.
- Maintained higher calorie formula (24 cal/oz) with PTDF and hydrolyzed protein formula to promote continued catch-up growth.

PTDF, preterm discharge powder formula.

A

Ava

Case Study "Benet"

Background		
Born at 25w5d	**DOB 6/29/2020**	
Birth weight	755 g	(35%, Z-score -0.38) [a]
Birth length	33 cm	(44%, Z-score -0.15)
Birth HC	23 cm	(37%, Z-score -0.33)
Born to 21-yr-old G1P0 via vaginal delivery due PTL, PPROM		
Mother with no PMH		
Feeding plan per mother is breastfeeding		

a. Fenton premature growth chart.
PMH, past medical history; PTL, preterm labor; PPROM, preterm prelabor rupture of membranes.

Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

B

Benet

Nutrition Progression: Phase 1 & 2

Phase 1:

- Feeds started on DOL 1 per feeding protocol
- Enteral feeds advanced per protocol and at goal on DOL 12

Phase 2: Goal feeds—advanced to MBM with HMF 24 cal/oz at 150 mL/kg

Nutrient	Recommended	Provided—MBM w/LHMF 24 at 150/KG
Energy, kcal/kg	110–130	**122**
Protein, g/kg	3.5–4.5	**3.9**
Vitamin D	400–1000	**589 (w/ supplementation)**
Iron	2–3	**3.3 (w/ supplementation)**
Calcium	120–200	**177**
Phos	60–140	**98**

DOL, day of life; HMF, human milk fortifier; LHMF, liquid human-milk fortifier; MBM, maternal breast milk.

Nutrition Progression: Phase 2 continued

Date	Nutrition Progression
DOL 25	NPO due to abdominal distention and pneumatosis on AXR, medical NEC tx started NPO x 7 days TPN/Lipids
DOL 32	Trophic feeds restarted, advanced slowly back to goal
DOL 40	Back on full feeds with MBM and HMF to 24 cal/oz at 150 mL/kg; + Vitamin D and Iron supplementation
Nutrition labs DOL 49	Alk Phos 458, Phos 6.0, Vit D 56 (Goals Alk Phos <400, Phos >6, Vit D >30)
Repeat labs DOL 85	Alk Phos 385, Phos 6.4, Vit D 93
DOL 101	Continued to work on both breast and bottle feeding. GT placed on 10/8/20 due to inability to take full feeds po.
Growth velocity from 7/31–9/9 (36 weeks) was 18 g/kg/d and from 36 weeks to discharge at 40 5/7 was 40 g/d on average	

AXR, abdominal X-ray; GT, gastrostomy tube; NEC, necrotizing enterocolitis; NPO, nothing by mouth; TPN, total parenteral nutrition.

Phase 3: Discharge Nutrition Assessment

Discharged 10/13/2020	Weight 3.72 kg (50%, Z-score—0.01 based on Fenton chart) at 40w6d and DOL 106
Discharge feedings	MBM with preterm discharge powder formula to 24 cal/oz at 160 mL/kg plus 1 mL infant multivitamin with iron. Infant taking bottle, breast and using GT if unable to finish goal volume
Nutrition labs prior to discharge WNL (Alk Phos 385, Phos 6.4, Vit D 93)	

Nutrient	Recommended	Provided—MBM with PDPF at 24 at 160mL/kg
Energy, kcal/kg	110–130	**128**
Protein, g/kg	3.5–4.5 (2.8–3.2) [a]	**2.2**
Vitamin D	400–1000 (400) [a]	**477**
Iron	2–3 (2) [a]	**3.5**
Calcium	120–200 (70–140) [a]	**64**
Phosphorus	60–140 (35–90) [a]	**34**

a. Estimated needs at discharge with no accumulated nutrient deficits (Uauy et al 2014 [1]; Agostoni et al 2010 [2])

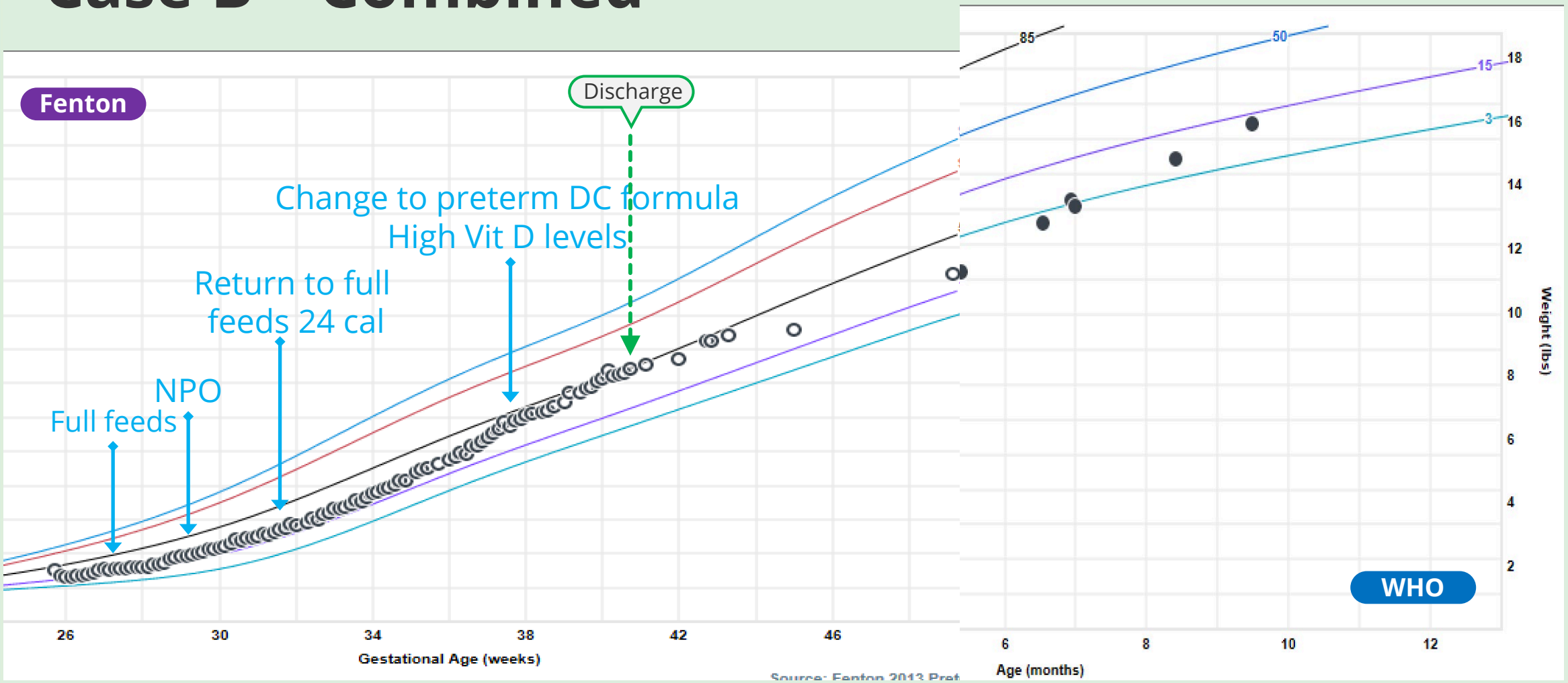
DM, donor milk; HP, high protein; MBM, maternal breast milk; PDPF, preterm discharge powder formula; SICC, Special Infant Care Clinic.

1. Uauy R, et al. *World Rev Nutr Diet.* 2014;110:4-10. 2. Agostoni C, et al. *J Pediatr Gastroenterol Nutr.* 2010;50:85-91. 3. Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

B

Benet

Case B—Combined



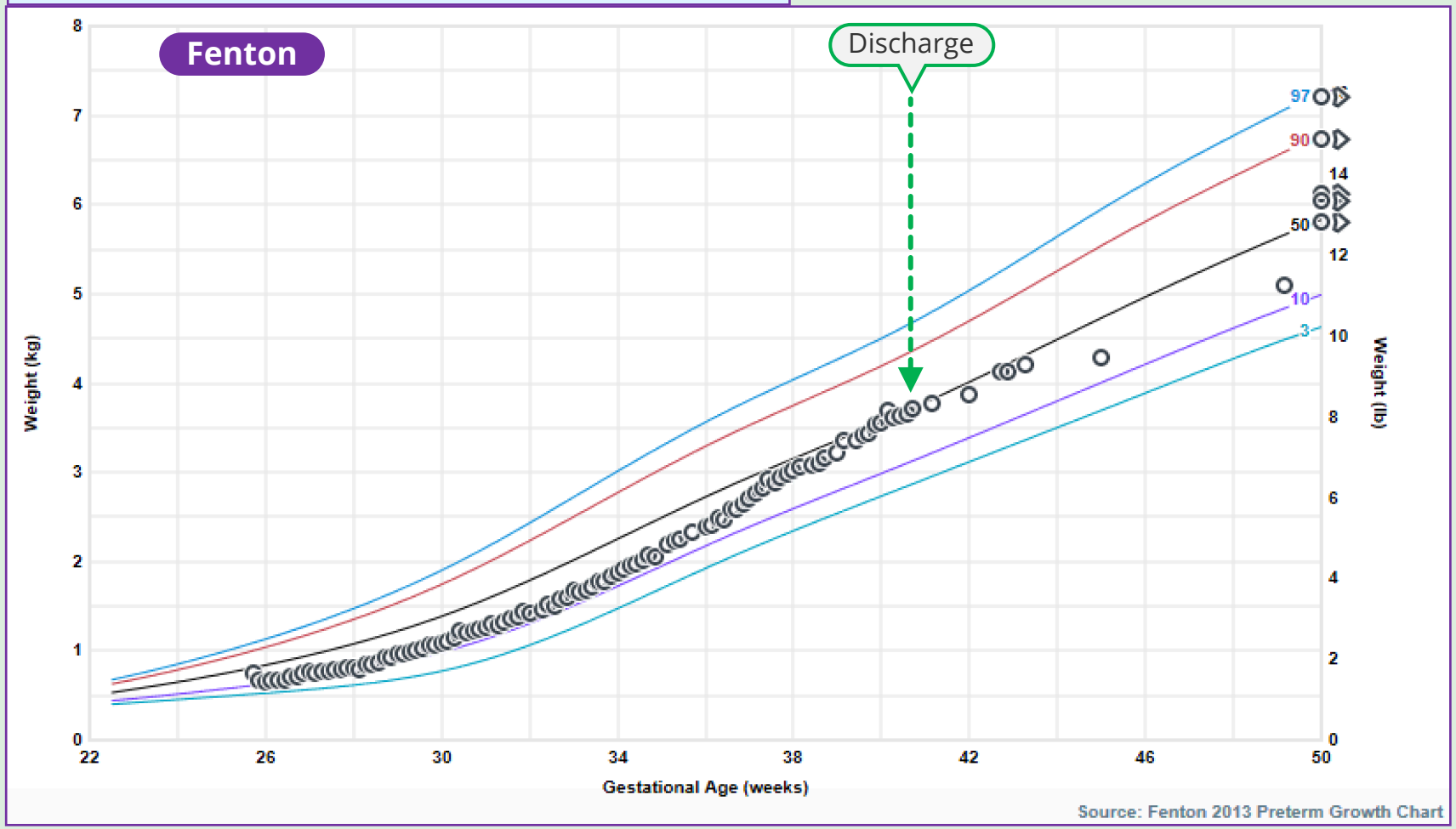
DC, discharge; NPO, nothing by mouth.

B

Benet

Case B—Fenton Curve

Weight-for-age Percentiles (Premature boys, 22.5 to 50 weeks)

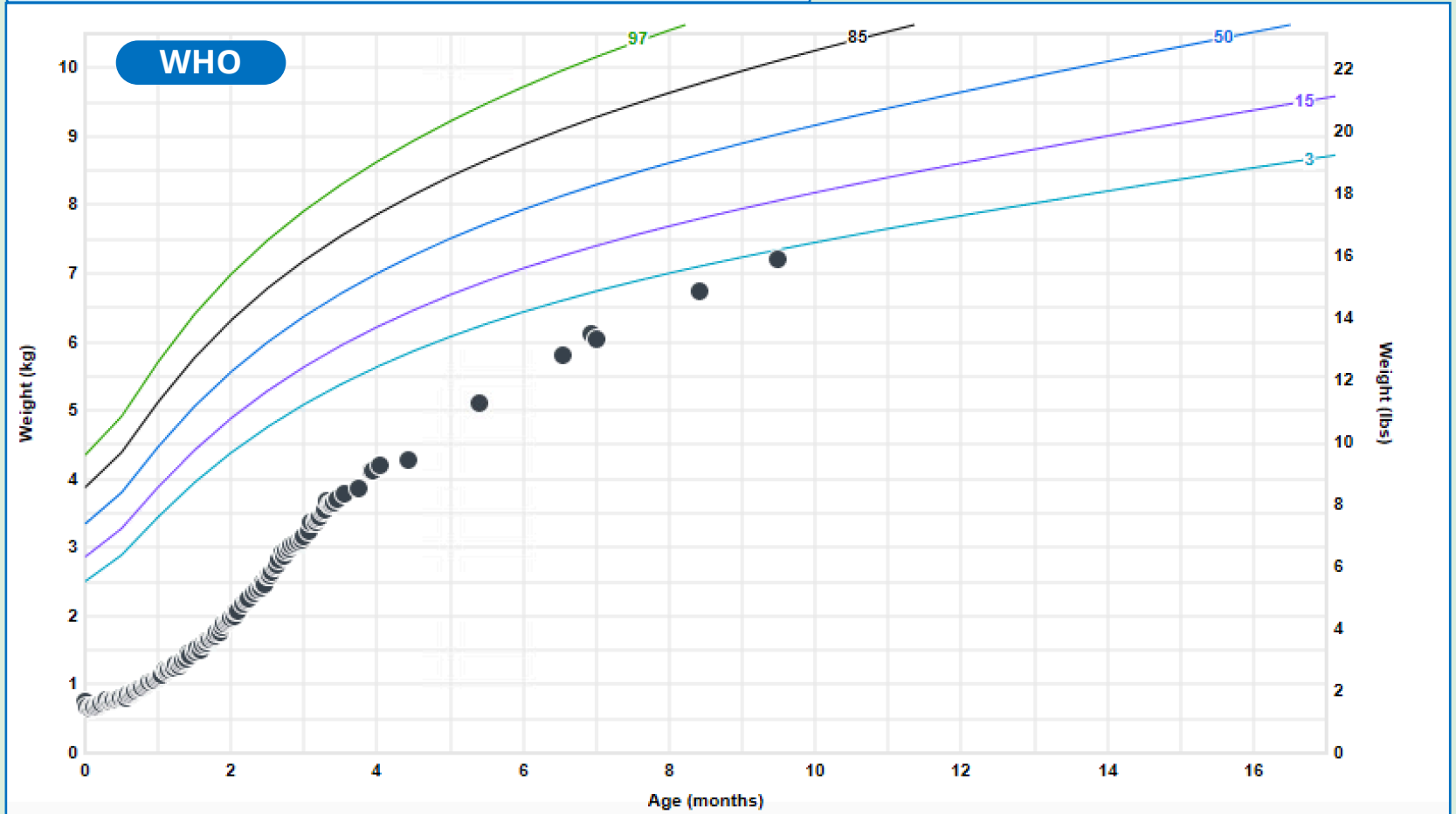


B

Benet

Case B—WHO Curve

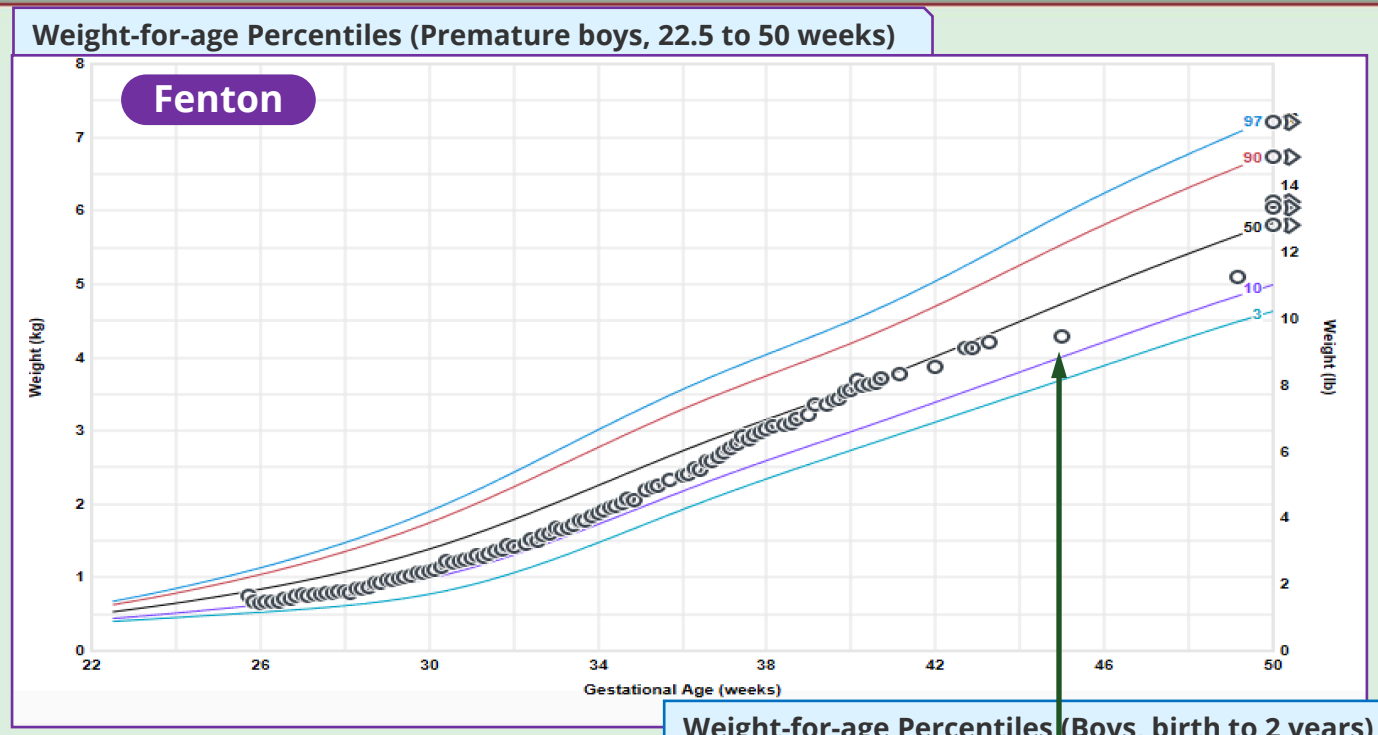
Weight-for-age Percentiles (Boys, birth to 2 years)

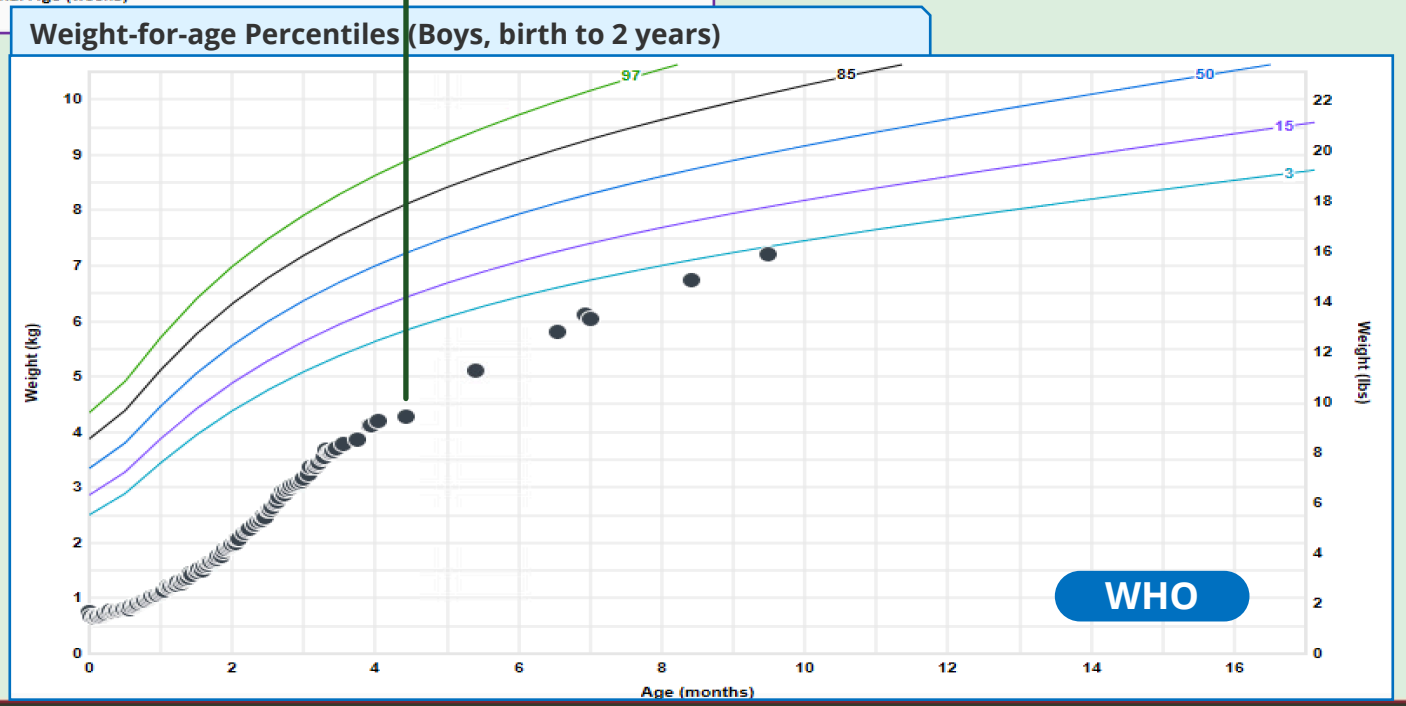


Source: World Health Organization (WHO), 2006

B

Benet

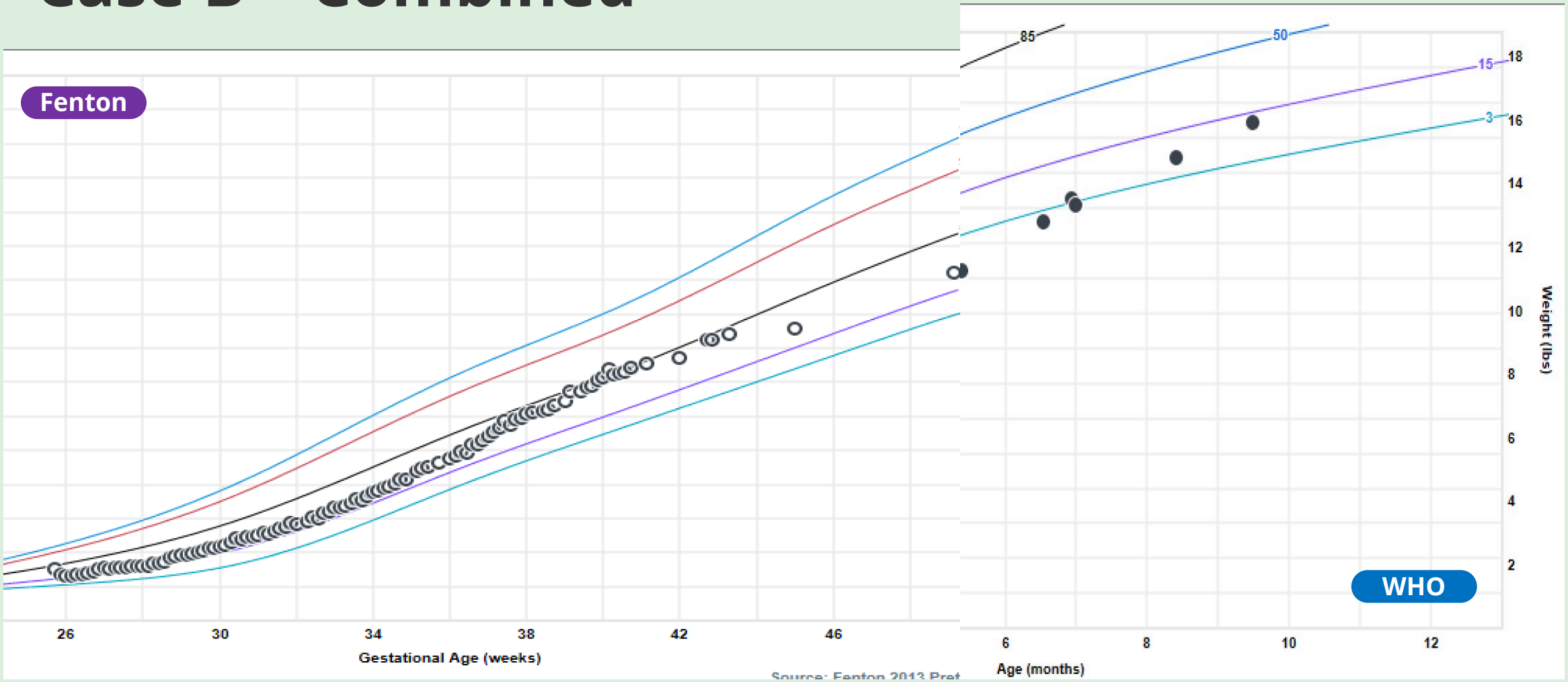

Weight-for-age Percentiles (Premature boys, 22.5 to 50 weeks)
Fenton
Weight (kg)
Weight (lb)
Gestational Age (weeks)
97
90
50
10
3


Weight-for-age Percentiles (Boys, birth to 2 years)
WHO
Weight (kg)
Weight (lbs)
Age (months)
97
85
50
15
3

B

Benet

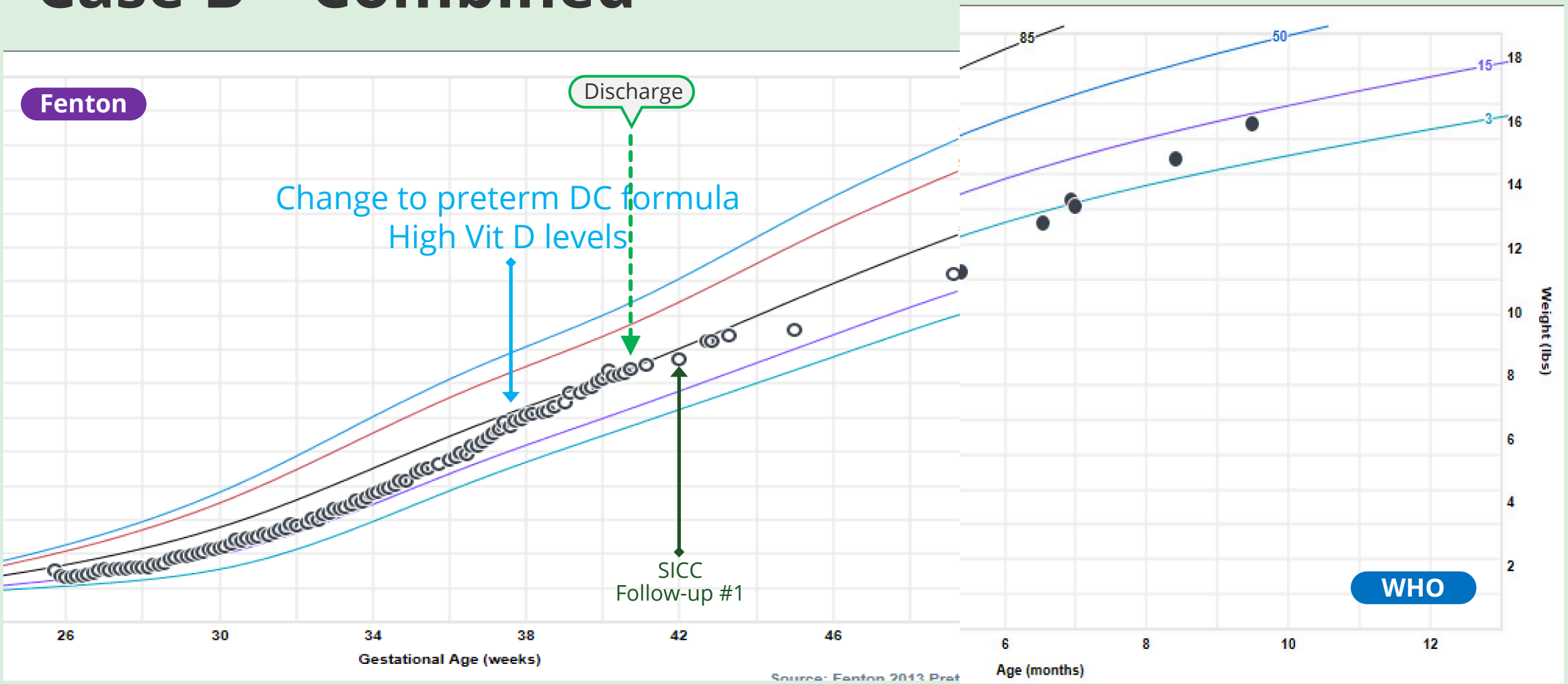
Case B—Combined



B

Benet

Case B—Combined



DC, discharge; SICC, Special Infant Care Clinic.

B

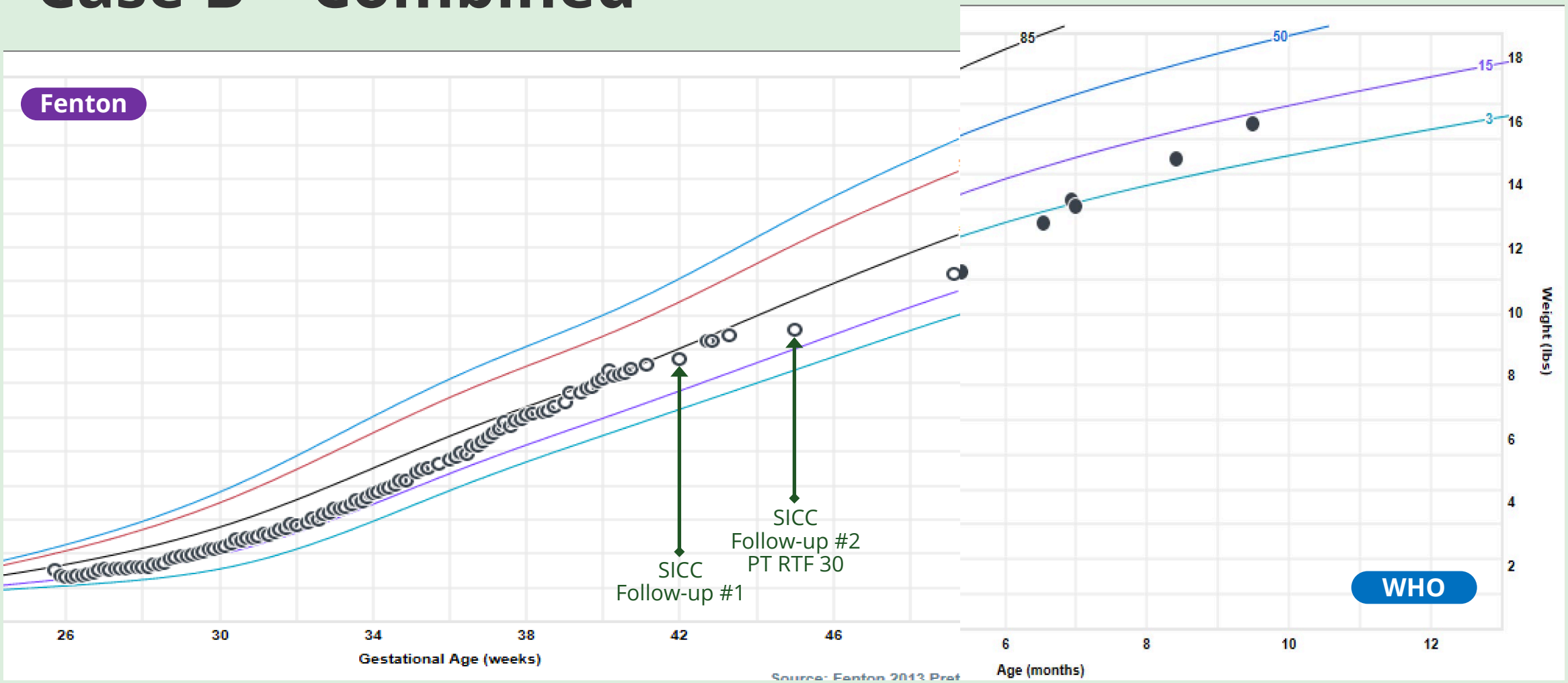
Benet

Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #1: 10/21/20	• **Taking good po (140–170 mL/kg)** • **Mom breastfeeding more** • **Not needing GT as much**	**Weight 3.863 kg (16 g/d on average)**
Follow-up #2 11/11/20	• Continues to take all feeds by mouth • Mom estimates ~18 oz po with fortified MBM + 3–4 breast feedings per day • 1 mL infant multivitamin with iron	Weight 4.29 kg Weight gain since last visit: 20 g/d Labs checked: Alk Phos 605, Phos 5.5, Vit D 88
11/11/20	• Changed feeds to 8 oz/d RTF HP preterm formula 30 cal/oz+ ~16-oz plain MBM (BF or bottle) • Discontinue PVS with iron, and changed to 2 mg/kg iron supplement	

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; RTF HP, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.

Case B—Combined



SICC, Special Infant Care Clinic.

B

Benet

Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #1: 10/21/20	• Taking good po (140–170 mL/kg) • Mom breastfeeding more • Not needing GT as much	Weight 3.863 kg (16 g/d on average)
Follow-up #2 11/11/20	• **Continues to take all feeds by mouth** • **Mom estimates ~18 oz po with fortified MBM + 3–4 breast feedings per day** • **1 mL infant multivitamin with iron**	**Weight 4.29 kg** **Weight gain since last visit: 20 g/d** **Labs checked: Alk Phos 605, Phos 5.5, Vit D 88**
11/11/20	• **Changed feeds to 8 oz/d RTF HP preterm formula 30 cal/oz+ ~16-oz plain MBM (BF or bottle)** • **Discontinue PVS with iron, and changed to 2 mg/kg iron supplement**	

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; RTF HP, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.

Nutrition Progression: Phase 3 continued

Nutrient	Recommended Preterm/ Recommended Discharge [a]	Estimated Intake at time of visit: (18-oz MBM w/PDF 24 cal + BF) (based on ~168 mL/kg)	New recommended feeds (based on 168 mL/kg) 8 oz RTF HP preterm formula 30 cal/oz + 16 oz plain MBM or BF
Energy, kcal/kg	110–130	129	**131**
Protein, g/kg	3.5–4.5 (2.8–3.2)	2.0	**2.9**
Vitamin D	400–1000 (400)	473 (w/ supplementation)	**729**
Iron	2–3 (2)	3.1 (w/ supplementation)	**3.1 (w/ supplementation)**
Calcium	120–200 (70–140)	60	**119**
Phos	60–140 (35–90)	35	**68**

a. Estimated needs at discharge with no accumulated nutrient deficits

BF, breast feeding; PDF, preterm discharge powder formula; HP, high protein; RTF, ready-to-feed, preterm formula; MBM, maternal breast milk; PMA, postmenstrual age.

1. Uauy R, et al. *World Rev Nutr Diet.* 2014;110:4-10.
2. Agostoni C, et al. *J Pediatr Gastroenterol Nutr.* 2010:85-91.

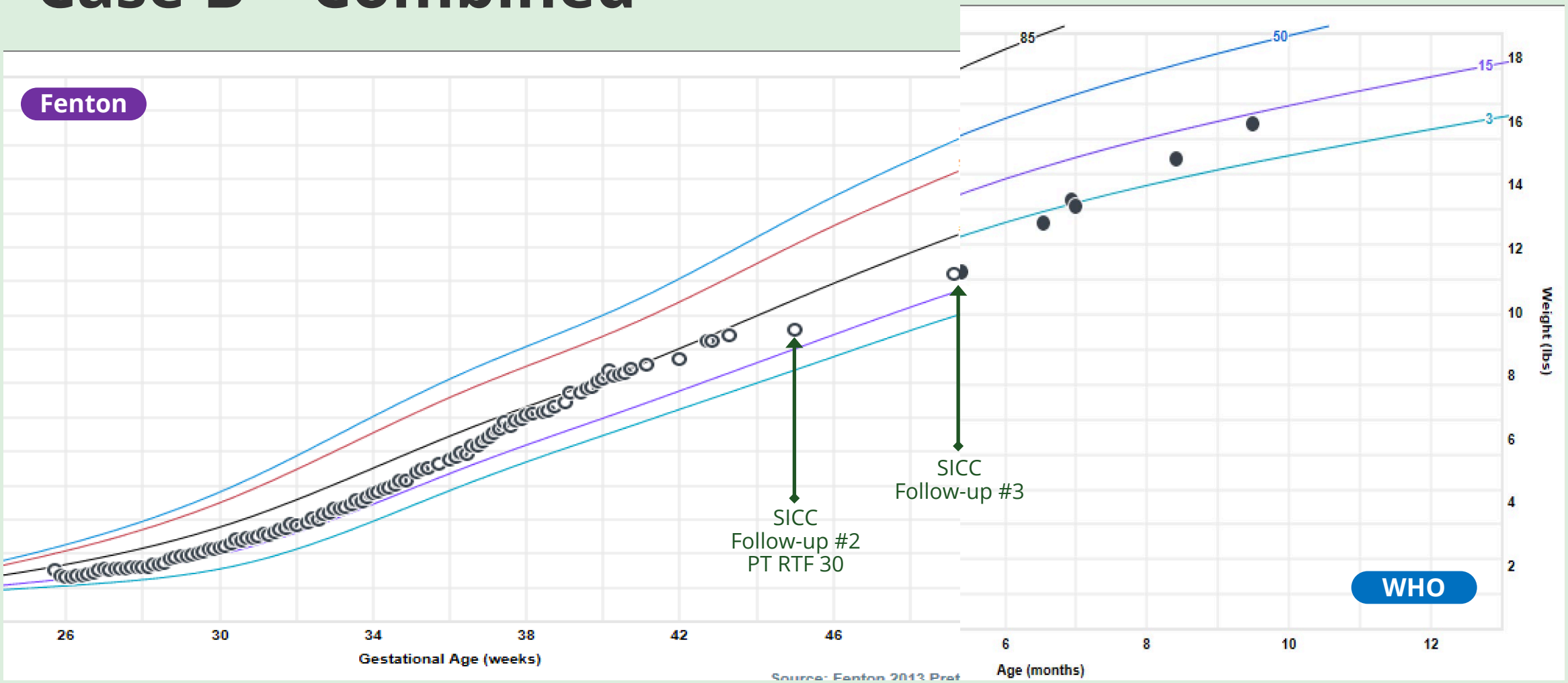
B

Benet

Audience Poll – Case B

Do you routinely check nutrition labs for premature infants after NICU discharge?

Case B—Combined



SICC, Special Infant Care Clinic.

B

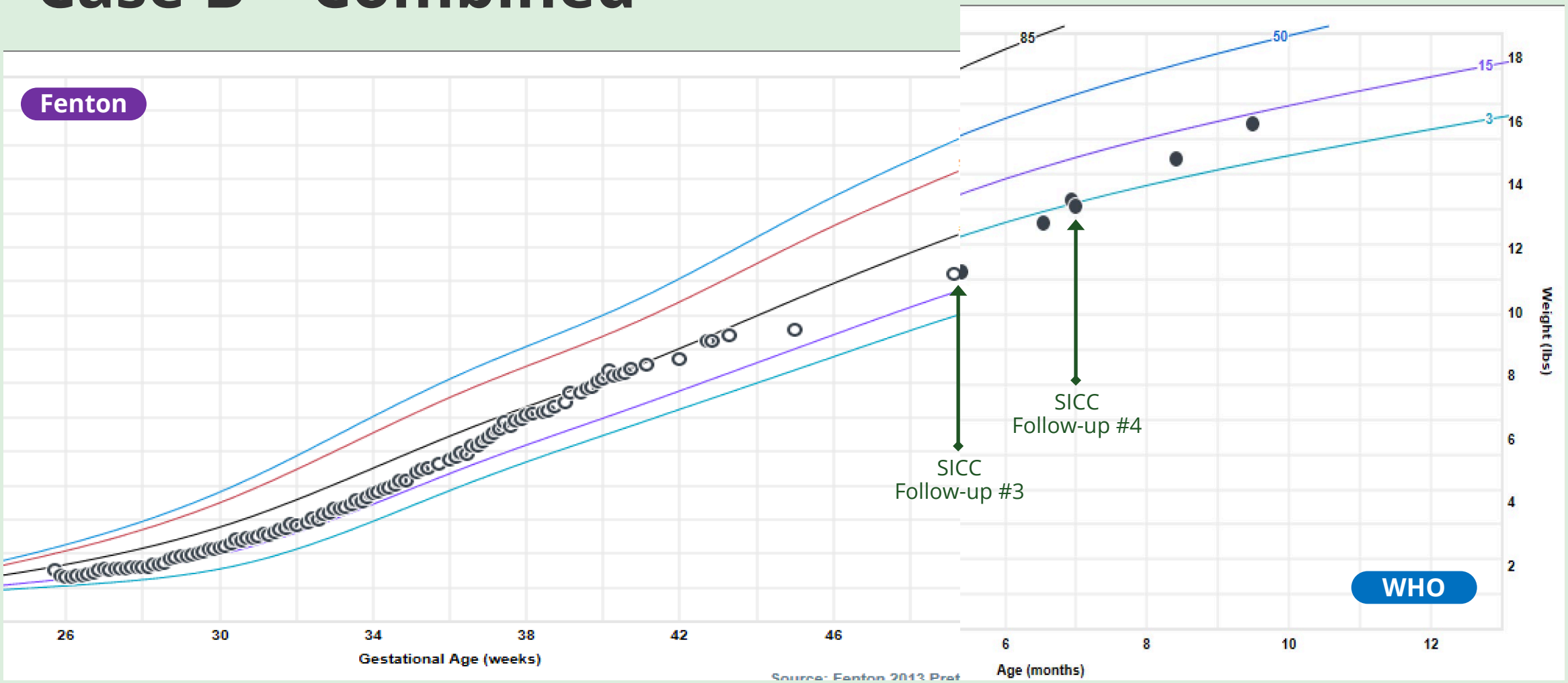
Benet

Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #3 12/10/20	• **RTF HP preterm formula 30 cal/oz, 4 oz x 2 feeds per day.** • **BF 5 times per day and taking additional plain MBM via bottle.**	**Weight: 5.1 kg Weight gain improved since last visit: 28 g/d on average**
Follow-up #4 1/28/21	• Mom recently ran out of HP RTF preterm formula and resumed adding preterm discharge powder powder to MBM 24-cal/oz recipe from NICU	Weight: 6.039 kg Weight gain velocity: 19 g/d on average **Attempted to do lab check, however, unable to obtain sufficient sample size.* Team decided to continue MBM fortified with preterm discharge powder formula
Follow-up #5 4/14/21	• Continues to take all po • Mom with good supply • Continues to BF and gives 24-cal/oz MBM with PDF when bottle feeds	Weight: 7.21 kg Weight-gain velocity: 15 g/d on average • Mom advised to start solids • GT removed

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; HP RTF, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.

Case B—Combined



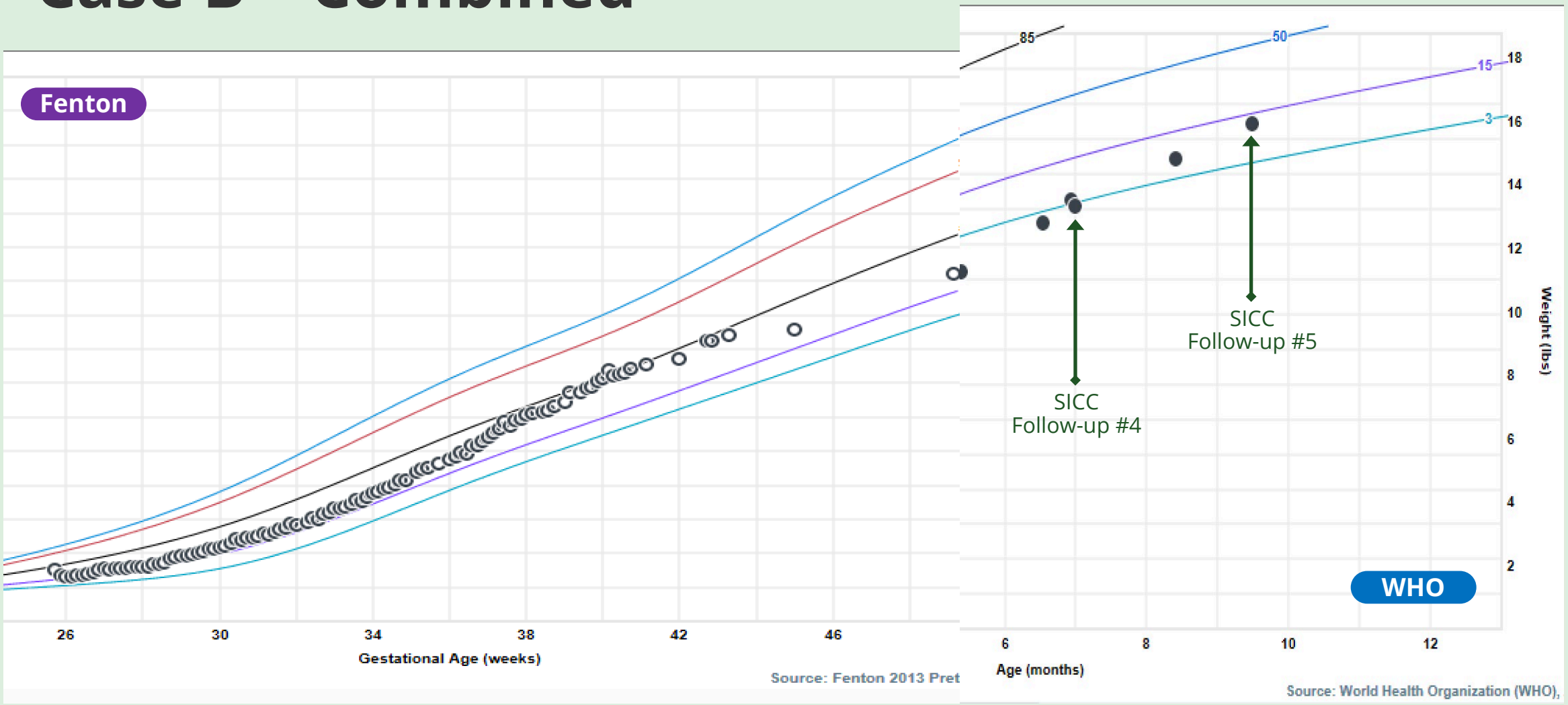
SICC, Special Infant Care Clinic.

Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #3 12/10/20	• RTF HP preterm formula 30 cal/oz, 4 oz x 2 feeds per day. • BF 5 times per day and taking additional plain MBM via bottle.	Weight: 5.1 kg Weight gain improved since last visit: 28 g/d on average
Follow-up #4 1/28/21	• **Mom recently ran out of HP RTF preterm formula and resumed adding preterm discharge powder powder to MBM 24-cal/oz recipe from NICU**	**Weight: 6.039 kg** **Weight gain velocity: 19 g/d on average** ***Attempted to do lab check, however, unable to obtain sufficient sample size.*** **Team decided to continue MBM fortified with preterm discharge powder formula**
Follow-up #5 4/14/21	• Continues to take all po • Mom with good supply • Continues to BF and gives 24-cal/oz MBM with PDF when bottle feeds	Weight: 7.21 kg Weight-gain velocity: 15 g/d on average • Mom advised to start solids • GT removed

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; HP RTF, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.

Case B—Combined



SICC, Special Infant Care Clinic.

B

Benet

Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #3 12/10/20	• RTF HP preterm formula 30 cal/oz, 4 oz x 2 feeds per day. • BF 5 times per day and taking additional plain MBM via bottle.	Weight: 5.1 kg Weight gain improved since last visit: 28 g/d on average
Follow-up #4 1/28/21	• Mom recently ran out of HP RTF preterm formula and resumed adding preterm discharge powder powder to MBM 24-cal/oz recipe from NICU	Weight: 6.039 kg Weight gain velocity: 19 g/d on average **Attempted to do lab check, however, unable to obtain sufficient sample size.* Team decided to continue MBM fortified with preterm discharge powder formula
Follow-up #5 4/14/21	• **Continues to take all po** • **Mom with good supply** • **Continues to BF and gives 24-cal/oz MBM with PDF when bottle feeds**	**Weight: 7.21 kg** **Weight-gain velocity: 15 g/d on average** • **Mom advised to start solids** • **GT removed**

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; RTF HP, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.

Benet

Nutrition Progression: Phase 3 Summary Table

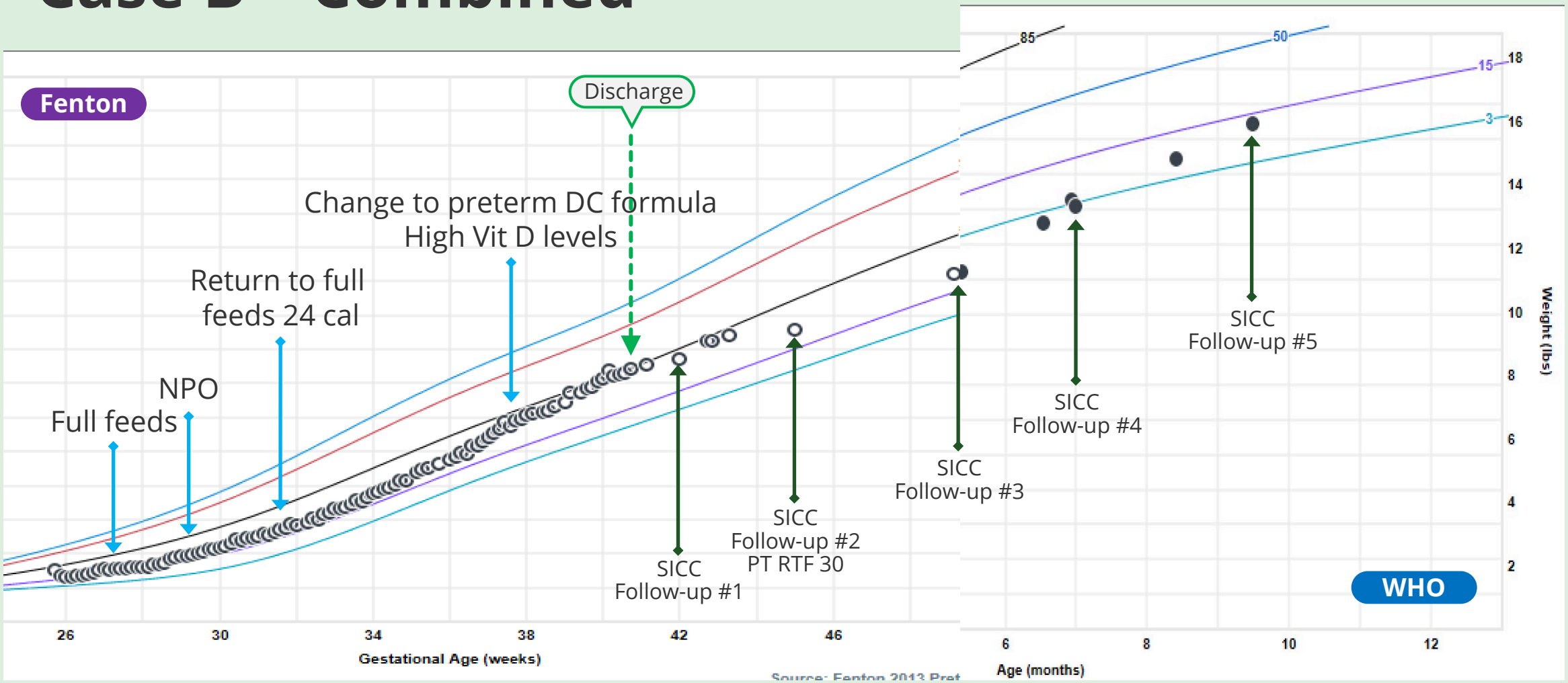
Dates	Gestational Age	Weights	Weight gain	Goals
8/8/2020–9/9/2020 (discharge)	31w3d to 36 weeks (From time back on full feeds after medical NEC tx) *Phase 2	1320–2388 grams	18 g/kg/d on average	15–20 g/kg/d
9/9/202–10/12/2020	36 weeks to discharge (40w5d) *Phase 2	2388–3720 grams	40 g/d	23–43 g/d (boys) 31 g/d per Fenton calculator
10/21/2020	First follow-up (40w5d) Phase 3	3.863 kg	16 g/d	23–43 g/d 33 g/d per Fenton calculator
11/11/2020	Second follow-up (42w0d) Phase 3	4.290 kg	20 g/d	23–43 g/d 36 g/d per Fenton calculator
12/10/2020	Third follow-up (2 months CGA)	5.1 kg	28 g/d	27 g/d per WHO at corrected age
1/28/2021	Fourth follow-up (3 months 3 wks CGA)	6.039 kg	19 g/d	21 g/d per WHO at corrected age
4/14/2021	Fifth follow-up (6 moths CGA)	7.21 kg	15 g/d	~12–17 g/d from 4–6 mo corrected age per WHO

CGA, corrected gestational age; NEC, necrotizing enterocolitis.

Fenton calculator can be found on peditools.org (also in EPIC, most electronic medical records)

Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

Case B—Combined

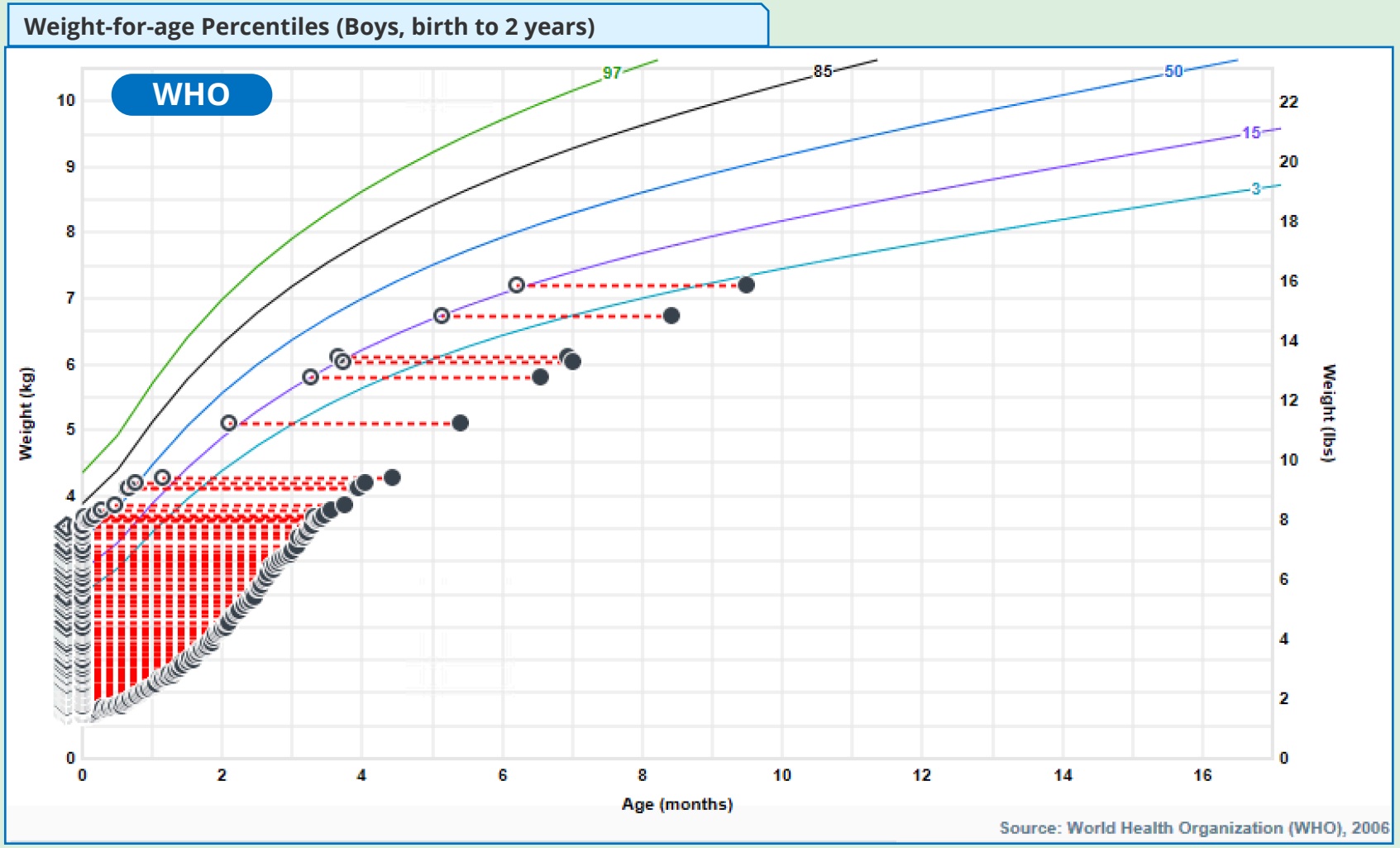


DC, discharge; NPO, nothing by mouth; SICC, Special Infant Care Clinic.

B

Benet

Case B—WHO With CGA



B

Benet

Case Study “Benet”

Key Takeaway for baby who continued to have nutritional deficits at time of discharge:

- Growth was appropriate during NICU course and had good recovery growth during NICU stay. Nutrition labs WNL at time of discharge.
- As patient transitioned to more BF and plain MBM at home, fortification strategy not enough to sustain adequate growth or bone mineralization. Alk phos found to be elevated, growth velocity slowed.

Use of nutrient-rich preterm formula paired with plain MBM can improve growth, and improve mineral provision.

BF, breastfeeding; MBM, maternal breast milk; WNL, within normal limits.

B

Benet

Case Study “Coygan”

Background		
Born at 33w3d	**DOB 8/10/2020**	
Birth weight	1190 g	(1%, Z-score -2.25) [a]
Birth length	38 cm	(44%, Z-score -0.15)
Birth HC	28 cm	(37%, Z-score -0.33)
Born to 36-yr old G3P1011 via C-section due to severe preeclampsia and decreased fetal movement		
Mother with PMH of anxiety, depression, abnormal pap smear of cervix		
Feeding plan per mother is breastfeeding		

a. Fenton premature growth chart.
PMH, past medical history.

Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

C

Coygan

Nutrition Progression: Phase 1

- TPN/Lipids while feeds advanced per high-risk feeding protocol
- Feeds reached goal on DOL 15, 35w4d
- MBM with HMF 24 cal/oz @ 150 mL/kg
- Working on bottle feeding and breastfeeding using cue-based feeding protocol
- PICC/Dextrose fluids discontinued on DOL 17, 35w6d

DOL, day of life; HMF, human milk formula; MBM, maternal breast milk; PICC, peripherally inserted central catheter; TPN, total parenteral nutrition.

Coygan

Nutrition Progression: Phase 2

- DOL 17 feeds increased to MBM with HMF 26 cal/oz and patient attempting 1–2 breast feeds per day
- Continued above feeds while working on bottle and breast
- NGT discontinued/ transitioned to po ad lib on DOL 33, 38w1d

Nutrient	Recommended	Estimated intake based on MBM w/LHMF 26x6 feeds, plain MBM via BF x 2 feeds @ ~150 mL/kg
Energy, kcal/kg	110–130	**123**
Protein, g/kg	3.5–4.5	**4**
Vitamin D	400–1000	**404**
Iron	2–3	**2.6**
Calcium	120–200	**192**
Phosphorus	60–140	**105**

DOL, day of life; HMF, human milk fortifier; LHMF, liquid human-milk fortifier; MBM, maternal breast milk; NGT, nasogastric tube.

Coygan

Phase 3: Discharge Nutrition Assessment

Discharged 9/13/2020	Weight 1.921 kg (0.12%, Z-score -3.04 based on Fenton) at 38w2d and DOL 34
Discharge feedings	Transitioned from liquid HMF to powder HMF for home 24 cal/oz po ad lib plus BF ad lib

- Growth velocity at time of discharge: 23.5 g/d on average
- Plan for follow up in SICC in one month to adjust feeding plan

Nutrient	Recommended	Estimated intake based on MBM w/powder HMF 24 cal/oz + BF 2 times/day (assuming ~160 mL/kg)
Energy, kcal/kg	110–130	**123**
Protein, g/kg	3.5–4.5 (2.8–3.2) [a]	**2.4**
Vitamin D	400–1000 (400) [a]	**362**
Iron	2–3 (2) [a]	**1.9**
Calcium	120–200 (70–140) [a]	**147**
Phos	60–140 (35–90) [a]	**81**

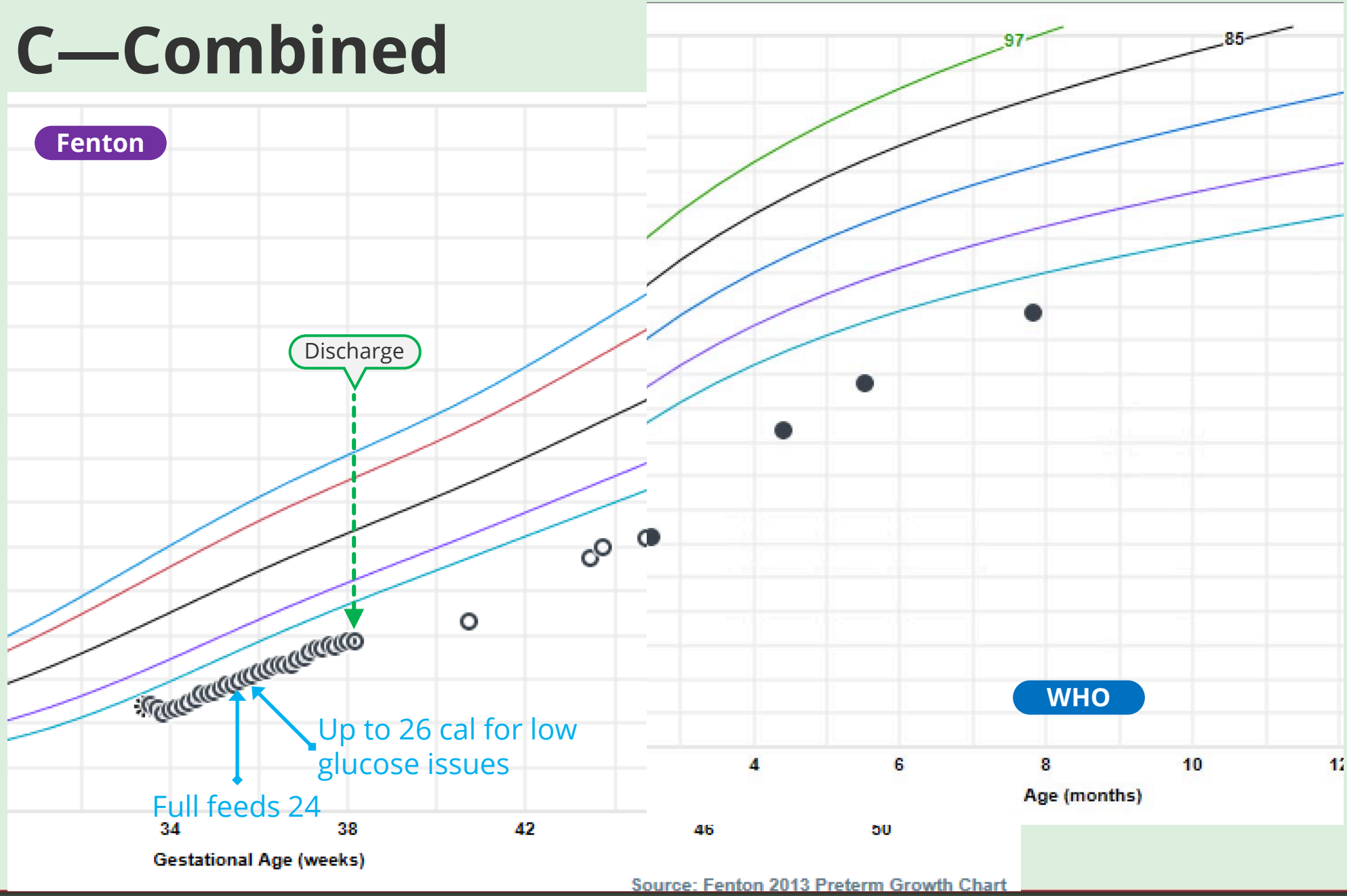
a. Estimated needs at discharge with no accumulated nutrient deficits (Uauy et al 2014 [1]; Agostoni et al 2010 [2])

BM, breast milk; HMF, human milk fortifier; MBM, maternal breast milk; SICC, Special Infant Care Clinic.

1. Uauy R, et al. *World Rev Nutr Diet.* 2014;110:4-10. 2. Agostoni C, et al. *J Pediatr Gastroenterol Nutr.* 2010;50:85-91. 3 Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

Coygan

Case C—Combined

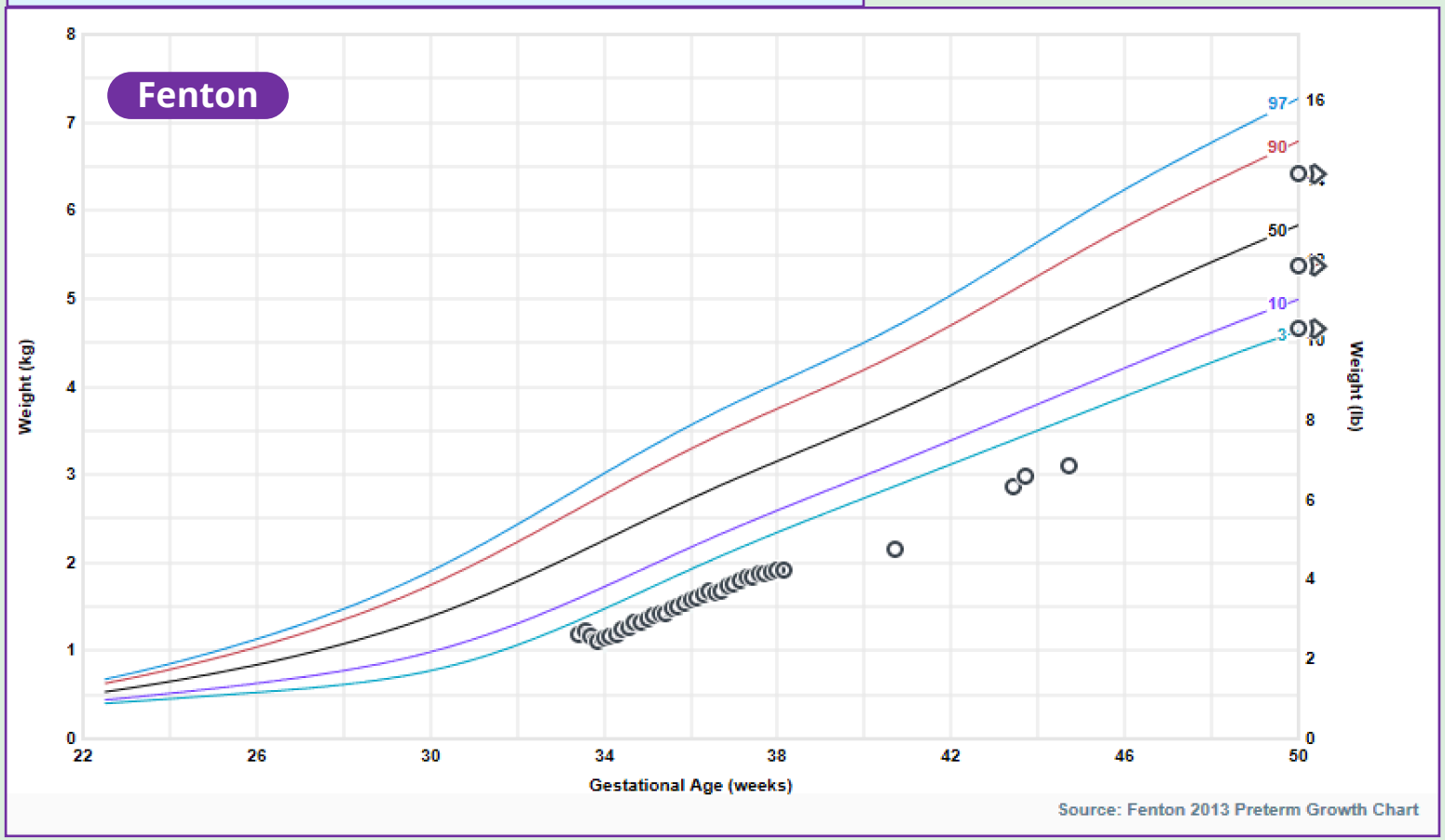


C

Coygan

Case C—Fenton Curve

Weight-for-age Percentiles (Premature boys, 22.5 to 50 weeks)

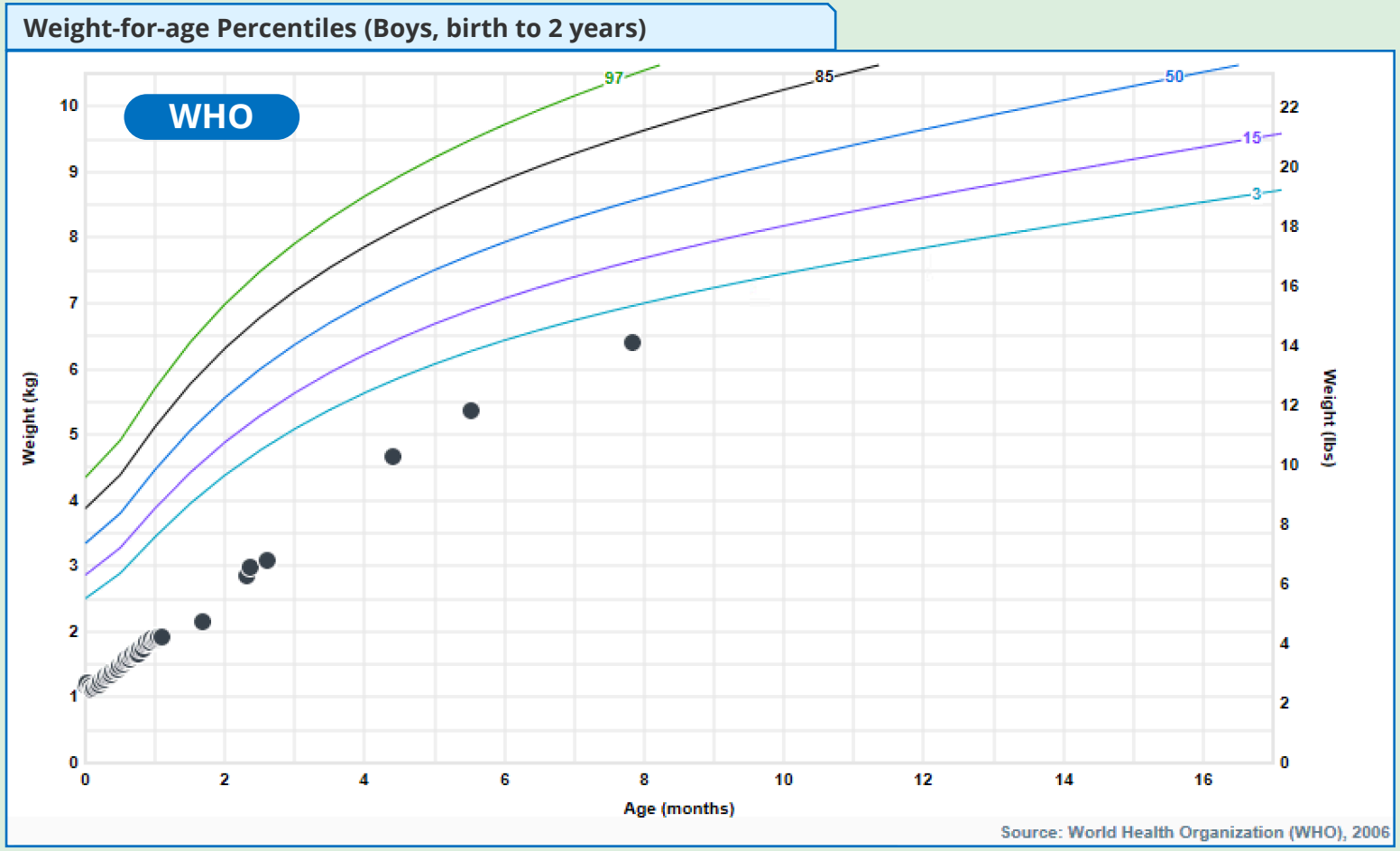


Source: Fenton 2013 Preterm Growth Chart

C

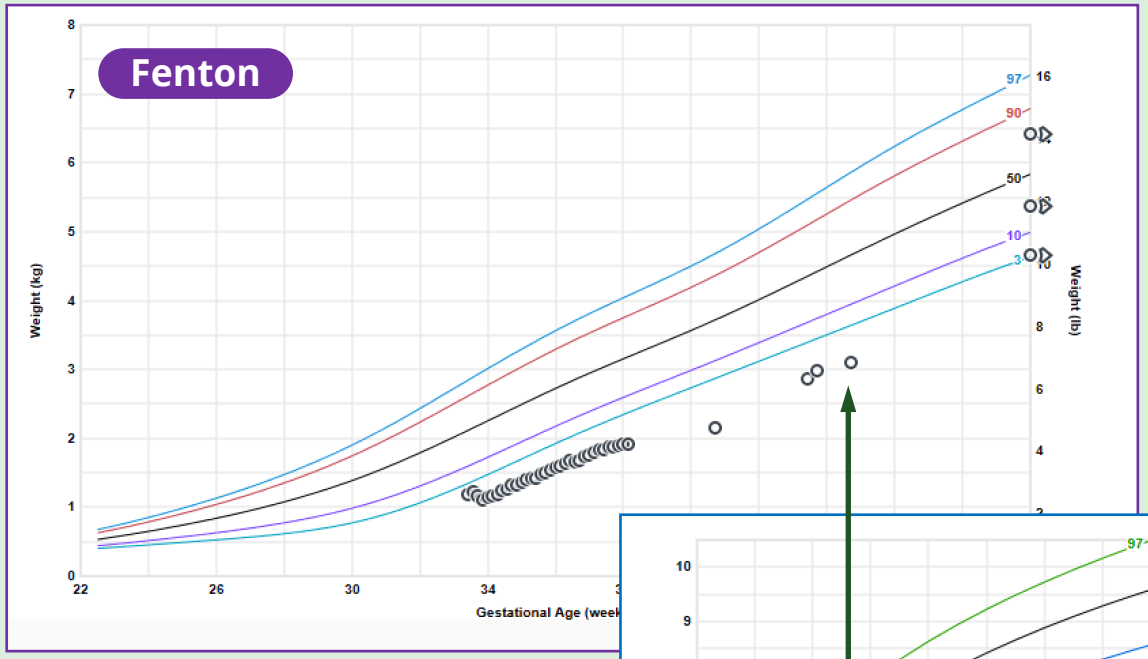
Coygan

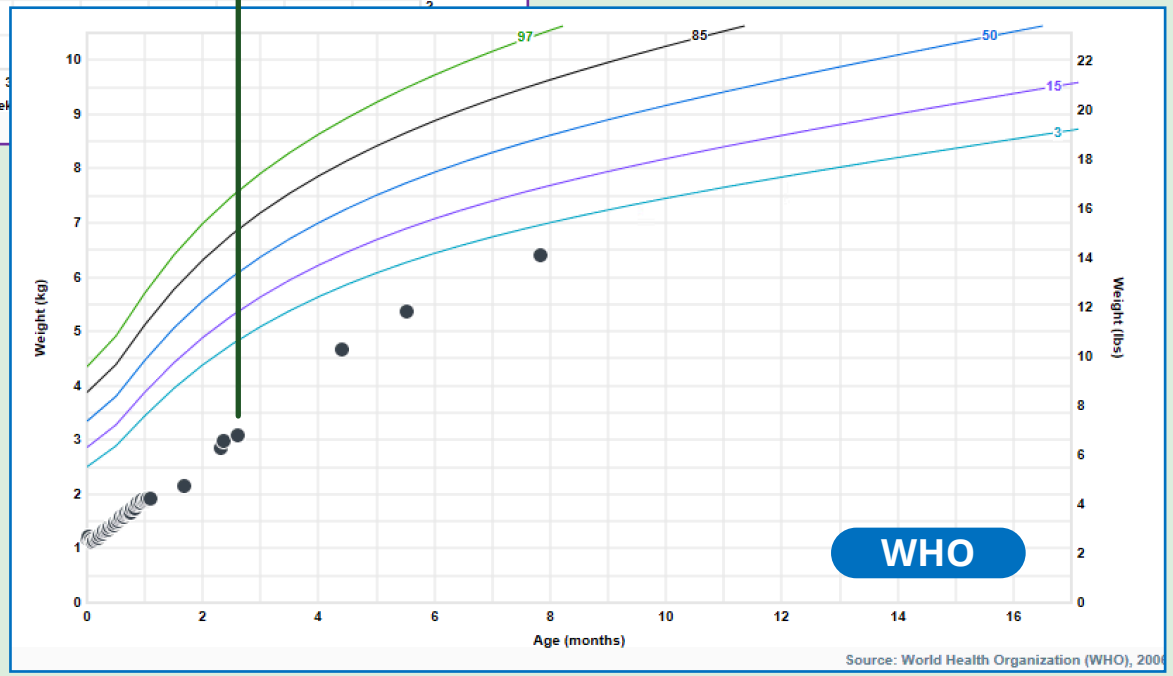
Case C—WHO Curve



C

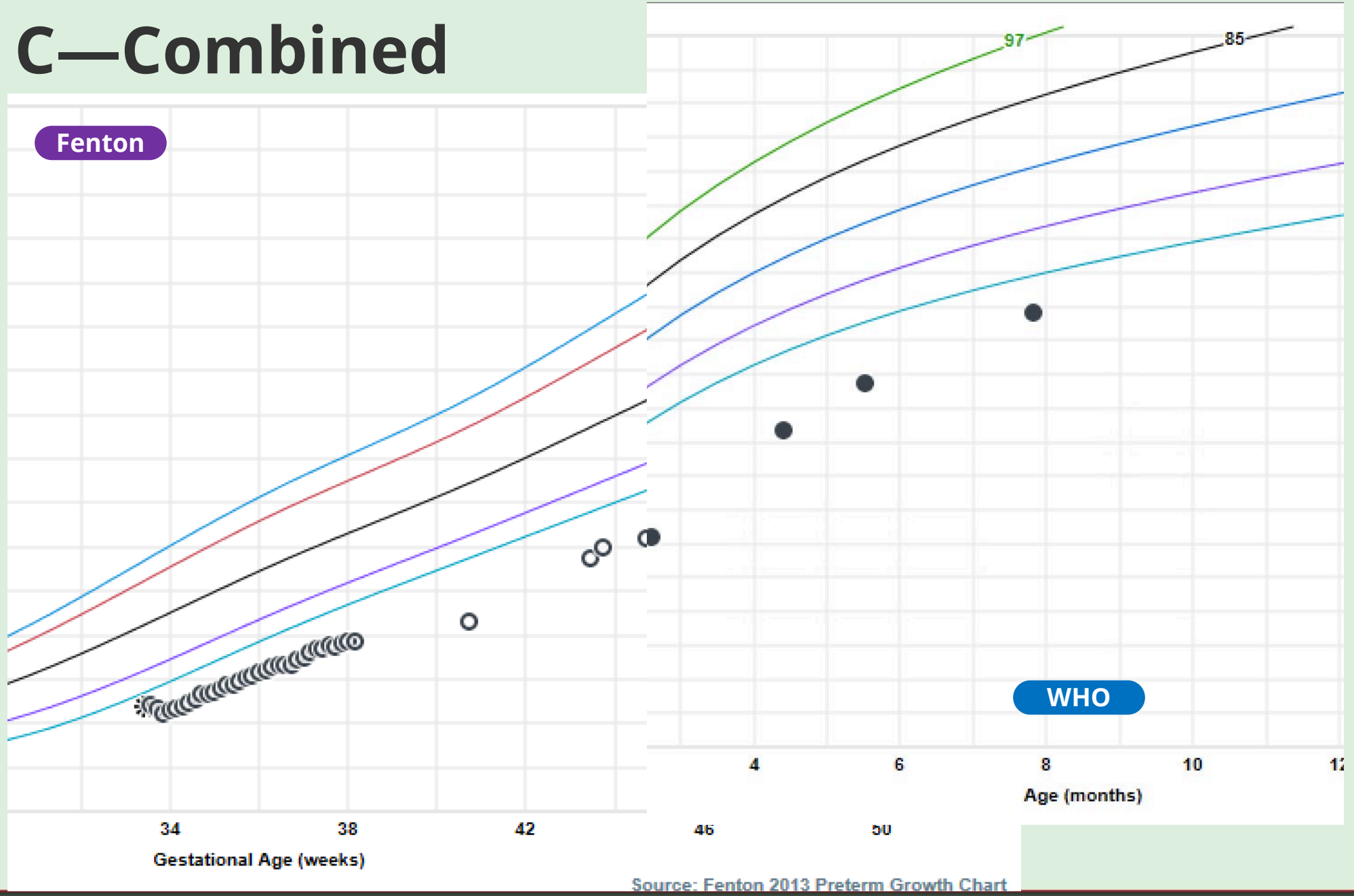
Coygan


Fenton
Weight (kg)
Weight (lb)
Gestational Age (week
97
90
50
10
3


WHO
Weight (kg)
Weight (lbs)
Age (months)
97
85
50
15
3
Source: World Health Organization (WHO), 200

Coygan

Case C—Combined



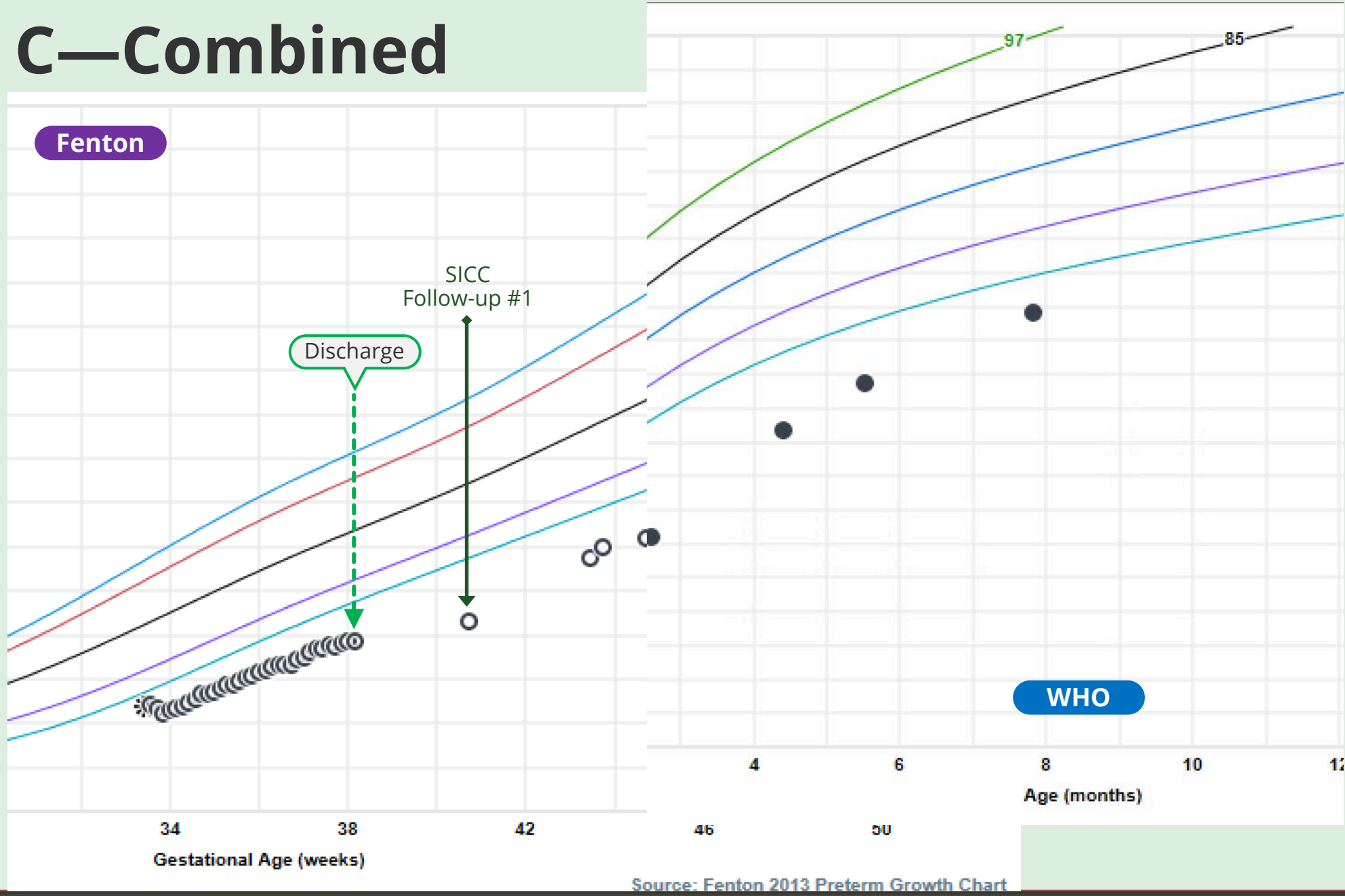
C

Coygan

Challenge Question #3

For a preterm baby >36 weeks to 3 months with CGA (ie, 2–3 months), what is an appropriate growth velocity?

Case C—Combined



C

Coygan

Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #1: 9/30/20, 40w5d	• Growth velocity—13.4 g/d on average • HMF d/c due to constipation; changed to MBM with extensively hydrolyzed protein formula to 27 cal/oz + BF 1–2 times per day • 0.5 mL multivitamin with iron supplementation recommended (0.5 mL until 2.5 kg, then 1 mL)	Weight: 2.162 kg (0.01%, Z-score: -3.69 based on Fenton)

Nutrient	Recommended	Estimated intake based on MBM w/EHP formula 27 cal/oz + BF 2 times/day (assuming ~160 mL/kg)
Energy, kcal/kg	110–130	**134**
Protein, g/kg	3.5–4.5 (2.8–3.2)[a]	**2.4**
Vitamin D	400–1000 (400)[a]	**240 (w/ supplement)**
Iron	2–3 (2)[a]	**3.1 (w/ supplement)**
Calcium	120–200 (70–140)[a]	**64**
Phos	60–140 (35–90)[a]	**39**

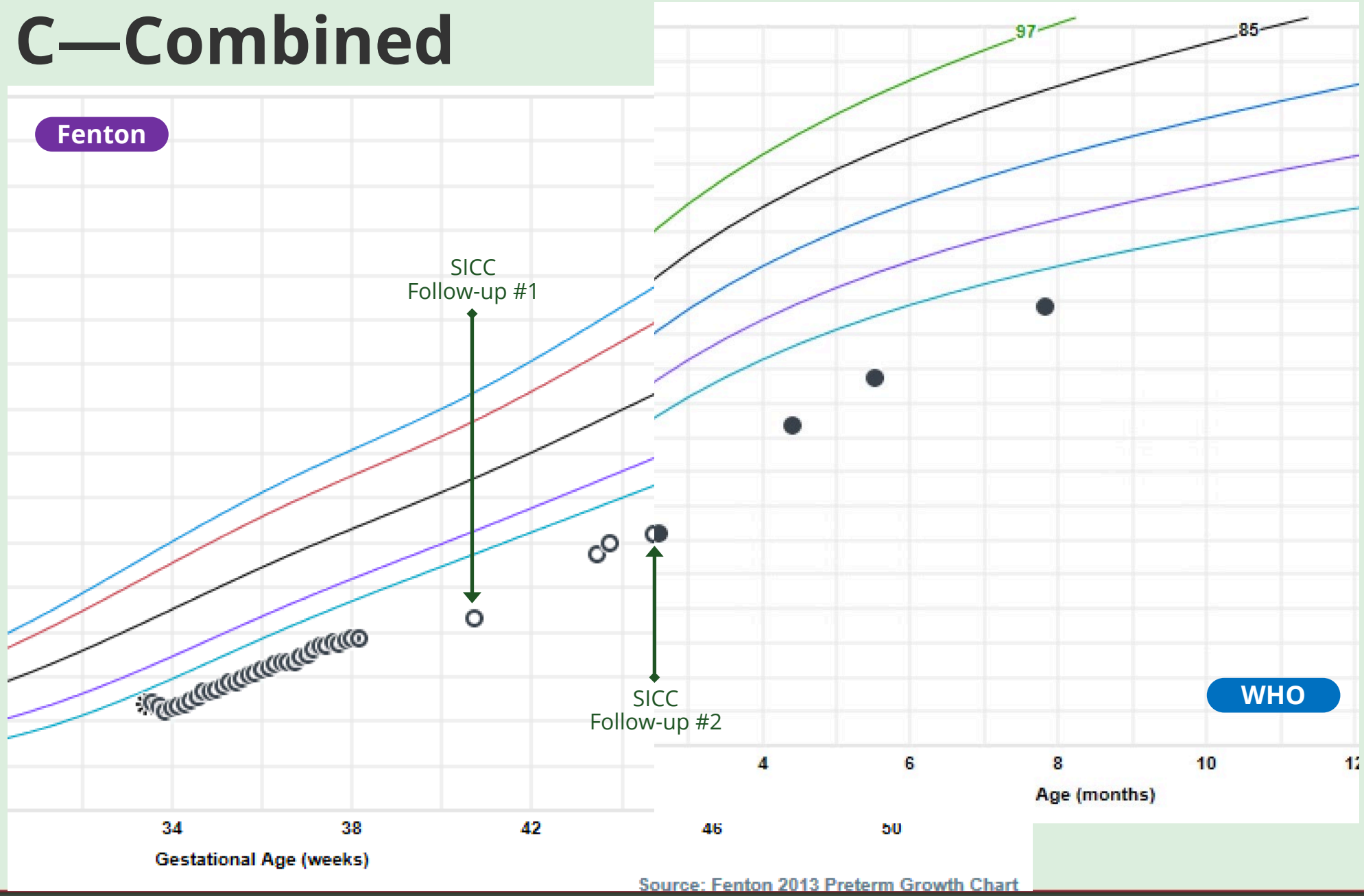
a. Estimated needs at discharge with no accumulated nutrient deficits (Uauy et al 2014[1]; Agostoni et al 2010[2])

BM, breastfed; EHP, extensively hydrolyzed protein formula; HMF, human milk fortifier; MBM, maternal breast milk.

1. Uauy R, et al. *World Rev Nutr Diet.* 2014;110:4-10. 2. Agostoni C, et al. *J Pediatr Gastroenterol Nutr.* 2010;50:85-91.
3. Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

Coygan

Case C—Combined



Source: Fenton 2013 Preterm Growth Chart

C

Coygan

Nutrition Progression: Phase 3 continued

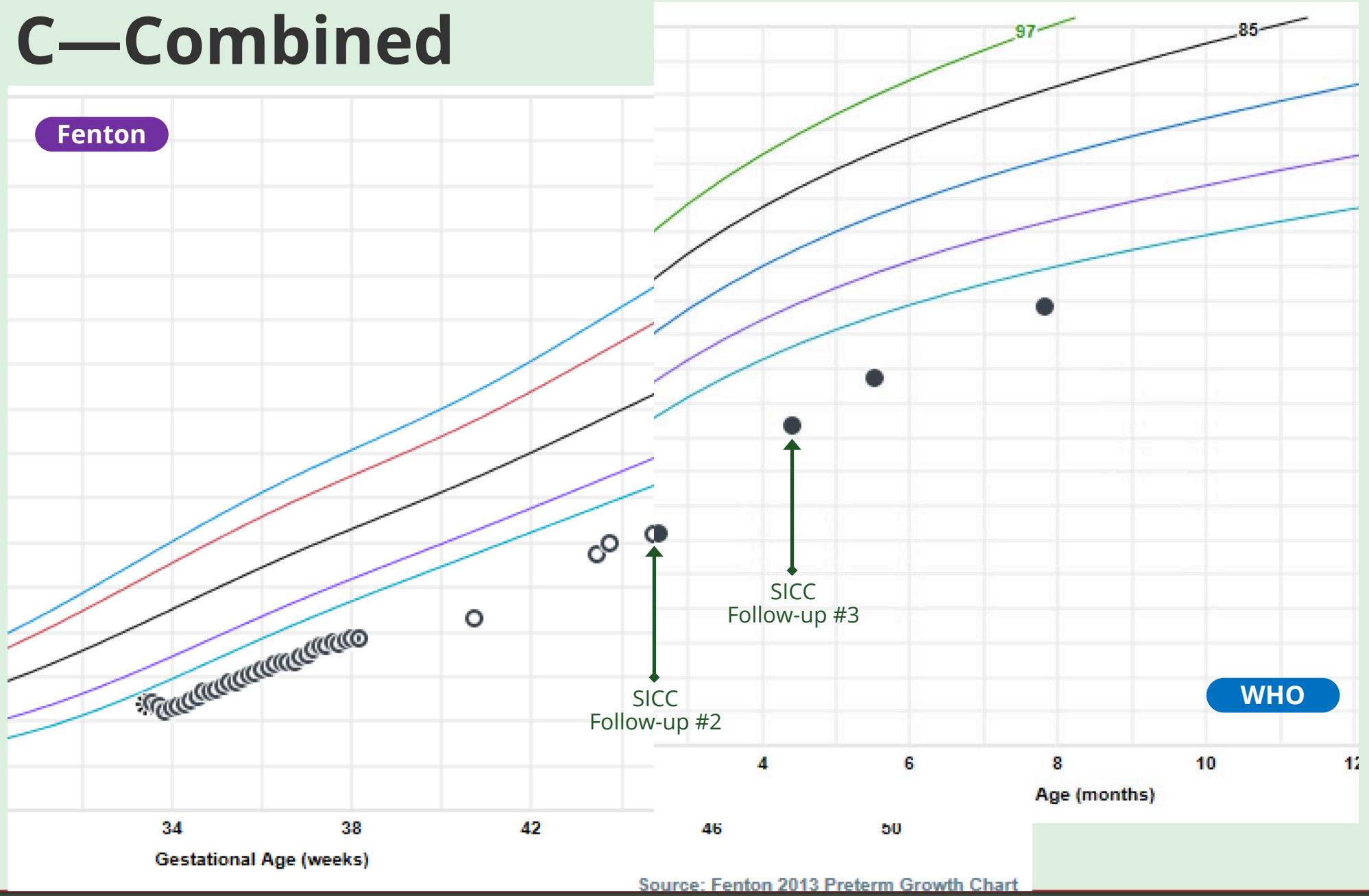
Follow-up Dates	Progression	Weight +
Follow-up #2: 10/28/20 44w5d	• **Taking 70–80 mL per feeding** • **Tolerating feeds better; constipation improved** • **Remains on MBM with extensively hydrolyzed protein formula to 27 cal/oz**	**Weight: 3.095 kg (0.12%, Z-score: -3.04 based on Fenton) Weight gain 33 g/d on average**
Follow-up #3: 12/22/20 2 mo 3 wks CGA	• Mostly breast feeding • Takes 4 bottles (2 days per week) of MBM with extensively hydrolyzed protein formula to 27 cal/oz when mom is working • MD recommends same feeds, decrease to 24 cal/oz if more bottle feeds	Weight: 4.663 kg (0%, Z-score: -3.76 based on chronological age WHO 0–2 yrs Boys) Weight gain 28.5 g/d on average
Follow-up #4: 4/5/21 6 mo 1 wk CGA	• Continues to mostly breast feed. • Taking one bottle per day of MBM with extensively hydrolyzed protein formula to 27 cal/oz	Weight: 6.41 kg (1%, Z-score: -2.62 based on chronological age WHO 0–2 yrs Boys) Weight gain 17 g/d on average

BF, breast feed; CGA, correct gestational age; MBM, maternal breast milk.

Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

Coygan

Case C—Combined



C

Coygan

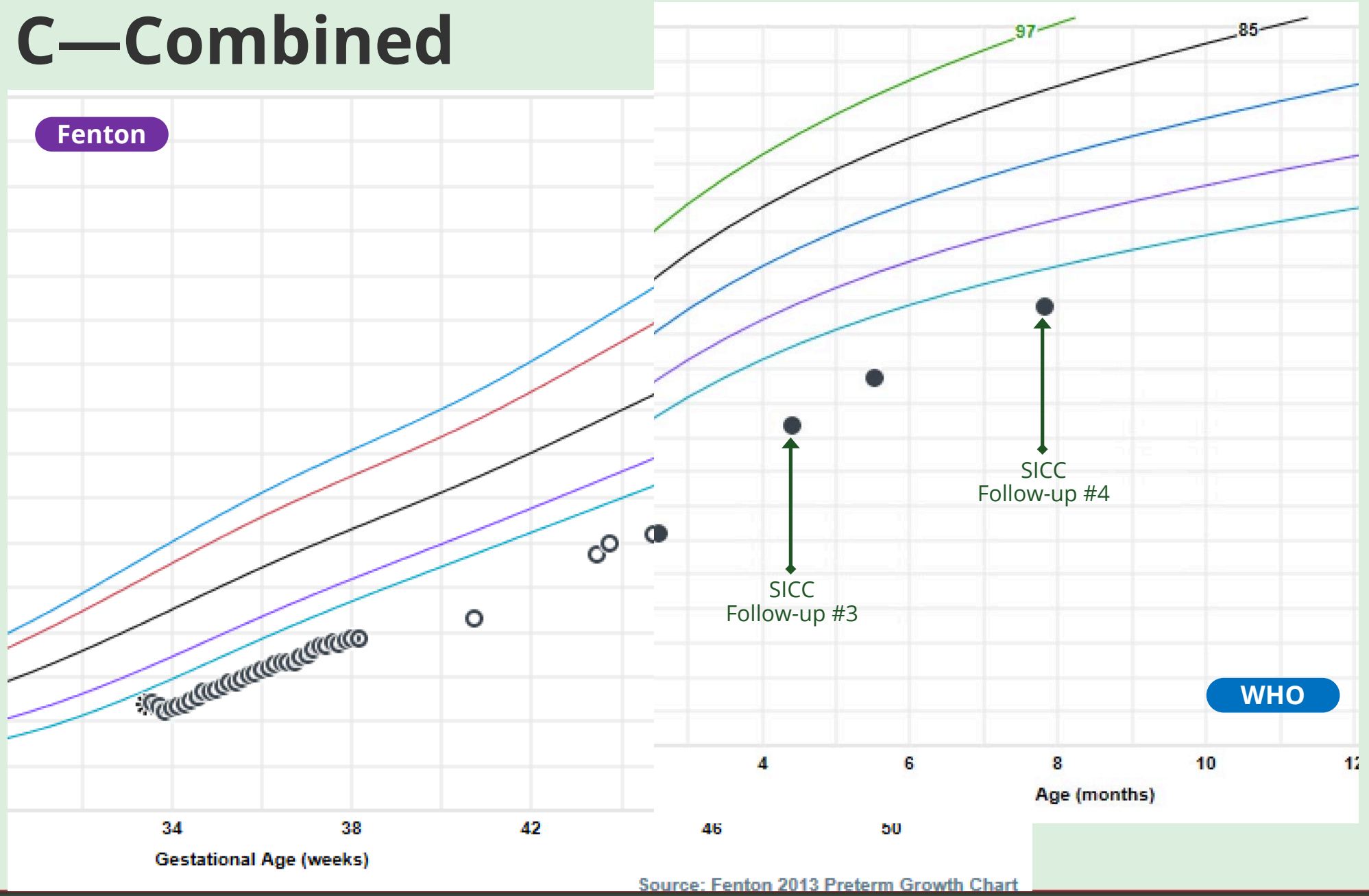
Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #2: 10/28/20 44w5d	• Taking 70–80 mL per feeding • Tolerating feeds better; constipation improved • Remains on MBM with extensively hydrolyzed protein formula to 27 cal/oz	Weight: 3.095 kg (0.12%, Z-score: -3.04 based on Fenton) Weight gain 33 g/d on average
Follow-up #3: 12/22/20 2 mo 3 wks CGA	• **Mostly breast feeding** • **Takes 4 bottles (2 days per week) of MBM with extensively hydrolyzed protein formula to 27 cal/oz when mom is working** • **MD recommends same feeds, decrease to 24 cal/oz if more bottle feeds**	**Weight: 4.663 kg (0%, Z-score: -3.76 based on chronological age WHO 0–2 yrs Boys)** **Weight gain 28.5 g/d on average**
Follow-up #4: 4/5/21 6 mo 1 wk CGA	• Continues to mostly breast feed. • Taking one bottle per day of MBM with extensively hydrolyzed protein formula to 27 cal/oz	Weight: 6.41 kg (1%, Z-score: -2.62 based on chronological age WHO 0–2 yrs Boys) Weight gain 17 g/d on average

BF, breast feed; CGA, correct gestational age; MBM, maternal breast milk.

Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

Case C—Combined



C

Coygan

Nutrition Progression: Phase 3 continued

Follow-up Dates	Progression	Weight +
Follow-up #2: 10/28/20 44w5d	• Taking 70–80 mL per feeding • Tolerating feeds better; constipation improved • Remains on MBM with extensively hydrolyzed protein formula to 27 cal/oz	Weight: 3.095 kg (0.12%, Z-score: -3.04 based on Fenton) Weight gain 33 g/d on average
Follow-up #3: 12/22/20 2 mo 3 wks CGA	• Mostly breast feeding • Takes 4 bottles (2 days per week) of MBM with extensively hydrolyzed protein formula to 27 cal/oz when mom is working • MD recommends same feeds, decrease to 24 cal/oz if more bottle feeds	Weight: 4.663 kg (0%, Z-score: -3.76 based on chronological age WHO 0–2 yrs Boys) Weight gain 28.5 g/d on average
Follow-up #4: 4/5/21 6 mo 1 wk CGA	**• Continues to mostly breast feed. • Taking one bottle per day of MBM with extensively hydrolyzed protein formula to 27 cal/oz**	**Weight: 6.41 kg (1%, Z-score: -2.62 based on chronological age WHO 0–2 yrs Boys) Weight gain 17 g/d on average**

BF, breast feed; CGA, correct gestational age; MBM, maternal breast milk.

Fenton TR, Kim JK. *BMC Pediatr.* 2013;13:59.

Nutrition Progression: Phase 3 Summary Table

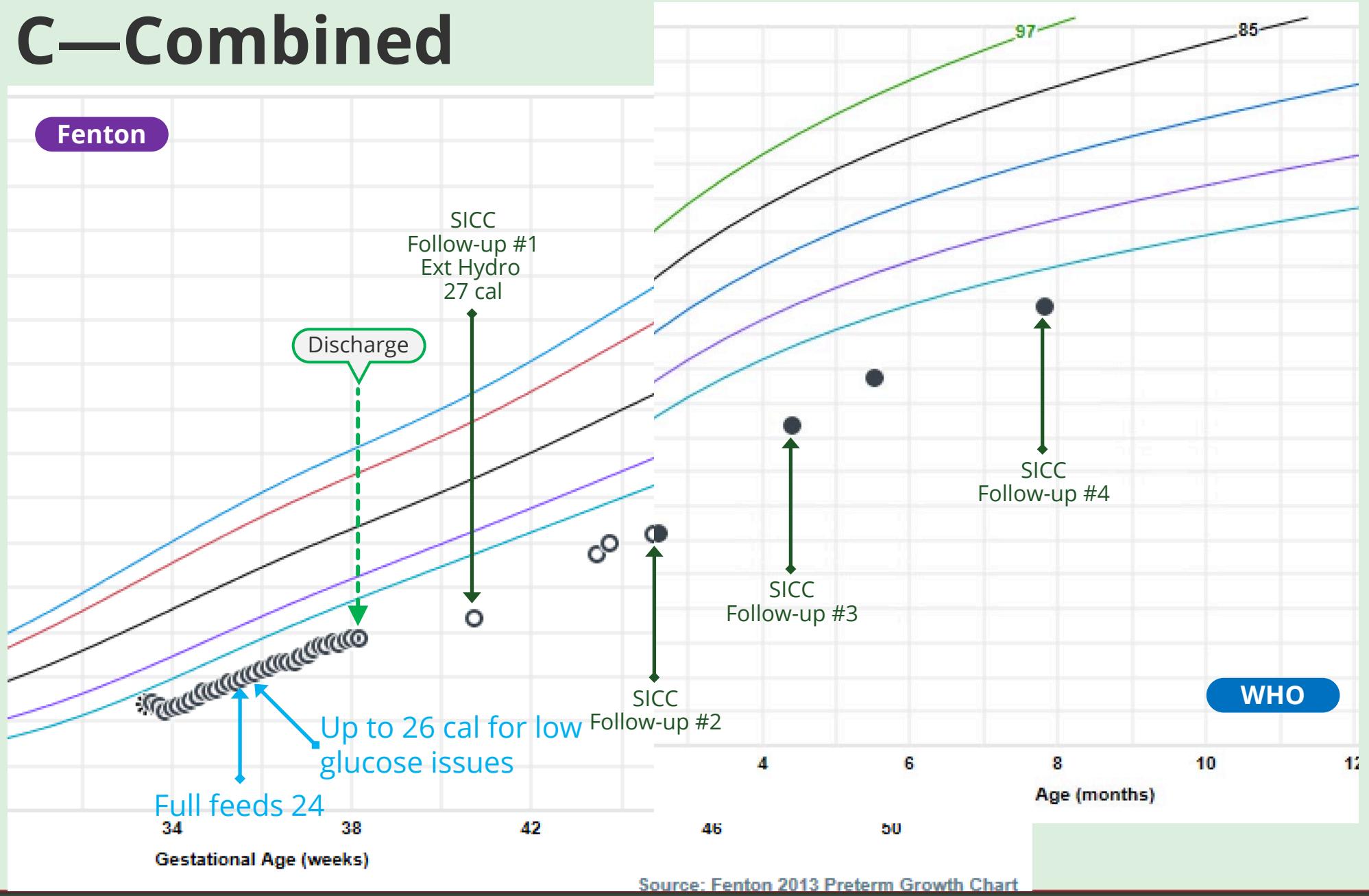
Dates	Gestational Age	Weights	Weight gain	Goals
8/27/2020–9/12/2020 (Phase 2)	35w6d to 38w1d	1545–1921 grams	23.5 g/d on average	23–43 g/d 32g/d per Fenton calculator
9/30/2020 (Phase 3) Clinic follow-up #1	40w5d	2.162 kg	13.4 g/d since discharge	23–43 g/d 24 g/d per Fenton calculator
10/28/20 (Phase 3) Clinic follow-up #2	44w5d	3.095 kg	33 g/d	23–43 g/d 25 g/d per Fenton calculator
12/22/20 (Phase 3) Clinic follow-up #3	2 mo 3 wks CGA	4.663 kg	28.5 g/d	27 g/d based on WHO at corrected age
4/5/21 (Phase 3) Clinic follow-up #4	6 mo CGA	6.41 kg	17 g/d	~12–17 g/d based on WHO at corrected age (between 4–6 mo)

CGA, corrected gestational age.

Fenton calculator can be found on peditools.org (also in EPIC, most electronic medical records)

Coygan

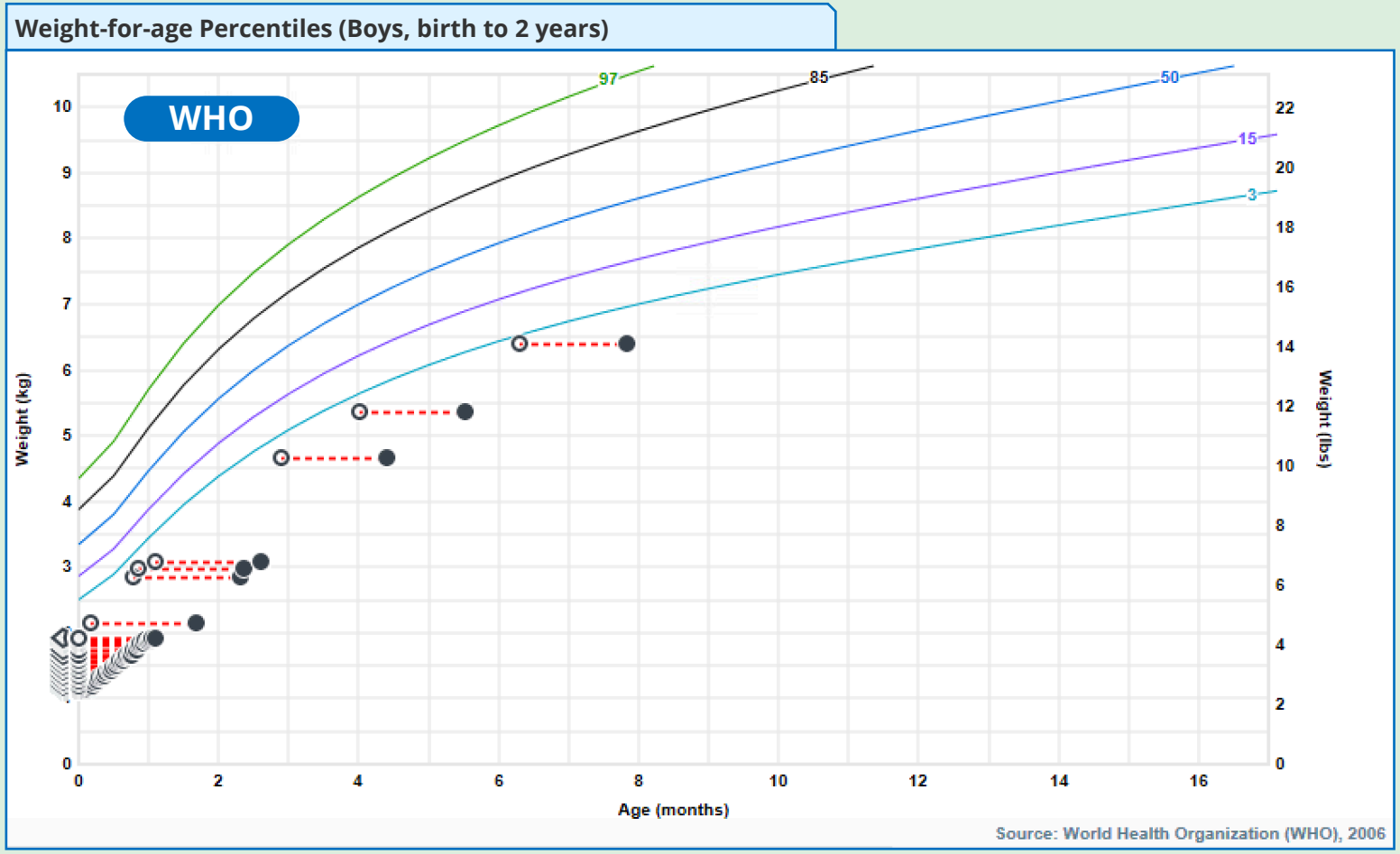
Case C—Combined



C

Coygan

Case C—WHO with CGA



CGA, corrected gestational age.

C

Coygan

Case Study “Coygan”

Key Takeaway:

- Nutrient-dense fortification is used in combination with BF to support nutrition needs at home.
- Transitioned to higher calorie supplementation for bottle feeds while mom increased BF throughout the day.
- No significant formula changes, allowed mom to incorporate more BF while catch-up growth supported with supplementation plan.

BF, breastfeeding.

Coygan

Wrap-Up

Growth Curve Summary

- Remember what they tell you, along with the data provided
- Fenton: shows where you've been—are you staying on track
- WHO: shows where going—are they on track to achieve recovery growth
- Chart/compare growth velocities of different PediTools options

Transitioning Care to Community Providers

- Pediatric partners are essential
- Discharge summaries can be valuable
  - Underscore why baby has specific feeding plan
  - Highlight ongoing nutrient needs
  - Reinforce that healing is still ongoing
- Specific feeding plan is in place to help support adequate growth

Individualized Feeding Plans

- Individualized feeding plans need to account for physical support
  - Immature feeding skills
  - Breastfeeding mechanics
  - Skills to manage O2 or G-tube
- Nutrient support needed in way of fortifiers
- Monitoring individual growth parameters
- “Standard Fortification” vs “Individualized Fortification”
  - Standard fortification falls short of supplying sufficient protein for some VLBW infants
  - Individualized fortification encourages providers and families to provide optimal nutrient intake

G-tube, gastrostomy tube; VLBW, very low birth weight.

Post-Discharge Growth Monitoring

- Having a structure is essential
- Using more “powerful” fortification strategies after NICU discharge can be powerful supports - But must be aware of risks of excessive micronutrient intake.
- Be mindful of risk mitigation.
- Have a process to follow up and actively monitor these infants to ensure excessive nutrient intake can be corrected if it occurs.

- Monitor infant’s growth, including weight, length, weight for length, and head circumference every 2–4 weeks after discharge.
- Monitor weekly to biweekly for first 4–6 weeks after hospital discharge.
- Once stable, monitor every month, then every 2 months.

Smith VC, et al. UpToDate.com. Updated Jun 24, 2020.; Griffin IJ. UpToDate.com. Updated Jun 17, 2020; Lapillonne A, et al. *J Pediatr Gastroenterol Nutr.* 2019;69(2):259-270; Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.

Key Takeaways

- Growth failure can occur during acute, convalescent, or later in post-NICU, recovery discharge phase.
- Nutritional deficiency induces poor postnatal growth. Poor growth in preterm infants has long-term effects.
- Nutrition evaluation prior to NICU discharge can help individualize fortification plan for home.
- Postdischarge growth monitoring is essential to avoid loss of hard-won gains made in the hospital.