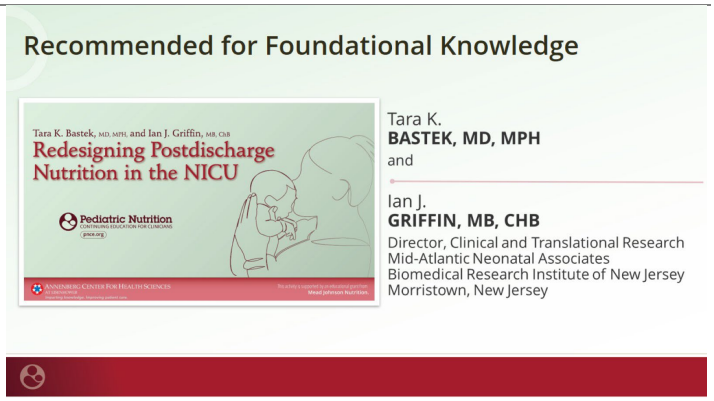
Preterm Nutrition Through Discharge: A Case-Based Challenge Transcript

Editor's Note: This is a transcript of an online presentation broadcast on June 23, 2021. It has been edited and condensed for clarity.

Dr. Tara Bastek: This is a connected piece of education to help put into practice some of the foundational knowledge that Dr. Griffin and I had discussed in our previous lecture, *Redesigning Postdischarge Nutrition in the NICU*. Dr. Griffin and I worked hard to try to cover the breadth of what is often a broad scope inside of premature infants' experience from acute to convalescent, to recovery nutrition. I am going to briefly touch on some of those highlights to set the stage as we talk about the cases today. We have 3 cases that we'd like to address. There is a lot of information. We will be moving very quickly. Hold onto your seats! It will be high-level in a lot of ways. We are happy to take questions, but we are really hoping to cover the breadth of how these different concepts get utilized.

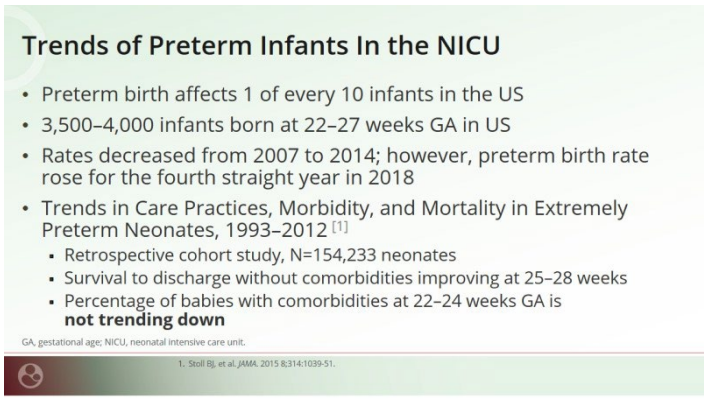
To set the stage for us, [we are] touching base very quickly on what we know about prematurity and its impacts here in the United States. Roughly 1 in every 10 births are born early, younger than 37 weeks. We know that that is about 4,000 infants a year [who are] born somewhere between 22 and 27 weeks in the United States. They are the smallest, the youngest, and consume the most resources.

The rates of prematurity have fluctuated over time, but they appear to be back on an upward trend after some period of at least holding steady, if not dropping. Those all may have important impacts on those of us who do this as a career.



Slide 1—Recommended for Foundational Knowledge

Thinking about how these infants survive and with what kind of lifelong impacts, we know that we are making some strides in the older ages, say, certainly the older gestations—30 weeks and up. But looking at the smallest, extremely low birth weight babies—25 to 28 weeks' gestation—appear to have improving survival rates without any of the comorbidities. But the children who are born at the very youngest gestational ages are not necessarily improving survival without comorbidities. [We've provided] these references,[1] and in our previous talk, there is certainly lots of information out there to be gathered if you are interested in learning more.



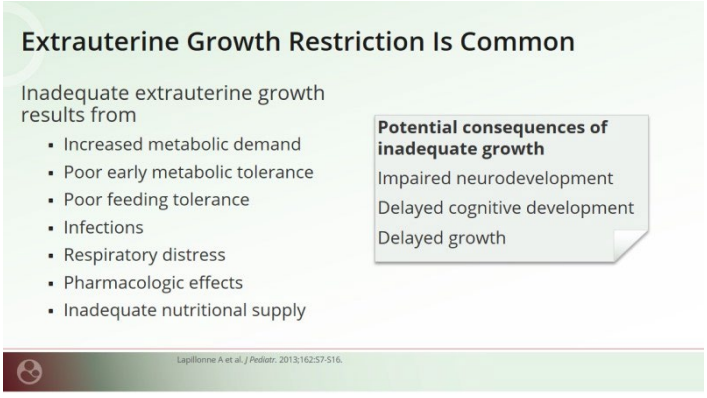
Slide 2—Trends of Preterm Infants In the NICU

Preterm Nutrition Through Discharge: A Case-Based Challenge

We also know that extrauterine growth restriction is common. Once they are born, once they are in our neonatal ICUs, it is still very challenging to get these small infants to grow. That has a number of different causes, as you see here on the slide [Slide 3]. There's increased metabolic demands; there is poor tolerance sometimes of enteral nutrition; there are physics and chemistry limits to the IV nutrition that we can use; and then there are the unforeseen inner current events like infections or other complications that come along the way.

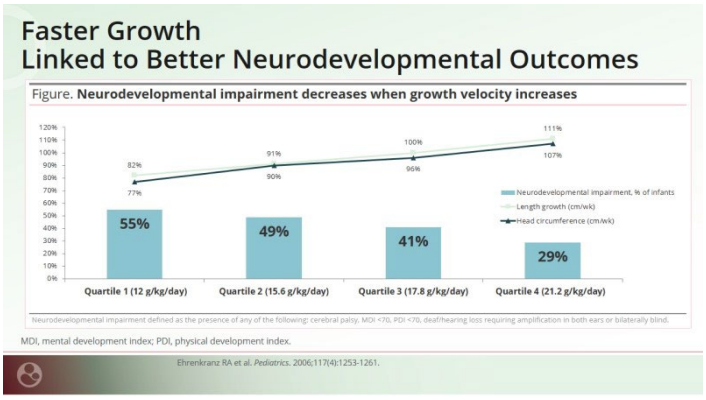
Growth Impacts Neurodevelopment

There's good literature to show us that poor growth is linked with impaired neurodevelopment, delayed cognitive development, and delayed physical growth.[2] The literature is beginning to really make us question what is the driver? The more likely it may be [is] that inadequate nutrition may be a driver of those comorbidities, but they certainly go hand in hand with one another.



Slide 3—Extrauterine Growth Restriction Is Common

There are significant bodies of work looking at how growth rates, nutrition, and long-term outcomes are connected. This is one of the seminal studies that were done by Dr. Ehrenkranz.[3] His research team shows that those babies who grow better have better neurodevelopmental outcomes. You can see across the quartiles as they grew faster (which is along your bottom axis), the percent of children with neurodevelopmental impact got smaller (that's your blue bar). The 2 lines you see at the top are head growth and length. Showing that **the better the length and head circumference changed, the less neurodevelopmental impact**. Good growth does seem to tie in with less neurodevelopmental impacts.



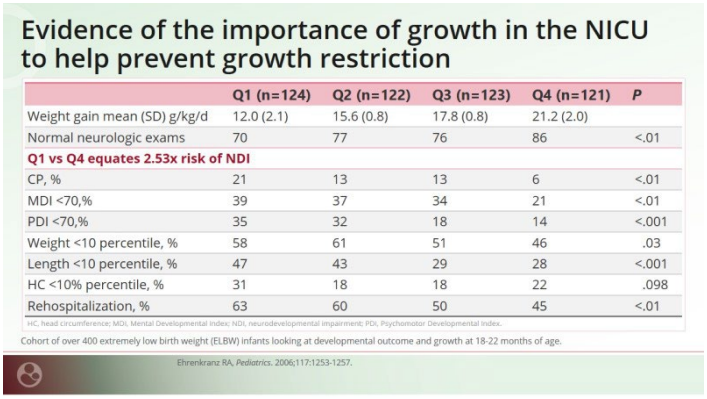
Slide 4—Faster Growth Linked to Better Neurodevelopmental Outcomes

That work was, I think, foundational in the last 15 years for really establishing some of the targets we all use when we are taking care of these infants.

This is a table graph [Slide 5] that shows the breakdown of those different neurodevelopmental components that were studied.[3] Across, you see that as you are growing from the first quartile, which was about 12 g/kg/d, to those growing in the fastest, the fourth quartile, growing at 21 g/kg/d. You can see a statistically significant drop in all of the long-term neurodevelopmental outcomes. It really

Preterm Nutrition Through Discharge: A Case-Based Challenge

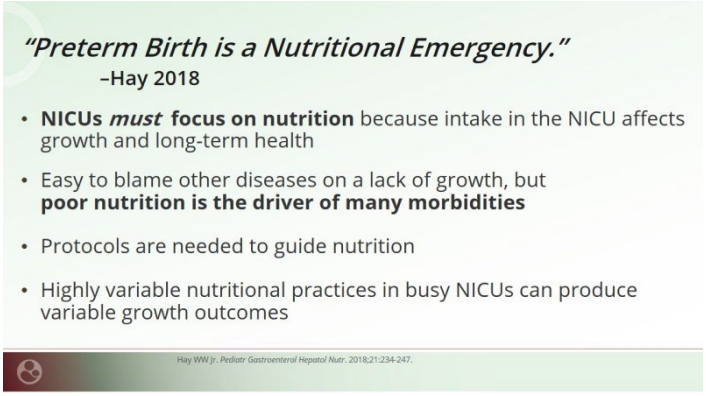
fundamentally..., when they wrapped up the tagline, it was you have about a 2½ times greater risk of neurodevelopmental impact if you are a slow grower compared to a fast grower, to use some general terms for brevity.



Slide 5—Evidence of the Importance of Growth in the NICU to Help Prevent Growth Restriction

That work, I think, foundationally has led many in the field, but Dr. Hay, I think, expressed it best by saying, "Preterm birth is a nutritional emergency."[4] Certainly, we know that the extremely low birth weight babies begin to burn energy and become catabolic almost instantly after they're born. It is why many NICUs are doing **early starter nutrition** so that we have it premade and ready to go. There's a growing call that **NICUs need to really focus on nutrition at every stage**.

Poor nutrition might be a driver of some of these morbidities, as opposed to a consequence of [them]. Growing our body of knowledge to better understand this work is something the field will continue to do for quite some time.

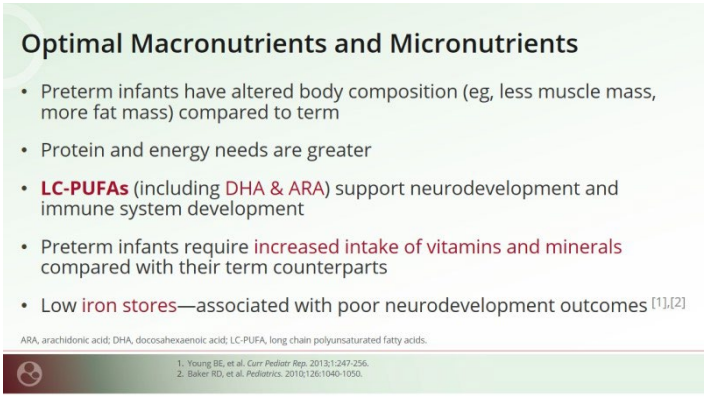


Slide 6—"Preterm Birth is a Nutritional Emergency."

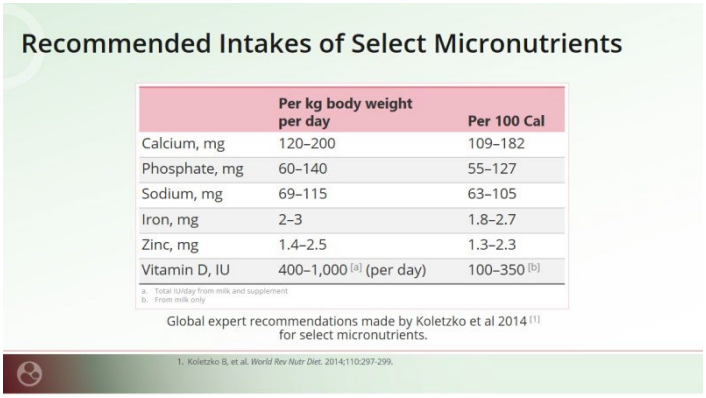
Nutrient Intake Recommendations

Again, very briefly hitting the highlights of what are those big goals we start thinking about from the very beginning. Those break down into both macro and micronutrient categories. Preterm infants often grow with altered body composition. They have less lean muscle mass. Historically, they've had more fat mass. Think of the classic chubby preemie about to go home. I think in the last 15 years, the field has learned that we **need to be much more thoughtful about how we're building muscle mass** and better body composition for these infants. The long chain, fatty acid information that's building to show us that neurodevelopment and immune systems have important benefits, as we are supporting those, is new work that we are beginning to incorporate.

Preterm Nutrition Through Discharge: A Case-Based Challenge



Slide 7—Optimal Macronutrients and Micronutrients



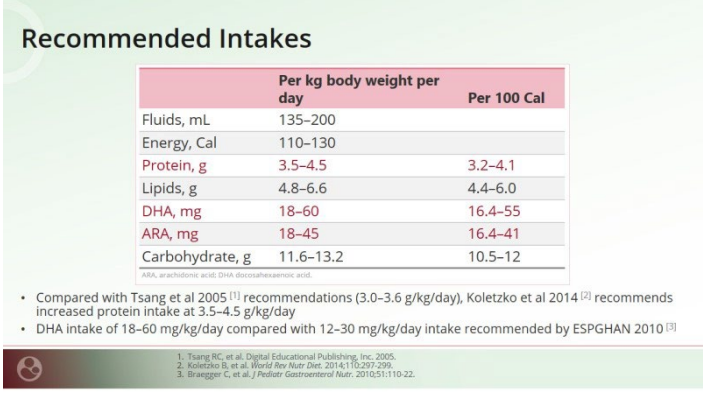
Slide 8—Recommended Intakes of Select Micronutrients

There are a number of vitamins and minerals: the calcium, the phosphorus, the things that influence bone density, along with magnesium, [and] some of these others. We are beginning to better understand what the adequate target levels are. How do we help with absorption? What are those limits we have by both using the vascular access when we need it, as well as using the enteral track when we need it. And how do we maximize those pathways for these babies?

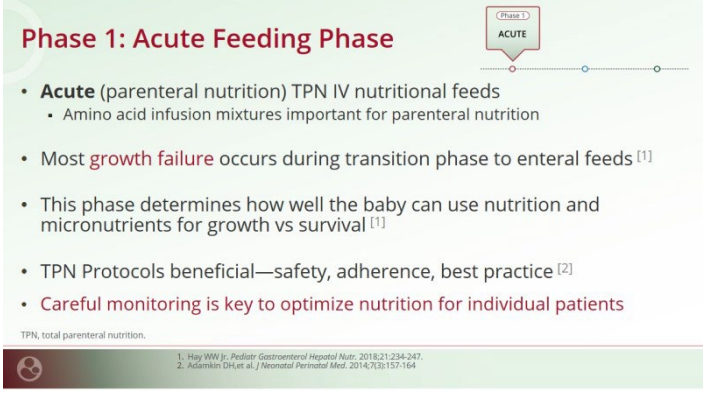
Iron, we know has long been linked with poor neurodevelopmental outcomes and figuring out how we help build those iron stores for the infants that are essentially missing the third trimester of fetal placental accretion.[5,6] These are all in categories where there has been lots of thought.

These tables that you're seeing, rather than walk through them, I know everyone on this talk can read and can take a look at this. You will see a lot of these again, but these are some of the target goals that have been put out there by the global expert recommendations.[7] This is the latest iteration that is not entirely new anymore. It is pushing on 6, 7 years. There are folks working on the newest iteration of those global recommendations that will be coming sooner than later. We will be using these targets. The ones you see in red here represent changes that were made when the 2014 guidelines came out. These were actually giving targets for the DHA and ARA, and it raised the protein goals, which many of us don't take as new information anymore, but certainly it was new when those guidelines came out.

Preterm Nutrition Through Discharge: A Case-Based Challenge



Slide 9—Recommended Intakes

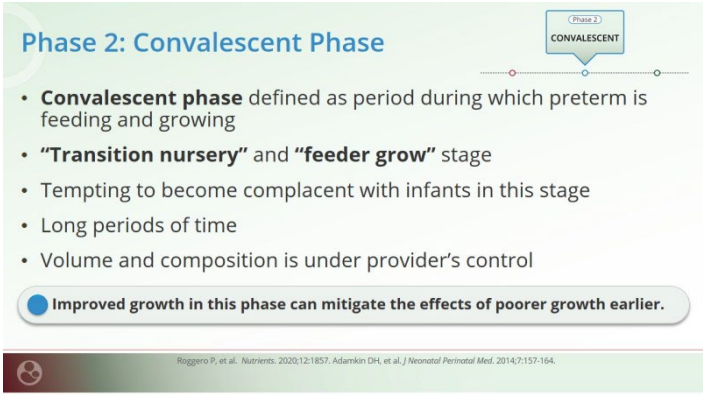


Slide 10—Phase 1: Acute Feeding Phase

We will be keeping the same outline and structure we used on the previous talk for those of you who have seen it. We had talked about phase 1 being acute, phase 2 in the convalescent NICU window, and then phase 3 being the out-of-hospital, post-discharge component. I'm briefly going to touch on those phases, and we will really be **focusing on the convalescent into discharge phase** as that is where this particular case-based focus is aimed today.

The acute phase really is focusing on the parental nutrition, where we are using TPN [total parenteral nutrition] and IV access to support these babies. We know there can be a pretty high rate of growth failure as we transition off of full IV nutrition onto full enteral nutrition. And because of the staged ways in which most NICUs are adding caloric density to those intestinal feeds, there's often a window where we are not necessarily getting full nutrient support for them. We know that monitoring is really important in this phase, and most NICUs have protocols and policies about getting electrolyte checks and frequencies with which we are watching the TPN—which is a skill set and a science in and of itself for these tiny neonatal infants.[4,8]

Moving into the convalescent phase, this is really the phase where we think about the feeders and growers. They are the ones that are not particularly needy inside your NICU. They're behaving themselves and ideally absorbing nutrients, growing and developing rapidly, just like you might expect a fetus in the third trimester of uterine development. This is a window that is pretty high risk and not necessarily because they are active and doing things, but it's really tempting to become complacent with how these infants are growing. Maintaining vigilance and surveillance and altering and adjusting for these infants to maximize each individual child's growth potential is, I think, where really the skill set lies in this phase.[8,9]



Slide 11—Phase 2: Convalescent Phase

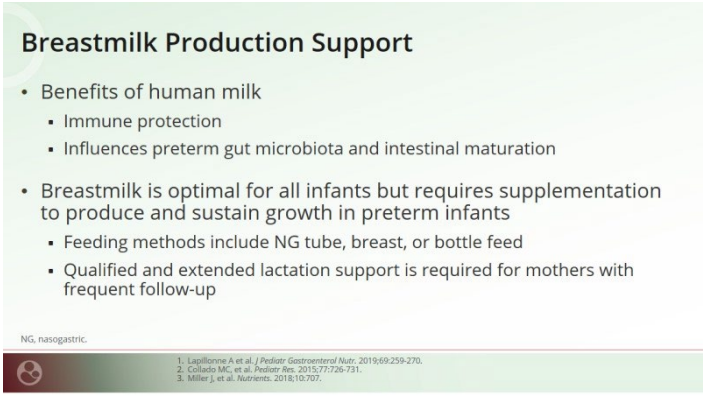
Preterm Nutrition Through Discharge: A Case-Based Challenge

Audience Challenge Question: What is an appropriate growth velocity for a baby in the convalescent phase of the NICU (<36 weeks' gestation)?

It looks like there was not a huge spread. We have a lot of people who are right on it. That helps us know who we're talking to, but also that goal of 15 to 20 g/kg/d that I referenced in Dr. Ehrenkranz's data certainly has hit home with everyone, which is fantastic.[3] That, indeed, are the goals that the majority of us use as we're looking at good growth velocity.

Here in the convalescent phase, [there is] also a lot of focus and support across NICUs in this country for breastmilk support. We know that direct breastfeeding is a hope and a goal of many of our families in the NICU. The ability to get the infant developed to where oral feeding, neurologic skills are in place, certainly takes time. But helping moms sustain their breast milk production through a complex—and often long—NICU stay, is a real challenge for us. I think it's something where many of us are putting lots of efforts to try to make it better. We know the benefits of human milk include immune protection and modulating influencing the preterm bacterial flora, as well as how that bacteria flora may influence the maturation of the intestinal tract.[10–12]

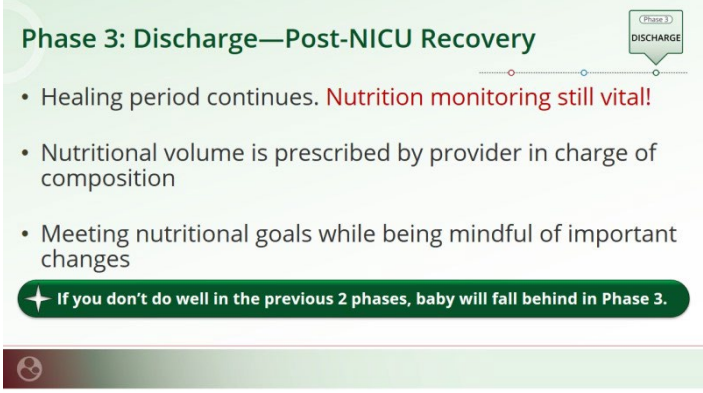
The other thing that we realize is that breast milk, for all of its amazing benefits… fundamentally, **mom's human body cannot reengineer breast milk to the extent that it can support the very young, premature infant through the entire third trimester**. Our ability to enhance and supplement the breast milk with fortifiers, and other things to help provide those nutrients, is something that the field is working hard to continue to develop.



Slide 12—Breastmilk Production Support

Then the third phase is discharge—post-NICU recovery, where a lot of that healing continues as, finally, these infants can recover from the significant impact they may have of serious surfactant deficiency or other complications along the way. Nutrition is still the way the human body heals and repairs itself, as well as builds anew. And so, a focus on nutrition, even in the after-hospital recovery phase, is something that in our community we have put a big focus on in an effort to support the recovery of these children. As we move into thinking about the cases, we are increasingly aware that if you fall behind in one phase, if you aren't thoughtful about the next, you can either remain behind or lose an opportunity to recover in those arenas.

Preterm Nutrition Through Discharge: A Case-Based Challenge



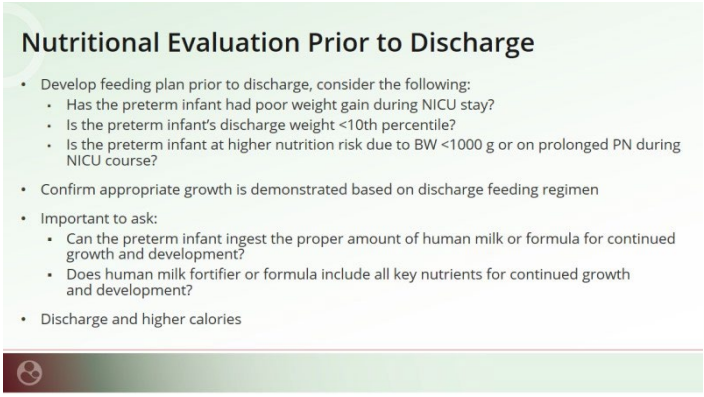
Slide 13—Phase 3: Discharge—Post-NICU Recovery

Nutritional Evaluation

Along those lines, we have begun to really think about how we establish a nutritional pathway plan evaluation for discharge, just like you might make a plan for respiratory support or other things. So, how do we help the nutrition component, not just the act of feeding? And so, thinking about questions, like

- What has the growth velocity and weight gain been during the NICU stay?
- Are they traditionally a good grower or have they been difficult to grow?
- Are they at the lower end?
- Are they less than the 10th percentile or increasingly beginning to think about are they less than the third percentile?
- Is this an infant who approaches it with baseline risks?
- They are a birth weight less than 1,000 g, or perhaps they've had significant complications requiring prolonged IV nutrition?

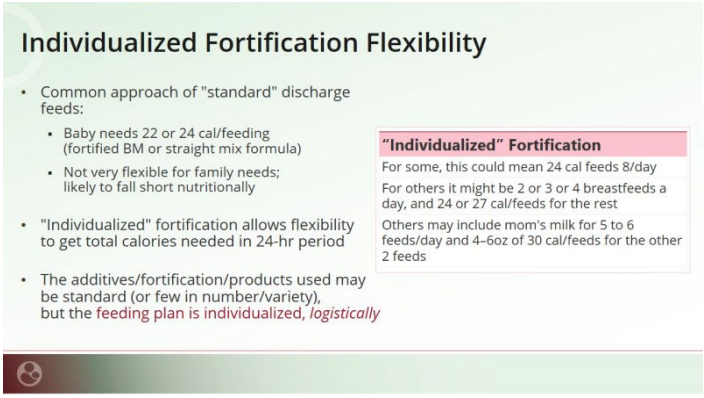
Those are markers of severity of illness across the NICU. Helping to figure out how we can work with whatever the infant stamina intake levels are and how do we develop the right combination of feeds and fortification so that family values, infant recovery, and growth can all be married together.



Slide 14—Nutritional Evaluation Prior to Discharge

That really gets us to something that we think about as an individualized fortification plan with some flexibility. We hope that we can begin to amend the strategies that we use with the family, and where they are, and the goals that they are working with, so that it's not the same thing for everyone, but that we can still meet the same nutritional intake goals for everyone.

Standard discharge feeds would be about taking 22 or 24 cal/feeds at every single feeding, whether that is fortified milk or straight mix formula, which might not be very flexible for a mom that, say, may want to be able to put the baby to breast some number of times a day.



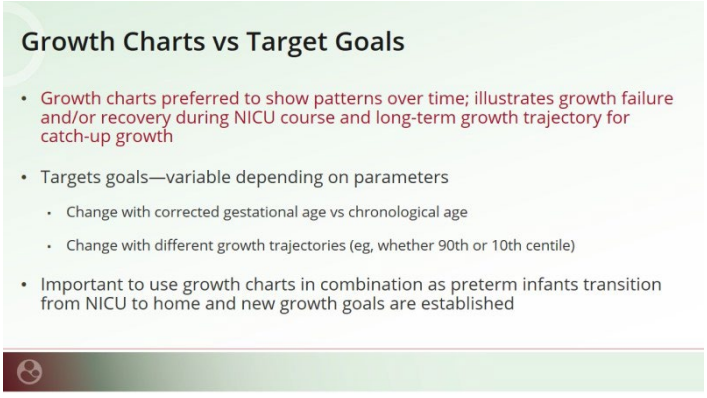
Slide 15—Individualized Fortification Flexibility

Preterm Nutrition Through Discharge: A Case-Based Challenge

How could we help allow for breastfeeding to a certain extent, whatever that infant stamina can allow, and how do we enhance the feeds on the alternatives so that they can still get the nutrients they need? Really trying to **think about planning for the individual baby** and their family—as opposed to this is what we do for all. For that kind of individual strategy [you can read] some examples that are popping up here on the slide [Slide 15, right].

A Word About Growth Curves

Karen Varga: I'm going to talk a little bit about growth charts at this time. Growth charts and target goals, otherwise known as growth velocity goals, are both great tools that we can use to follow the baby through their clinical course. Growth charts are preferred to show patterns over time. They illustrate growth failure and recovery during a NICU course. We also have different growth charts that we will get into in this presentation, both to show us where the baby's been and where we're going in the outpatient setting.



Slide 16—Growth Charts vs Target Goals

Target goals can be variable. We do want to remember that they can change at different corrected gestational ages, but they're helpful to show target goals to help promote catch-up growth. They also can change whether you're trending at the 90th percentile or the 50th percentile or the 10th percentile.

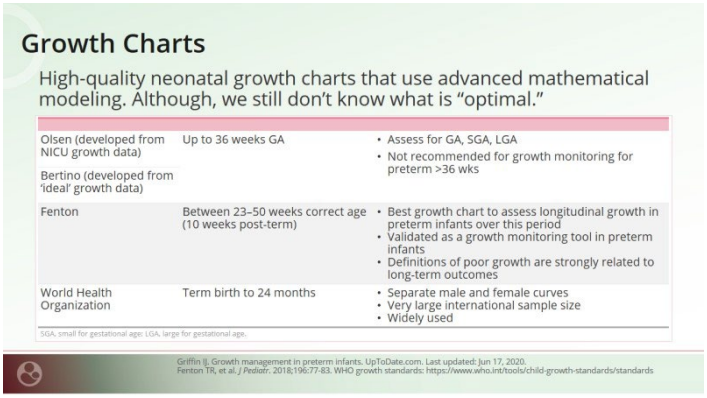
It's very important to use growth charts in combination with preterm infants as they leave that convalescent stage, and they're entering into the discharge phase. We're going to go through this in our case studies, how we pair our growth charts together to show the transition from inpatient to outpatient.

There are several different growth charts out there that are used. The Olsen and the Fenton growth charts tend to be most widely used in the NICU. And then the WHO tends to be used in the outpatient setting. The Fenton growth charts do go up to 50 weeks corrected age, so they can overlap in that 40 to 50-weeks' gestational age period and can be beneficial. We will show you this in our cases—how we can use both the Fenton and the WHO growth chart simultaneously to see the big picture of how a baby's been growing.[13,14]

What parameters do we want to look at and what are our target goals? Weights, obviously, are easy to do. **We want to do weights every day, preferably at the same time each day in the NICU.** It's easy to see trends. We have clear association with short and long-term outcomes with weight. Do keep in mind that they can be affected by fluid status, diuretics, and they reflect a short period of time.

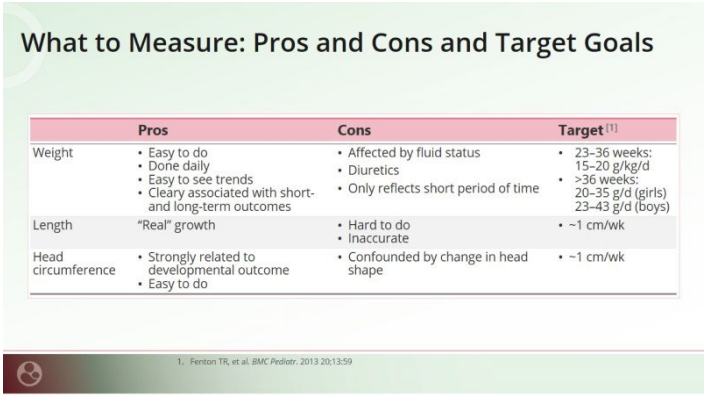
The target goals for our weight—as we touched on already briefly—between that 23 to 36 week gestational age during the NICU, looking for somewhere between 15 to 20 g/kg/d.

Preterm Nutrition Through Discharge: A Case-Based Challenge



Slide 17—Growth Charts

It is important to keep in mind when you're doing this growth velocity calculation—that the kilos you're using in your denominator…—that there is an average weight between the time period that you're looking at. If you're tracking a baby from, let's say, day-of-life 10 to day-of-life 20, you would want to use the difference between those 2 weights as your grams, and then you would want to use the average of those 2 weights as your kilos divided by 10 days. Greater than 36 weeks, we can transition over to grams-per-day and 20 to 35 g/d for girls is ideal, and 23 to 43 g/d for boys is ideal.[15]

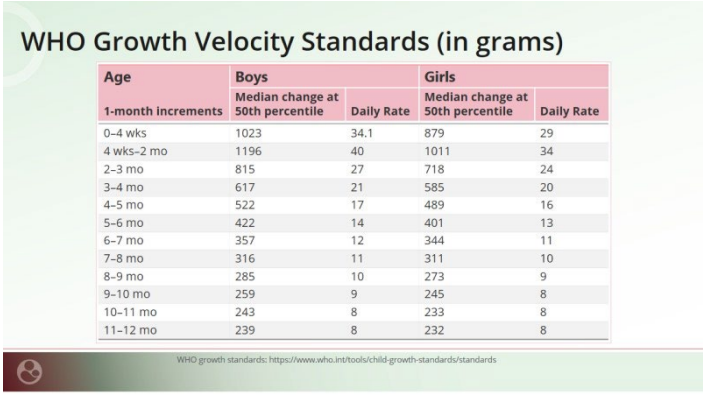


Slide 18—What to Measure: Pros and Cons and Target Goals

Lengths are very important, and also give us a good measure of real growth. They are hard to do, so definitely [one] would want to have experience in the NICU using length boards. Otherwise, they tend to be very inaccurate just using paper tape. We are looking for about a centimeter per week. And then head circumference is very important to follow, as well, also looking for about 1 centimeter per week.

This chart (slide 19) talks about the WHO growth velocity standards. This data is available from the WHO.[14] These charts can be very helpful, specifically in the outpatient setting as the baby starts to transition from inpatient to outpatient, whether they're being followed in a pediatrician's office or in a special infant care clinic that may follow NICU graduates.

This chart specifically is one that we use frequently. It's looking at the weight change and these intervals of time. The first column would be the median change at the 50th percentile for babies in those time periods. And then the daily rate is the median change divided by 30 for daily growth velocity.



Age 1-month increments	Boys Median change at 50th percentile	Boys Daily Rate	Girls Median change at 50th percentile	Girls 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

Slide 19—WHO Growth Velocity Standards

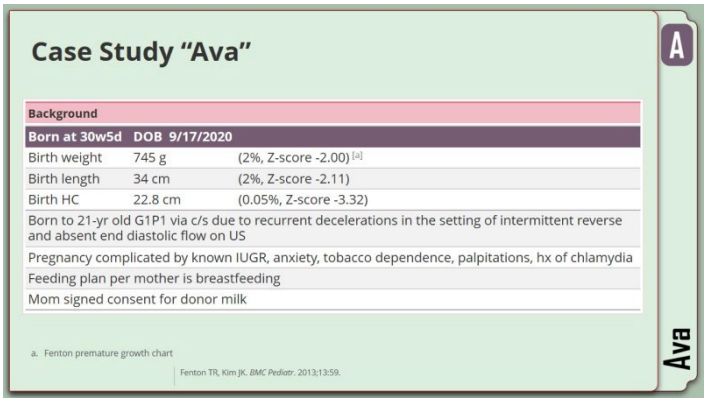
Do keep in mind that this example is at the 50th percentile. You can certainly pull the data if you want to have charts for your own clinical use to look at it for babies that might grow closer to the 75th percentile or the 25th percentile. This also shows you how these growth targets

Preterm Nutrition Through Discharge: A Case-Based Challenge

change from each time period. In a clinic where you're following a preterm infant, you would be looking at these target goals based on their corrected age to keep the baby growing towards catch-up growth. But the growth goals do decrease over time just as the growth chart starts to flatten a little bit over time.

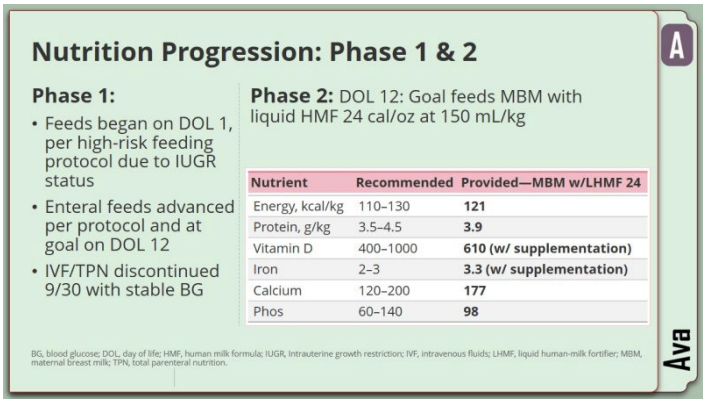
Case Study: "Ava"

Dr. Tara Bastek: With that as a setup, we will dive into these cases. The first case we're going to talk about is Ava. You can see the basic statistics in front of you. She is a preterm infant in that moderate range, born at 30 weeks and 5 days, on the small side, had some growth restriction, being only 745 g at birth. You can see the length and head circumference. She was delivered because of recurrent decelerations in the setting of worsening placental blood flow. She had reverse and absent end-diastolic flow. Known growth restriction [is] likely thought to be related to that placental insufficiency. There were some other maternal health features along the way of her pregnancy. Mom's plan was breastfeeding. She had agreed to donor milk in the beginning.



Slide 20—Case Study "Ava"

As we very briefly touch on phase 1, here we began feeds: IV nutrition was begun on day of life (DOL) 0; enteral feeds were begun on DOL 1 and advanced along the lines of the high-risk protocol that we have developed here. Her growth restriction is what placed her on the high-risk feeding protocol. (In our unit, the diagnosis of maternal preeclampsia will also place infants on the high-risk protocol.) As we progress, she reached full feeds and full fortification on DOL 12, and we were able to stop the IV nutrition with glucosis.



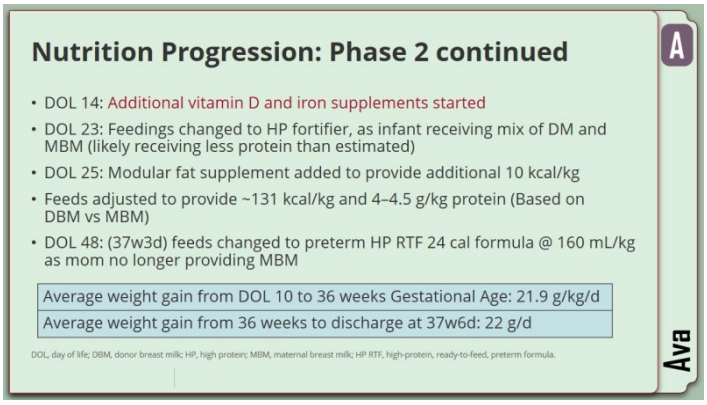
Slide 21—Nutrition Progression: Phase 1 & 2

As we get to phase 2, we have reached the original starting place of our standard enteral feeding: maternal breastmilk with our liquid human milk fortifier to 24 cal/oz, our target volume goals are 150 mL/kg/d. You can see in this grid in front of you the calculation of how that hits the target goals [Slide 21, right]. For these grids that you will see, the recommendations are in the middle column, and then what the actual feeding provides will be in the far-right column.

As we enter convalescent phase, this infant was exactly where we expected her to go. As her hospital course unfolded, essentially what this slide is here to show is that we were, with active surveillance, tweaking and altering her feeding as she went. We would add vitamin D and iron

Preterm Nutrition Through Discharge: A Case-Based Challenge

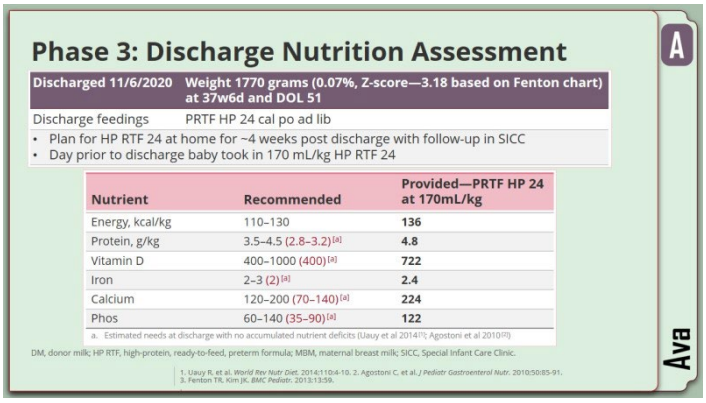
supplements on DOL 14 for all infants when they're at full volume feeds at DOL 13, but not before DOL 14.[16,17] As we watched her growth velocity, it began to slow some, so she was changed to the high-protein version of human milk fortifier, as by then, she was having a combination of donor human milk as well as Mom's own milk, and we know that donor human milk has less protein than mom's own milk. The change was meant to supplement that. As her growth velocity did not pick up, we also added modular fat supplement to provide additional 10 kcal/kg/d, which did a nice job of boosting her growth support so she was maintained on that higher feeding.



Slide 22 – Nutrition Progression: Phase 2 continued

As we approached closer to where she ultimately was ready for discharge, we were transitioning her over to the preterm ready-to-feed formulas at 24 calories because Mom was no longer pumping milk, and we no longer had a supply. As we shifted across her course, we were able to sustain an average weight gain from essentially reaching full enteral feeds to 36 weeks gestation at almost 22 g/kg/d, and then from 36 weeks to discharge, which was essentially 2 weeks later at 37w6d, one day shy, at 22 g/d. So, really maintaining the growth velocity goals that we would hope for this preterm infant while she was in the NICU. As we progressed towards discharge, we began to do our discharge nutrition assessment and begin to really assess what can we do to help support this infant as she transitions home. I'll hand it over to Karen.

Karen Varga: As we started to look at Ava for home, things that you know are important to think about as you're sending a baby like this home, she's now 1,770 g. Based on the Fenton growth chart, she's still right around the 0 percentile, and her Z-score is -3.18. She was born with a Z-score of -2. She's had a decline of about 1.18 standard deviation from where she was born. Given the fact that she is less than the third percentile on the Fenton growth chart, we felt as though she still had high growth recovery needs. She's below 2 kg. The risk of toxicity of sending her home on a preterm formula is low.



Slide 23—Phase 3: Discharge Nutrition Assessment

The team decided that we would send her home on the ready-to-feed preterm formula to keep the nutrient-rich formula and diet for her for about 4 weeks or so and reevaluate her in our special infant care clinic on follow-up.

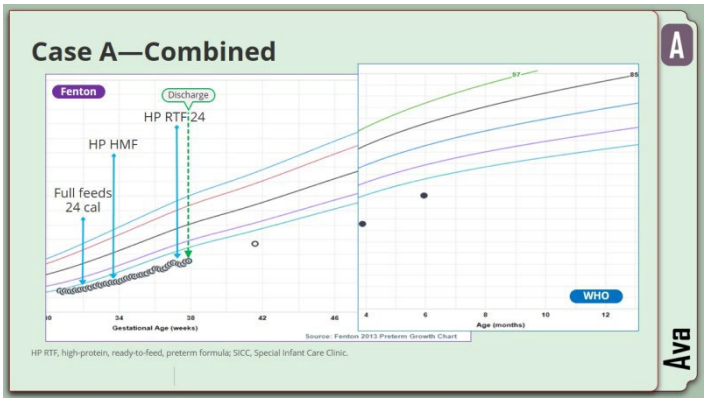
You can see her feeding plan for discharge. We have the recommended nutrients there. Also highlighted in the red is recommended

Preterm Nutrition Through Discharge: A Case-Based Challenge

nutrients at discharge for infants with no nutrient deficiencies. We are still meeting the preterm nutrient recommendations because we felt like she does still have deficiencies and she still has growth recovery to do at home.

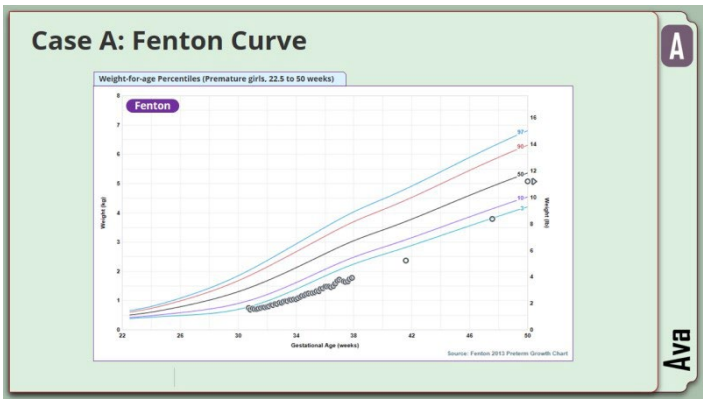
Dr. Tara Bastek: Next, I'm going to show you a series of growth charts. And since our polling questions have told us that we have a very savvy audience who are used to looking at these growth curves, we will do the same sequence for all cases, but cover them very quickly.

This slide that you see is a combination of the Fenton chart on the box on the left and the WHO growth chart on the right. We have annotated the steps along the way, mostly to try to begin to show how you can combine the continuum, and how life of a child would stretch across these monitoring devices that we all use to be able to measure growth. This is a picture of the combined [charts] with the hospital course in terms of growth and weight highlighted.



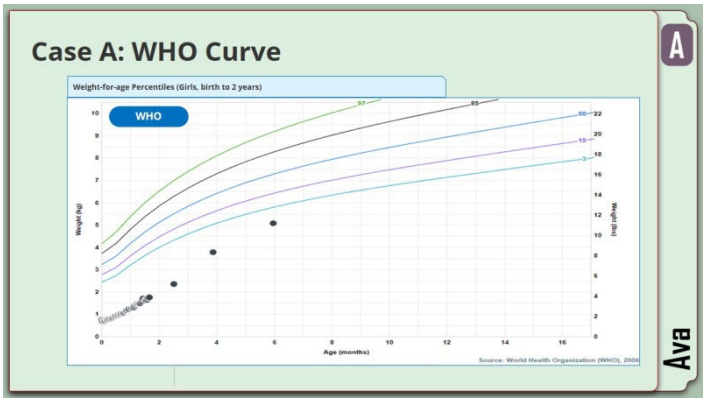
Slide 24—Case A—Combined

As I move through the growth charts, this is what we typically see when we are looking at Fenton charts and infants who are growing in the NICU. That's something that's common.



Slide 25—Case A: Fenton Curve

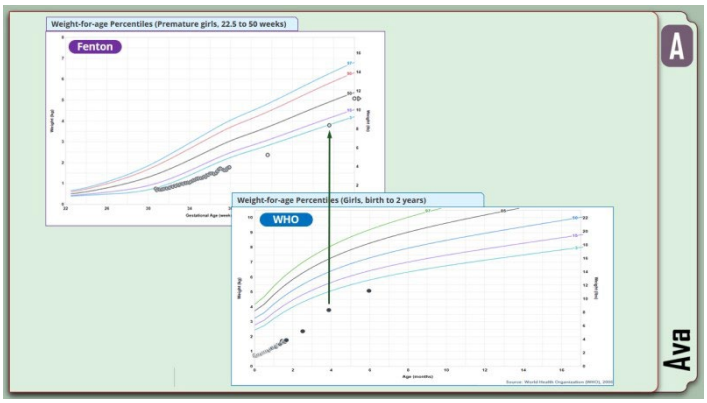
This is how that same growth trajectory looks when you put it on the WHO curve without any additional correction.



Slide 26—Case A: WHO Curve

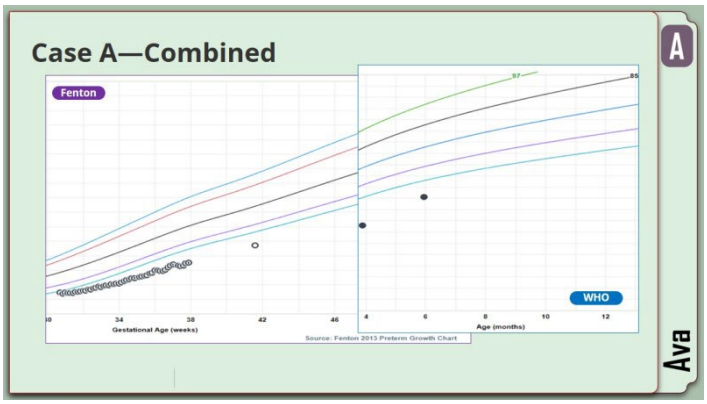
If we were to try to really help draw for those that are less familiar with transitioning from the Fenton to the WHO—where we find this—is something that trips up a lot of our community providers. Being able to think about how they may look okay on one but really behind on another, this is the weight data point where the Fenton and the WHO would essentially cross over as she grows close to that 50-week mark.

Preterm Nutrition Through Discharge: A Case-Based Challenge



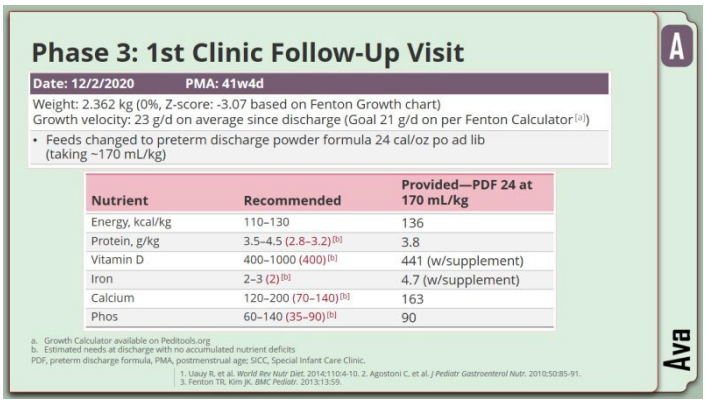
Slide 27—Case A—Combined

That gets us to this, again, combined image where we have put it together across a continuum for growth. We will see this on the next several sets of slides.



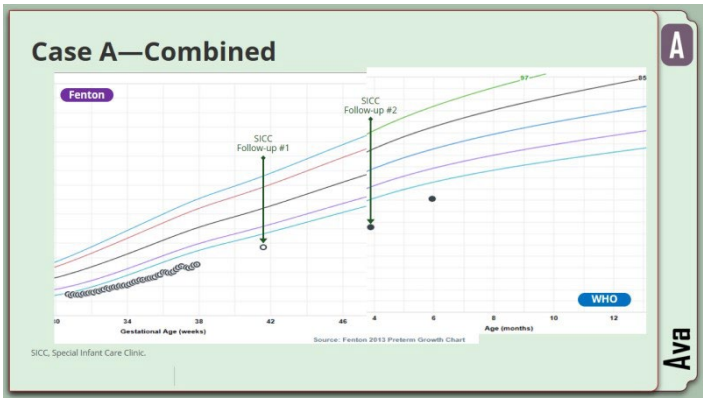
Slide 28—Case A—Combined

Karen Varga: Our first clinic visit with Ava, she's coming back to us at 2.362 kg. She's now with a Z-score of -3.07. If you remember, she left at -3.18. She's made a little bit of ground. She's been growing at 23 g/d since her discharge over the past month. Based on that Fenton calculator, her goal would be 21 g/d. One thing to keep in mind **with the Fenton calculator, it does calculate growth needs to maintain a percentile. If you are expecting a little bit of catch-up growth or wanting catch-up growth for a baby, you're going to shoot slightly above the target number.**



Slide 29—Phase 3: 1st Clinic Follow-Up Visit

On follow-up, since she's now above 2 kg approaching 2½ kg, she's feeding ad lib well, taking large amounts. We decided to switch her over to the discharge preterm powder formula at 24 cal/oz. Again, here's our chart. You can see it keeps her calories about the same. We're still within normal limits for protein, with adequate protein, vitamin D, iron, and calcium and phos [phosphate].

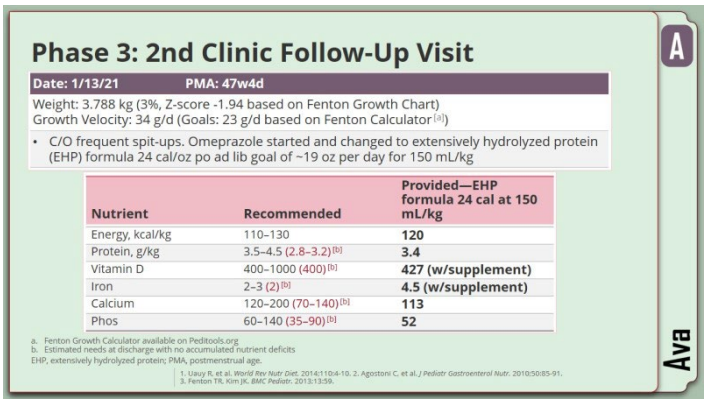


Slide 30—Case A—Combined

Here, we're looking at her visits. That was her second visit. She's coming back into the special infant care clinic. She's now almost 3.8 kg. We've made great gains with her Z-score. She's now hit the Fenton growth chart at the third percentile with a -1.94 Z-score. She's gaining 34 g/d and making clear catch-up growth, as her goal to maintain her percentile was 23 g/d.

Preterm Nutrition Through Discharge: A Case-Based Challenge

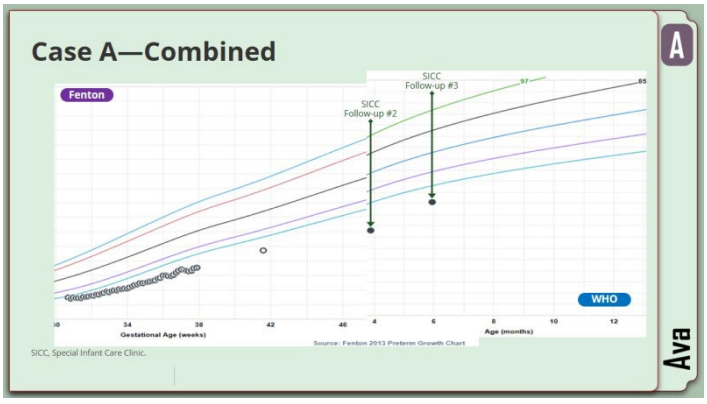
Mom did complain at this visit—which I think a lot of us hear frequently—Mom was complaining about spit-ups and being uncomfortable with feedings.



Slide 31—Phase 3: 2nd Clinic Follow-Up Visit

The physician at the visit decided to start omeprazole. We did change her to an extensively hydrolyzed protein formula, but maintaining it at 24 cal/oz, to see if that would help her reflux symptoms. We did give her a goal of 19 oz/d. You can see here, we're still within range with our protein and our calories. It does decrease our calcium and phos somewhat as we are now transitioning from a preterm discharge formula for preterm infants to more of a term formula.

And then here's her growth chart. She continues to grow.



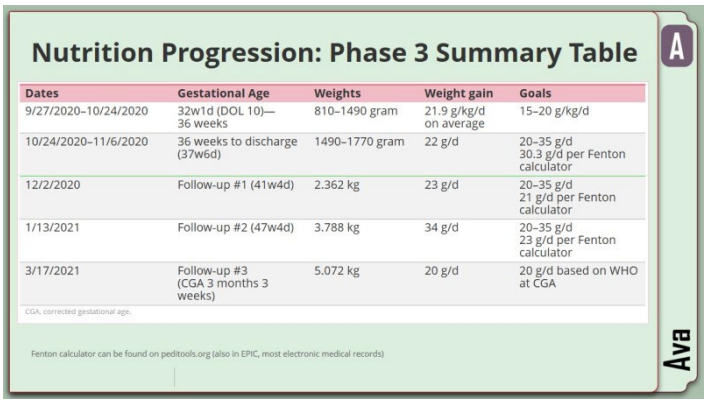
Slide 32—Case A—Combined

At her third visit, she's now 3 months, 3 weeks CGA. She's over 5 kg. We've now transitioned her completely over to the WHO growth chart. She's starting back with a lower Z-score, but that's based on her chronological age as opposed to her corrected age. She is growing well still, 20 g/d. We flipped over to the growth velocity standards based on WHO data. At a corrected age of 3 to 4 months, we'd like to see 21 g/d. She's hitting that goal. She's doing well. She's tolerating her hydrolyzed formula. Her reflux has improved, and she's been meeting her growth goals. We'll start talking about starting solids between 4 to 6 months CGA.

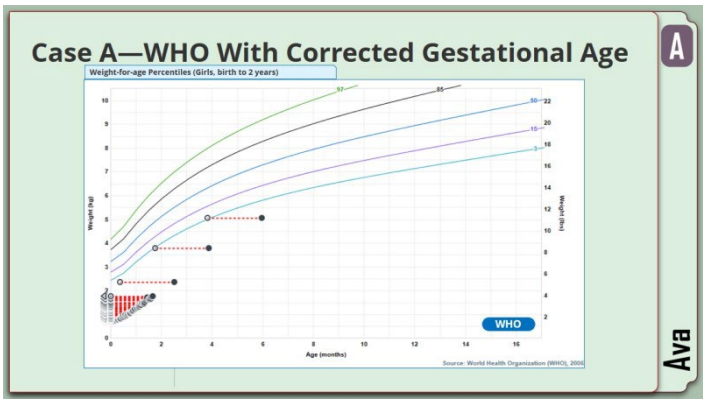
Slide 33—Phase 3: 3rd Clinic Follow-Up Visit

Dr. Tara Bastek: Here, for reference, we have a summary table of the sequence of events. The dates are there to help identify how much time between visits since I know that's important for those folks who are trying to think about how we are doing long-term follow-up.

Preterm Nutrition Through Discharge: A Case-Based Challenge

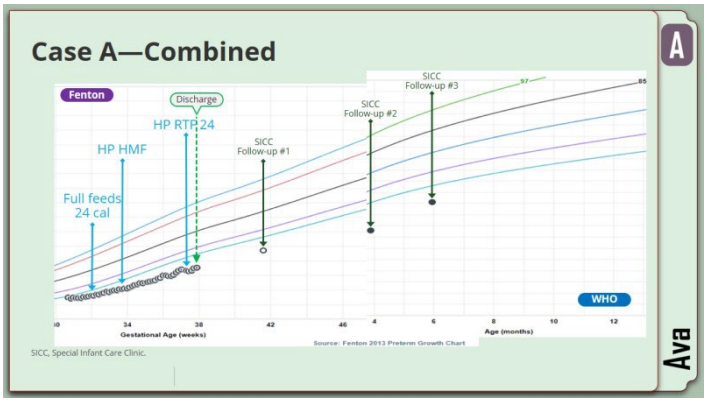


Slide 34—Nutrition Progression: Phase 3 Summary Table



Slide 36—Case A—WHO With Corrected Gestational Age

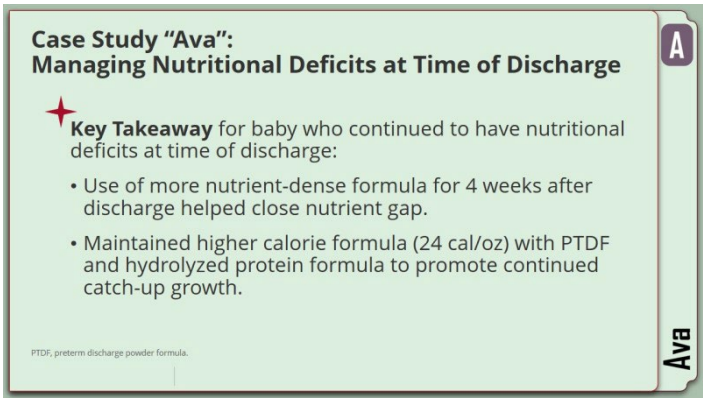
This is, again, that image (slide 35) showing you the combined [charts] with all the different visits and how they were growing along the way. And then as she has been switched over to the WHO growth curve completely.



Slide 35—Case A—Combined

This is an image (slide 36) of what that growth curve looks like once you add in the corrected gestational age function, which we find to be very helpful, particularly when we are working with community physicians. Some of us remember having to draw the circle, doing it by hand on your chart. But the electronic medical records make it so much easier to be able to see where they fall. We think that is helpful imaging once you switch over.

For this case, really, the takeaway thoughts are thinking about using a more nutrient-dense formula for a period of time after discharge to help support the ongoing nutrient needs and help close the nutrient gap they have. There is a conversation out there about how long that might be done. Increasing surveillance and being able to link these children with a provider, whether that's a community pediatrician or a developmental follow-up clinic that has people who are trained in the ex-preemie, and other things, depends on your location, but that's very helpful in managing [the question] how long do we go? When do we start to change it up?



Slide 37—Case Study "Ava" Key Takeaway

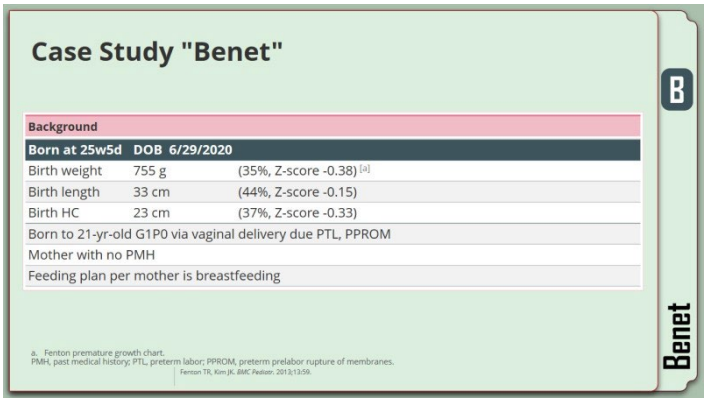
And continuing to maintain the higher caloric density of the formula, regardless of the type of

Preterm Nutrition Through Discharge: A Case-Based Challenge

formula we might be using, is a strong strategy to help continue to give these children the energy needs they... meet their energy needs, while they are developing and growing and becoming more active in doing all those things that... sometimes it's the baby changing, not so much the caloric density or the feeds that we are giving them.

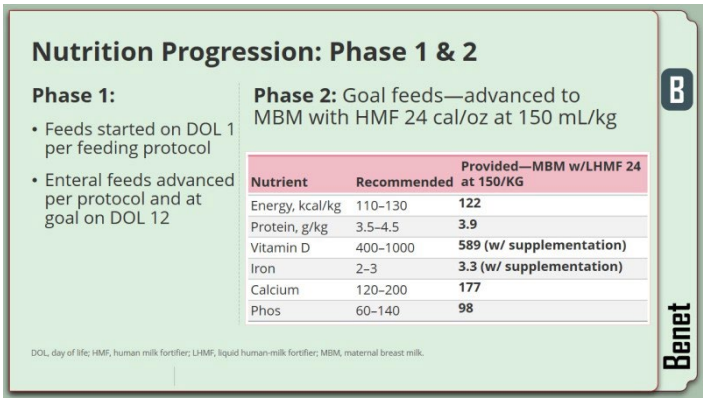
Case Study "Benet"

Benet is a younger, smaller infant born at 25w5d, and was about the same birth weight as our previous child. Again, those of us in the NICU very much understand that weight is a relative number and having the context of what the gestational age [is that] goes with it, is important. This infant was delivered vaginally due to preterm labor and premature rupture of membranes. This was not a preeclamptic situation or some other circumstance. Mom was otherwise a very healthy woman.



Slide 38—Case Study "Benet"

Her interest was breastfeeding, [and] also was her stated feeding plan. Again, phase 1 for this baby, IV nutrition was started on DOL 0. He was relatively well and stable on CPAP. Feeds were started on DOL 1 per our protocol and advanced through that protocol. He reached full volume and full fortification on DOL 12, which is, again, roughly the targets. We again begin phase 2 with him at goal feed, which is maternal breast milk fortified with our liquid human milk fortifier to 24 cal/oz at that goal volume of 150 mL/kg/d. Sort of the exact same start that our previous infant had.



Slide 39—Nutrition Progression: Phase 1 & 2

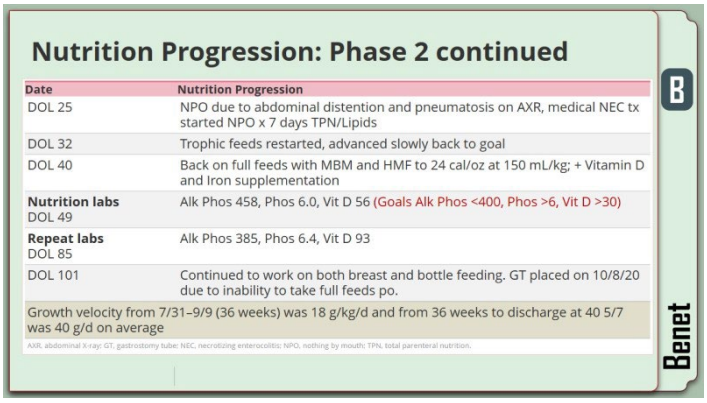
Again, you can see the recommended goals and how that feeding combination of maternal milk with HMF gets us into all of those ranges with good support.

His course, however, becomes a bit more complicated as he develops necrotizing enterocolitis. Underwent a period of NPO [nothing by mouth] with all the requisite antibiotics and IV nutrition support. That was a 7-day course for him. His feeds were restarted and slowly advanced back to goal. By DOL 40, he was back on maternal milk with a full fortification, sort of back to the start 24 cal/oz at 150 mL/kg.

You can see that for some of these infants when you have an event like this, that derails feeds and nutrition a solid 2 weeks. That's 15 days it took for that baby to get back to where he started, essentially. We were actively doing some surveillance for nutrition labs and here you can see the things that we check more

Preterm Nutrition Through Discharge: A Case-Based Challenge

often [Slide 40]: alkaline phosphatase, phosphorus levels, calcium levels, vitamin D. He was actually elevated on many of those, which we continued to do repeat surveillance for him, where we saw some improvement along the way when changing his feeds and fortification.



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.

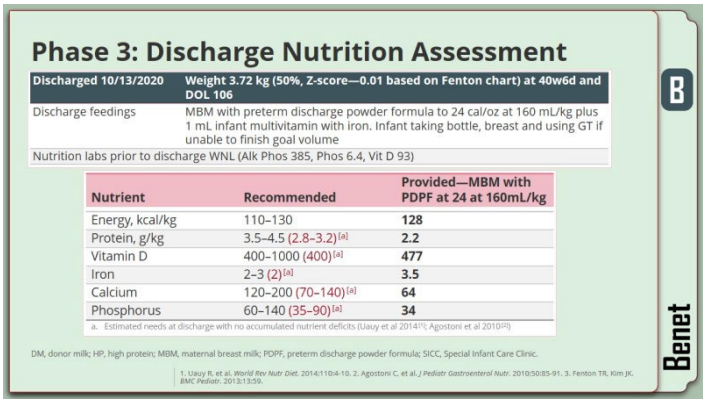
B

Benet

Slide 40—Nutrition Progression: Phase 2 continued

As we went through this, just as we got close to DOL 85, the vitamin D level you see here is 93. He had been on the liquid HMF and then had some feeds where the ready-to-feed high-protein preterm formula was used. We took him off that because vitamin D was pushing values close to 100 and switched him to the preterm discharge powder, even while in the NICU because we were monitoring these labs. He struggled to achieve stamina, and the neurodevelopmental complexity for feed [was] such that he ended up having a gastrostomy tube placed later in his course to help him maintain full nutrition intake, although he lacked the stamina to feed orally by himself.

Despite these challenges and these complications, he had a growth velocity from early on at birth all the way up through 36 weeks at 18 g/kg/d, so able to maintain right there in the middle of the target zone. And then from 36 weeks to discharge, which was at a much later age, 40 weeks, so for the next essentially month, he was gaining 40 g/d on average, which is on the high end of that goal, but it's maintaining a recovery velocity. We'll see his growth chart in a minute. But as we approach discharge, we began to do the exact same nutritional assessment for what would be the right way to support this baby going home.



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 (Ujayy 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. Ujayy 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

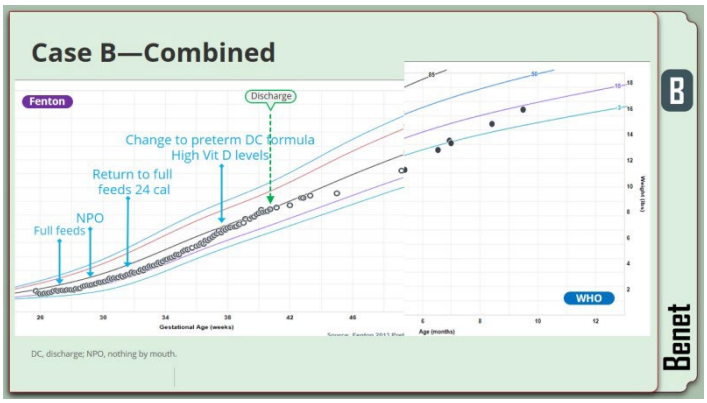
Benet

Slide 41—Phase 3: Discharge Nutrition Assessment

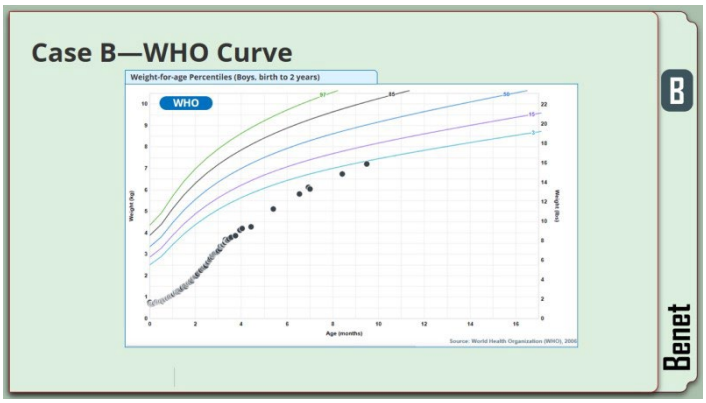
Karen Varga: This mother had lots of breast milk, and it was her goal eventually to breastfeed some, although she wasn't breastfeeding a lot right at discharge. She was bringing in a lot of milk. Because of that high vitamin D level, we decided not to send him on the preterm fortifier. We went with the discharge preterm fortifier to 24 cal/oz plus multivitamin each. You can see here we keep our calories good [Slide 41]. It does significantly drop the protein levels, which I'm sure many providers are familiar with this sort of sprinkle effect. We can maintain our vitamin D and our iron, but our calcium and our fat really drop off at this point.

Dr. Tara Bastek: This is his growth curve [Slide 42], which we annotated for the key events during his neonatal course.

Preterm Nutrition Through Discharge: A Case-Based Challenge



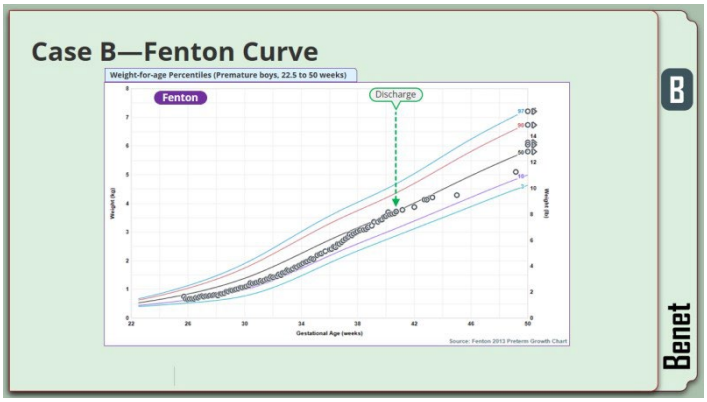
Slide 42—Case B—Combined



Slide 44 - Case B—WHO Curve

You can see how his growth velocity holds steady. It slows a bit, but then holds steady through the NPO NEC window. He begins to show some nice recovery growth well before we get to the discharge component. Remember, this is the combined form.

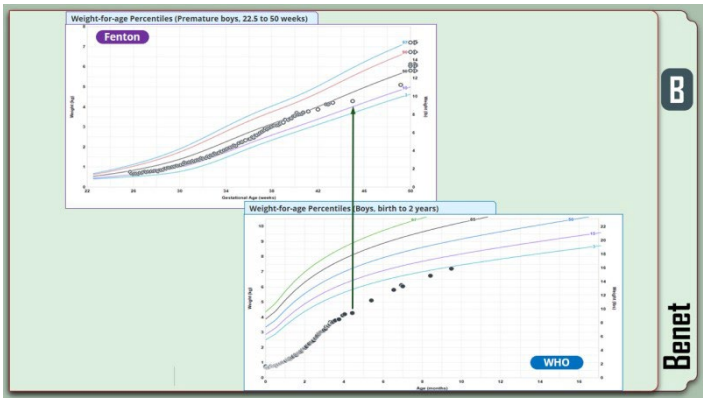
For completeness sake, this is what he looks like on the Fenton alone [Slide 43].



Slide 43—Case B—Fenton Curve

This is that same growth curve, including his after-discharge outpatient data points [Slide 44], as he transitions to the WHO.

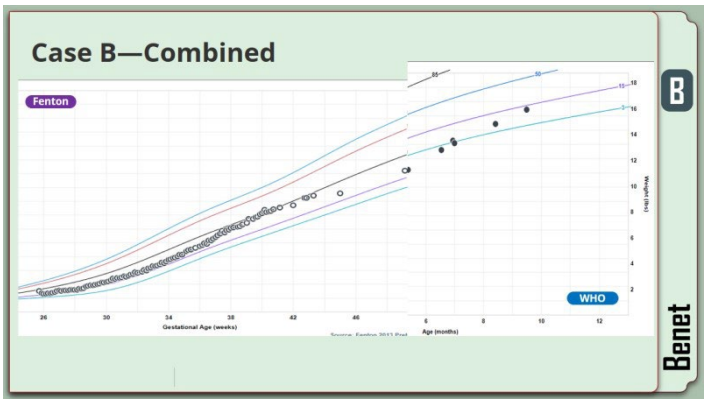
This is that very clear overlap as the data point moves from the Fenton onto the WHO [Slide 45]. This is a great example of a child who is growing decently well above the 50th percentile on the Fenton, but as you plot him on the WHO, even when you correct for gestational age, he looks like he's way behind on the WHO curve by the nature of the transition.



Slide 45—Case B—Combined

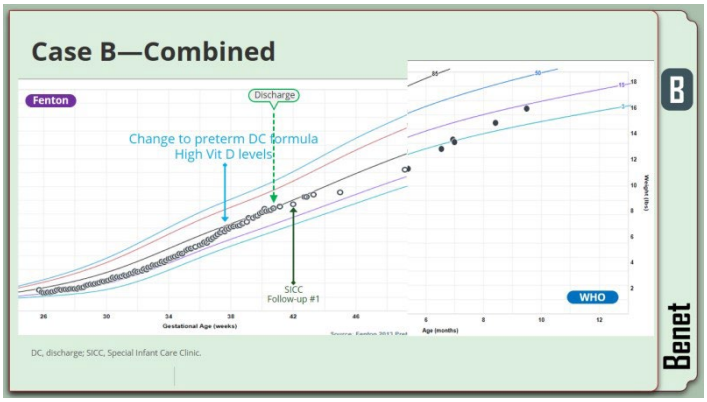
This is the superimposed growth curves on top [of] one another, which really illustrates how the Fenton velocity and the WHO are a bit different, and [for] those of us who are going back and forth between, [it is] helpful to remember those pros and cons.

Preterm Nutrition Through Discharge: A Case-Based Challenge



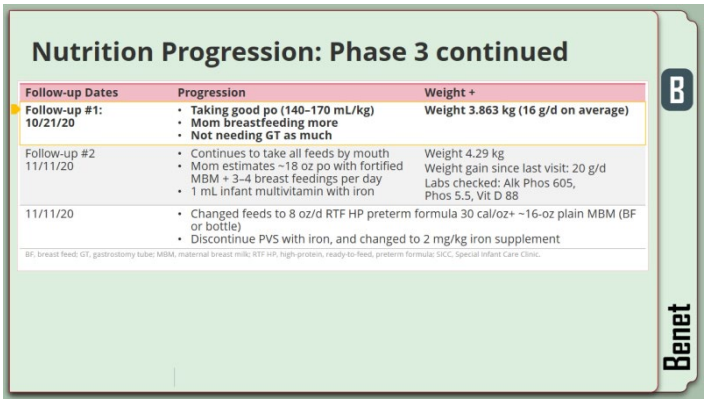
Slide 46—Case B—Combined

As this guy was discharged home now on Mom's milk fortified with the preterm discharge formula, we did a lot of close watchfulness on this little guy. Here he is and his first follow-up visit a week after discharge [Slide 47].



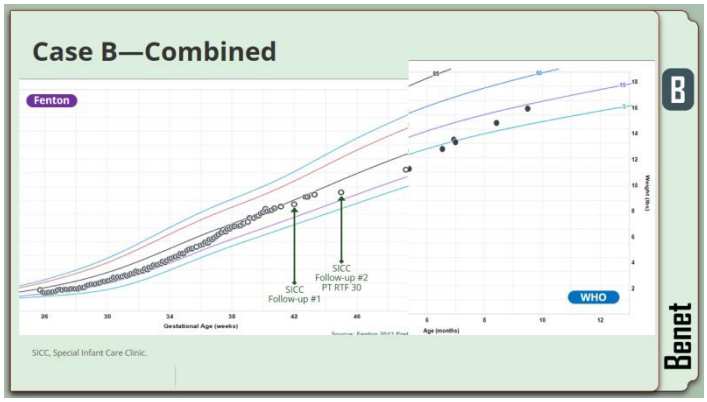
Slide 47—Case B—Combined

Karen Varga: We sent him home with the breast milk, with the sprinkles of the discharge formula. He was over 3 kg, and for the most part, his nutrition labs were normal at that time. Those were other factors that came into that decision-making. On his first follow-up, he was taking good PO (oral feeding). Mom was encouraged that he was breastfeeding much more. Right away, we knew he was getting more plain milk, and he was not needing his G-tube very much at that point. His weight gain was fair. It was 16 g/d on average about 2 weeks out of the NICU. At this point, no changes were made.



Slide 48—Nutrition Progression: Phase 3 continued

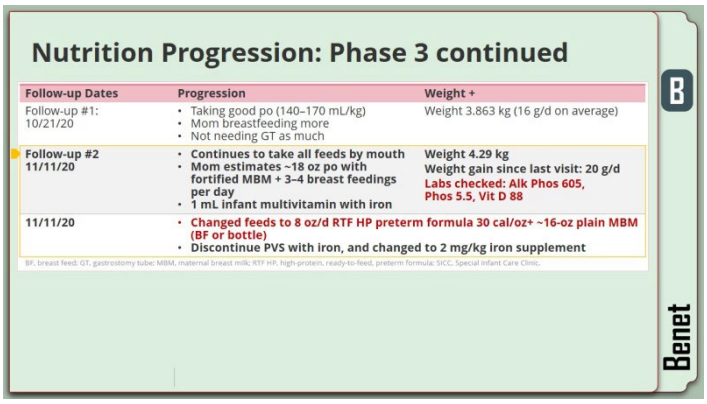
You can see his growth here [Slide 49]. There's his next visit at our Special Infant Care Clinic where we start to drop a little bit.



Slide 49—Case B—Combined

Here's our follow-up visit number 2 [Slide 50]. His growth is starting to falter a little bit. Mom is breastfeeding more, 3 to 4 times a day, and we estimated about 18 oz of fortified milk per day. We were wanting to check his nutrition labs and see how his bones are doing. On that visit, we did find that his alk phos had almost doubled. It was in the 300s, and we went up to 605. His phos drops below 6, and his vitamin D was stable at 88.

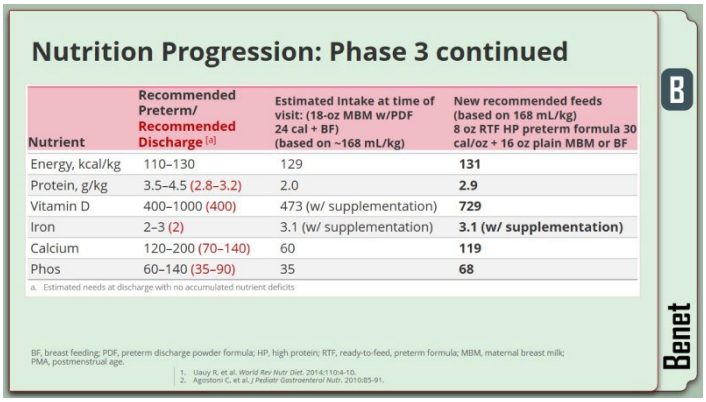
Preterm Nutrition Through Discharge: A Case-Based Challenge



Slide 50—Nutrition Progression: Phase 3 continued

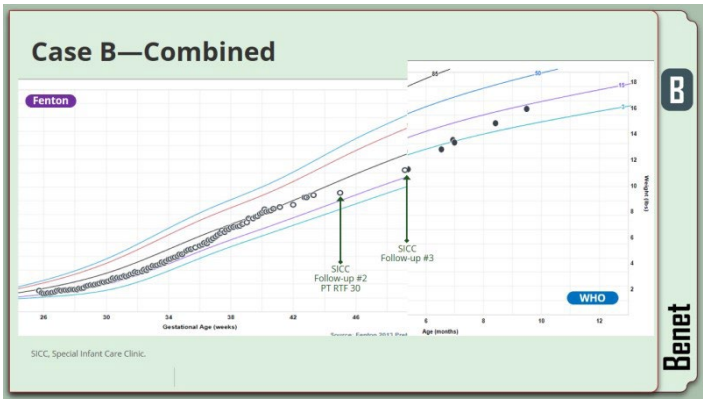
We had a discussion about what to do with his feedings. We talked about what would be the best scenario for Mom. She was very encouraged with the breastfeeding, and we certainly wanted to support that. We decided to use 8 oz of a higher calorie preterm formula and gave her a fixed amount for him to have in a 24-hour period, and then allow him to breastfeed or bottle feed plain milk the rest of the day. With using a preterm formula, we certainly had to discontinue the PVS vitamin supplement, and we changed to just an iron supplement.

You can see how those numbers work out [Slide 51]. You see the recommended intake on the left. The middle column is the estimated nutrient intake when he first came to us at that visit with his current feeding plan from discharge. Then you can see when we switched to 8 oz of a higher calorie ready-to-feed preterm formula. This was a 30 cal/oz formula plus 16 oz of plain breast milk or breastfeeding. We keep our calories similar. We gain almost a g/kg of protein, which we were hopeful that would help with growth velocity. We are still within normal limits with our vitamin D. We're able to supplement with iron to keep that where we need it. Our biggest gain here was that we double our calcium and phosphorus intake with this plan.



Slide 51—Nutrition Progression: Phase 3 continued

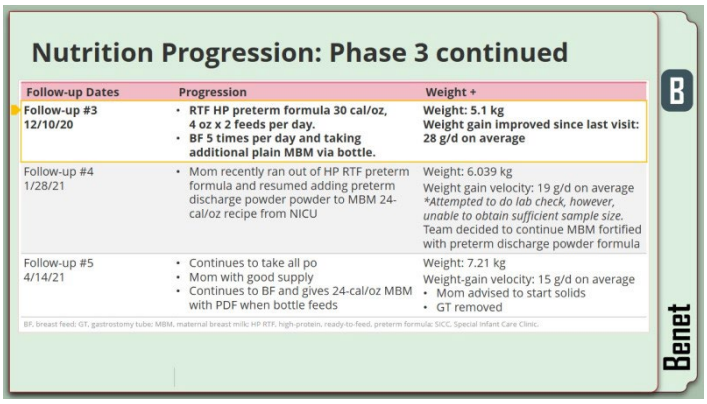
Dr. Tara Bastek: This is his next visit, and you can see his interval growth velocity [Slide 52].



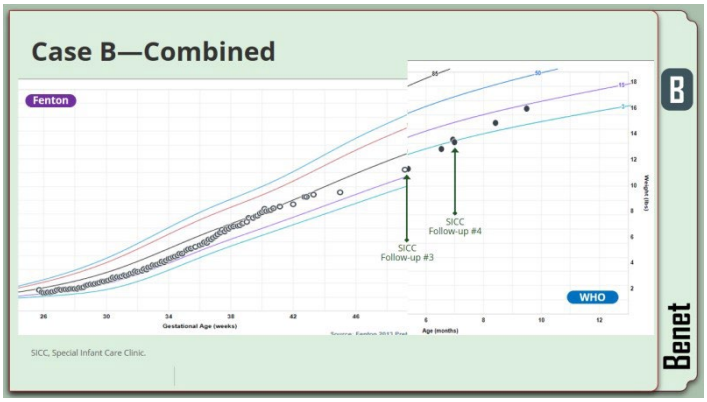
Slide 52—Case B—Combined

Karen Varga: With our change in our feeding plan, we're now seeing him back for his third visit. He's now gaining 28 g/d on average, which is up from 20. If you look at his corrected age at this time, his goal would be about 27 g/d. We've improved our weight gain.

Preterm Nutrition Through Discharge: A Case-Based Challenge

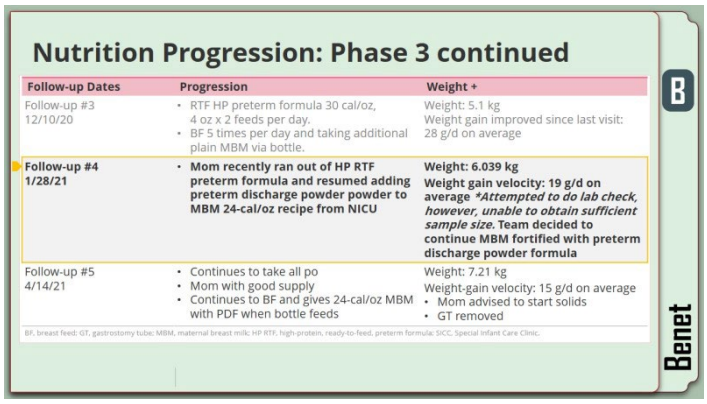


Slide 53—Nutrition Progression: Phase 3 continued



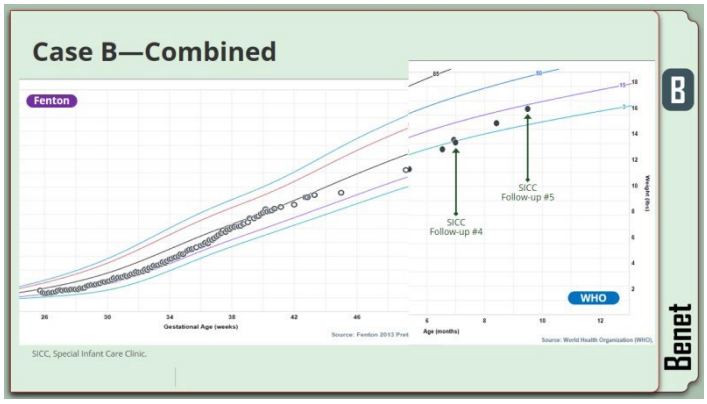
Slide 54—Case B—Combined

We see him back again for visit number 4. You can see as he transitions over to the WHO growth chart [Slide 54]—and he's starting to hit the growth chart for corrected age, he's now back with us for visit number 4 [Slide 55]. He's over 6 kg. He had been doing well on the previous plan. Mom started to run low on the preterm formula. On her own, she went back to our previous plan, from a couple months earlier, to any of the bottle feedings she was fortifying. Otherwise, he was getting plain breast milk.



Slide 55—Nutrition Progression: Phase 3 continued

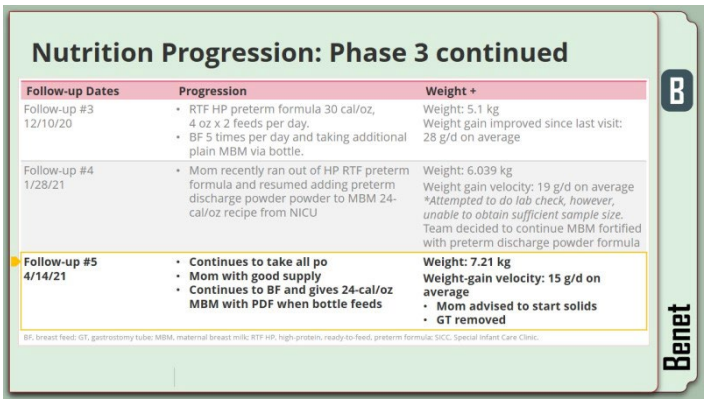
We did try to check some follow-up labs at this visit. Unfortunately, he wasn't very willing to give us some blood. We had some trouble getting labs on him. We decided not to torture the baby, and we felt like at this point he's several months out, he's approaching 4 months or so corrected age. He's over 6 kg, and his weight gain has been good. We are going to go ahead and continue with her [Mom's] current plan of doing plain milk and then fortifying any of the bottle feeds.



Slide 56—Case B—Combined

I think we see him one more time at visit number 5, and he continues to grow well. He's growing at 15 g/d and making good catch-up growth.

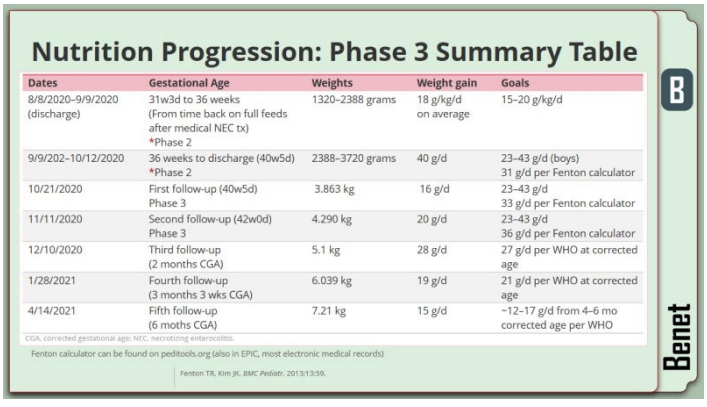
Preterm Nutrition Through Discharge: A Case-Based Challenge



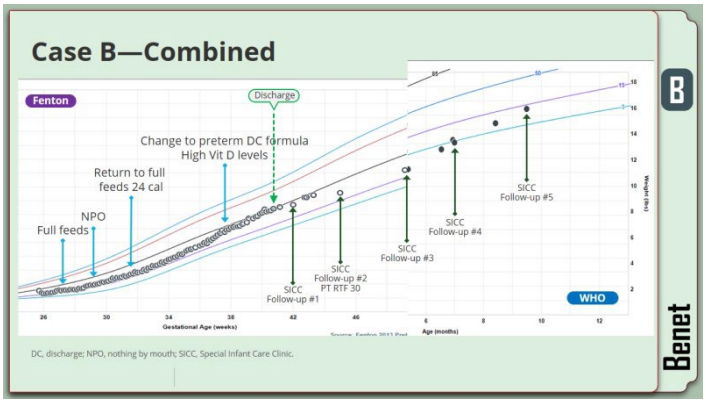
Slide 57—Nutrition Progression: Phase 3 continued

Dr. Tara Bastek: Included in the presentation is this summary table of the steps and events for him that also show the growth velocity and the goals [Slide 58].

With some work, we were able to recover his growth velocity. In this particular case, [to] really address the micronutrient impacts that he had for the changes that were made for what are all the reasons we think about. Yet, the balancing measures and looking for the unintended consequences of the interventions that we do is also part of our work. We were able to address that for him.



Slide 58—Nutrition Progression: Phase 3 Summary Table



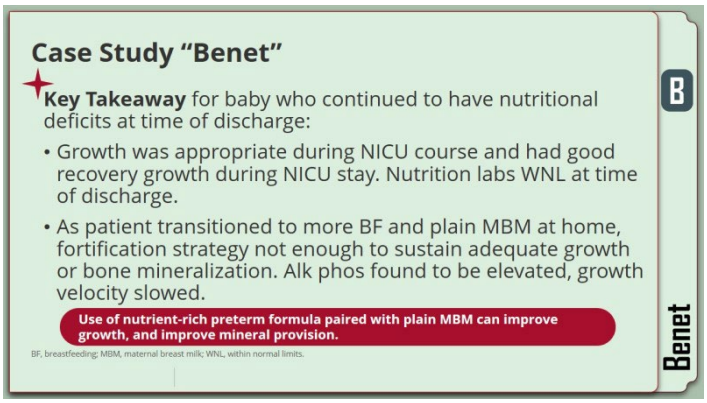
Slide 59—Case B—Combined

This is the WHO curve with his corrected gestational age, just as he now moves fully into being someone who you only look at this curve for how this plots him against.

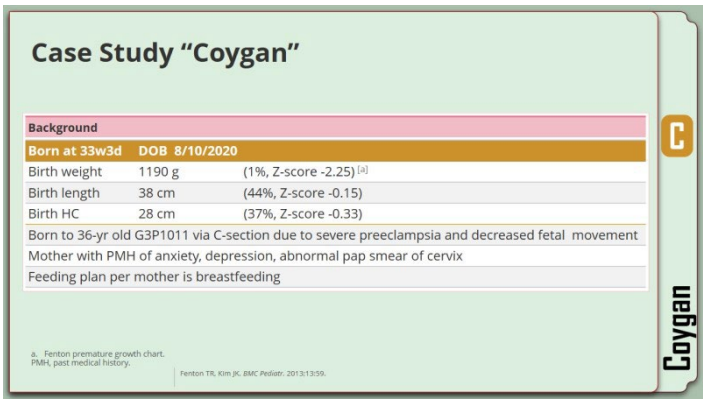
Slide 60—Case B—WHO With CGA

Our takeaway here for the case of baby Benet is really that we felt like this was a NICU course that went really well by all marks, maybe not so much to getting the NEC, but those events happened. We were able to address and recover, so moving through those stages inside the NICU with really active surveillance is something we could sustain.

Preterm Nutrition Through Discharge: A Case-Based Challenge



Slide 61—Case Study "Benet" Key Takeaway



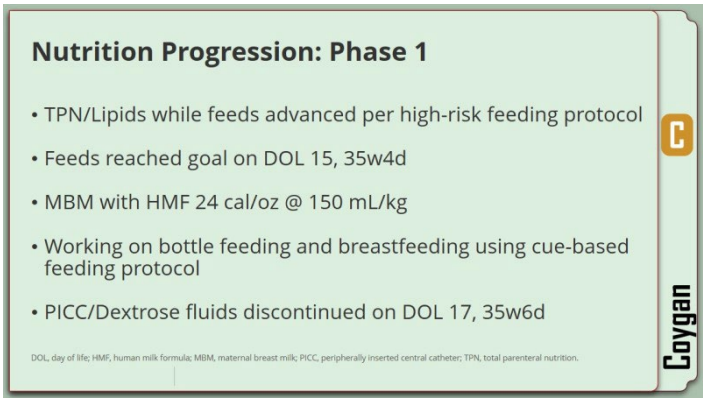
Slide 62—Case Study "Coygan"

But moving into the outpatient arena, that is still a time for surveillance and monitoring, and he had a family very dedicated to helping him breastfeed and introduce more and more plain maternal milk, which is a great thing to have. But our fortification strategy wasn't enough to sustain the bone mineralization and some of the micronutrients. And [we asked] how could we alter and shift for him to meet him and where his family might be?

Case Study "Coygan"

In the interest of time, we will talk about the third case study, baby Coygan, but we'll do it at a higher level as we still want to hit the takeaway points for this case. The third case is an infant that is much older than our others, born at 33w3d and is at much heavier birth weight at 1,190 g. Again, this is a pregnancy that was complicated by a preeclampsia, worry of placental insufficiency and for uterine growth within decreased fetal movement, so it was delivered. Mom's feeding plan was breastfeeding.

Again, IV nutrition was begun, and feeds advanced per protocol. He reached full feeds on DOL 15. What is not uncommon—but it's a complication in this case given the growth restriction relative to age—[is that] this baby required additional days of IV fluid to maintain good glucose levels, and it required us to do some extra fortification to the enteral feeds in order to maintain that glucose level. This infant ended up at his base starting feeds on maternal breast milk fortified with liquid HMF to 26 cal/oz, with the infant already beginning to work on breastfeeding because we were at an advanced gestational age.



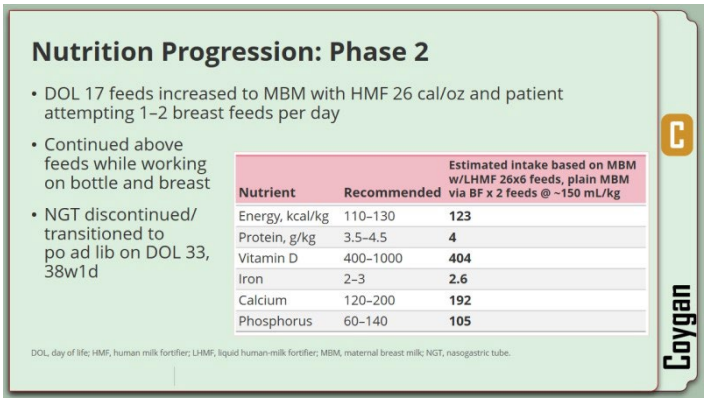
Slide 63—Nutrition Progression: Phase 1

And so, higher than our typical 24 cal goals, you can see here in the grid [Slide 64] how the caloric density [improved] and how it met all of

Preterm Nutrition Through Discharge: A Case-Based Challenge

the protein and micronutrient goals there. This baby was able to continue to work on oral feeds and transition to full oral feeds on demand on DOL 33, as they were a corrected age of 38 weeks.

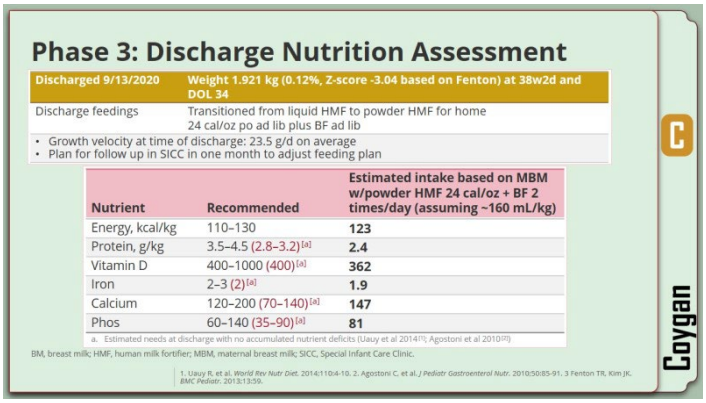
As we move into discharge, I will let Karen talk about the discharge plan, and then we will jump to the end of the case to talk about the changes that we made in this one.



Slide 64—Nutrition Progression: Phase 2

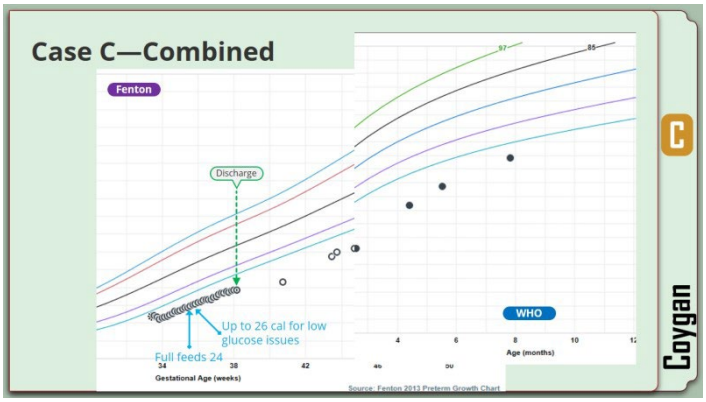
Karen Varga: Baby Coygan went home at 1,921 grams. He was discharged with below the third percentile with a -3.04 Z-score based on the Fenton chart. Like Dr. Bastek said, he was very advanced in everything except for his weight. Given those parameters of less than third percentile at discharge and less than 2 kg, we also knew that breastfeeding was very important. We decided to send Mom home with human milk fortifier so she could fortify her breast milk for any of the bottle feeds and [so we] know that we were getting a little bit more nutrient-rich feedings per bottle feeds, and then also pair that with the breastfeeding she was going to do at home.

We tried to give a breakdown. These numbers are assuming the baby would be taking about 6 feeds a day of the powder HMF at home via at the bottle, and then 2 breastfeeds a day at 160 mL/kg. We're meeting all our nutrient needs there.



Slide 65—Phase 3: Discharge Nutrition Assessment

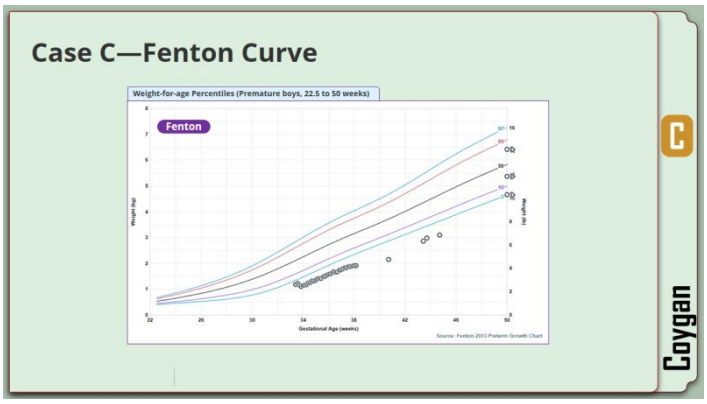
Dr. Tara Bastek: As you've seen before, this is the growth curve overlap with the annotated NICU course up until the point of discharge [Slide 66].



Slide 66—Case C—Combined

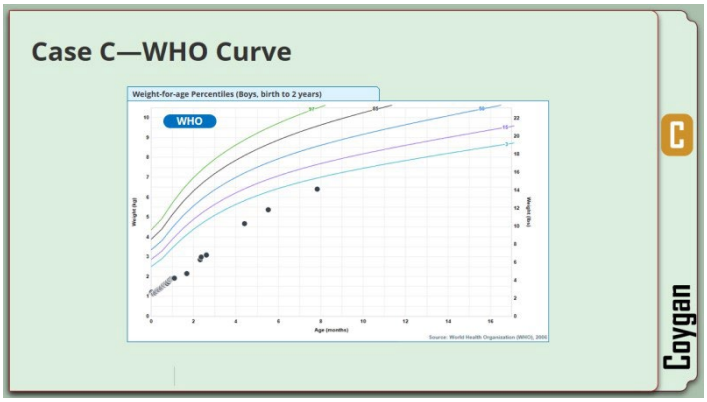
This is the Fenton alone with the outpatient data points [Slide 67].

Preterm Nutrition Through Discharge: A Case-Based Challenge



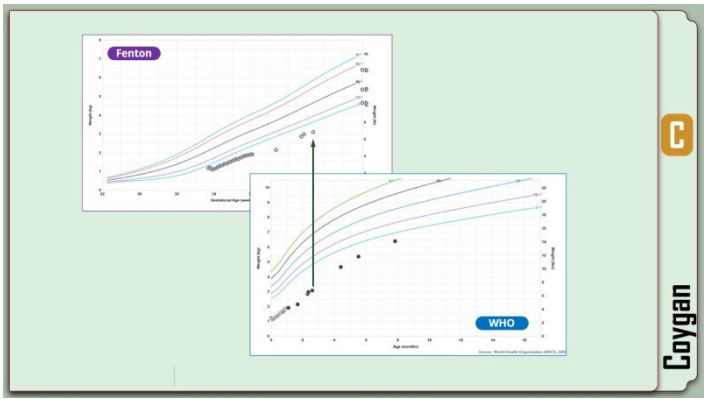
Slide 67—Case C—Fenton Curve

This is the WHO, to see the difference [Slide 68].

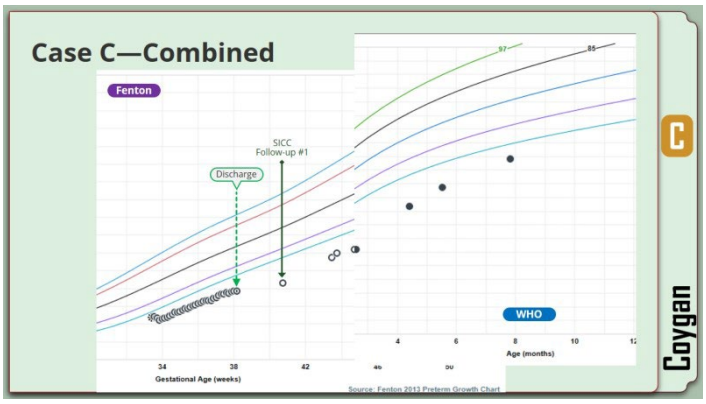


Slide 68—Case C—WHO Curve

And here again is the explicit connection of the data point as it crosses to the two graphs [Slide 69] that get us to this combined chart [Slide 70].



Slide 69—Case C—Combined

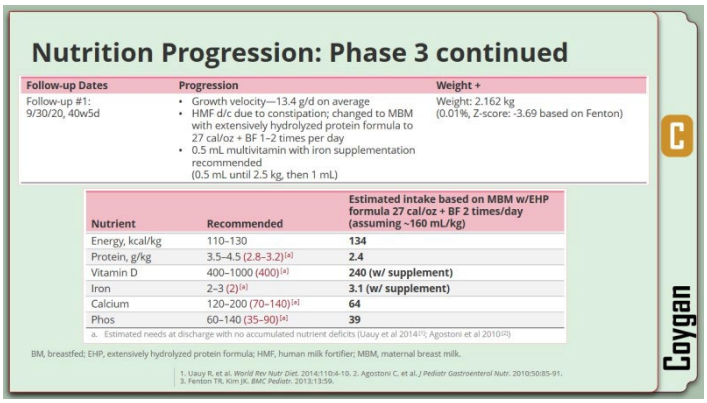


Slide 70—Case C—Combined

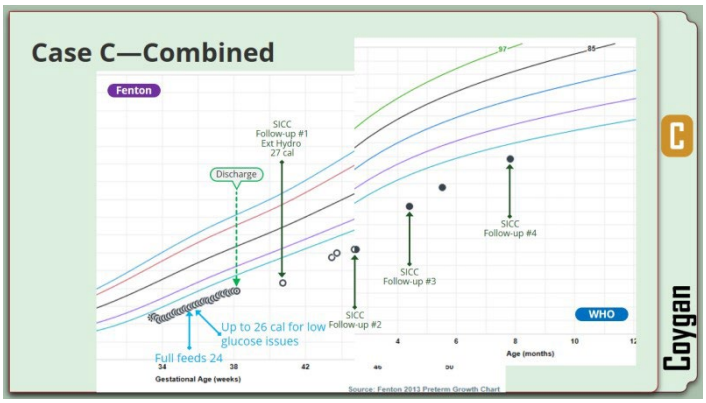
We'll talk about the first follow-up visit and then we'll jump to the summary of the case since, as always, there are adjustments to be made in these families.

Karen Varga: At his first follow-up, he came in, Mom was still using the powder HMF, but had concerns about constipation. We weren't sure exactly how much of that he was getting. I think he was breastfeeding more. Growth velocity definitely slowed. We went down to 13.4 g/d on average. The provider at that time decided to take him off of the powder HMF and try a hydrolyzed protein powder formula to fortify Mom's breast milk and go up to a higher calorie level, 27 cal/oz, to close that gap and make up the difference of some of the calories we may be missing and help promote better growth velocity. So, we're encouraging moms to breastfeed.

Preterm Nutrition Through Discharge: A Case-Based Challenge

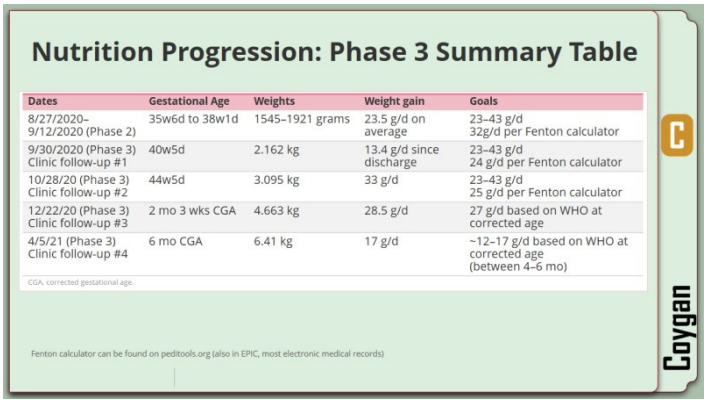


Slide 71—Nutrition Progression: Phase 3 continued



Slide 73—Case C—Combined

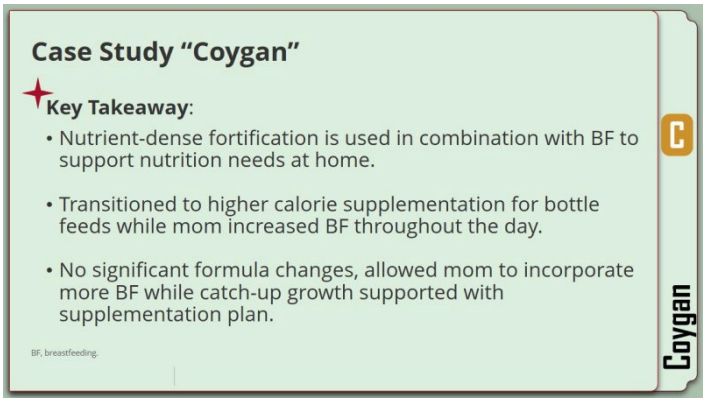
Dr. Tara Bastek: I'm going to take us to the summary table for this baby because we would like to give as much time as possible for questions and answers. Part of the takeaway for this case is that we were able to maintain the growth velocity with changes.



Slide 72—Nutrition Progression: Phase 3 Summary Table

I'm going to show you the combined chart across the different visits. And the real takeaway for this case is that once we transitioned this infant to a maternal milk with the extensively hydrolyzed protein formula powder to 27 cal/oz, that feeding combination recipe never changed for that infant the remainder of the time.

What changes across all those visits, although we have this nice recovery growth, is that this baby was able to introduce more and more breastfeed sessions a day from a very dedicated mom, who worked hard to keep her supply up in stamina. At every visit when he was seen, he was doing more and more breastfeeding, and the fortified feeds were fewer and fewer, but they all remained maternal-milk fortified with a particular formula to 27 cal/oz for this child.

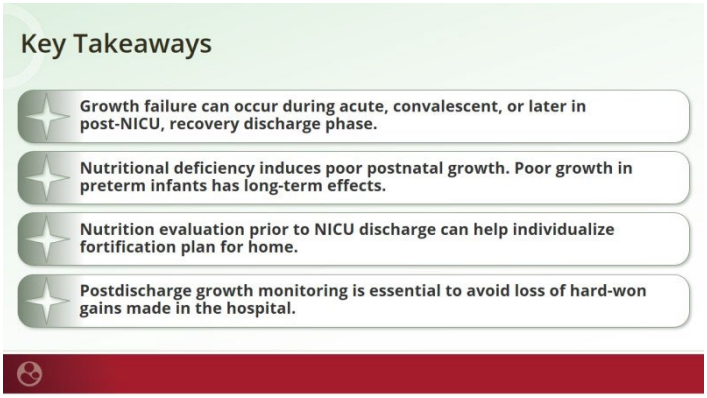


Slide 74—Case Study "Coygan" Key Takeaway

The real takeaway for this case is that growth failure can occur during acute, convalescent, or later in [the] 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 [the] fortification plan for home. And postdischarge growth monitoring is essential to avoid loss of hard-won gains made in the hospital.

As in life, and in real medicine, we are making decisions and guidelines and protocols, and things are all very helpful. Every one of us as healthcare providers are then facing real children and real decisions and how do we come to those conclusions and how do we follow them up.



Slide 75—Key Takeaways

Audience Question & Answer

Editor's Note: This is a transcript of audience questions together with presenter responses from the June 23, 2021 audio webcast.

✧ How do you get funding for or provide PT RTF [preterm ready-to-feed] formulas to patients if needed after discharge?

Dr. Tara Bastek: That is a great question. I would answer that not quite so much from a funding perspective but from a logistic provision perspective, in that the challenges we face when we first looked into being able to do this is those are traditionally hospital-only products and being able to have families access them on the outside, in the community, was more the challenge. Actually, the [solution] turned out to be a really strong partnership with our formula providers and our central supply distribution here in our hospital.

As part of the importance of the nutrition assessment prior to discharge—and we define what it is those infants will need—we were able to provide families with... I think we now provide 2 cases of whatever that particular need might be, whether that's preterm discharge formula, whether that is the preterm ready-to-feed, or whether that's the powdered human milk fortifier. The strategy behind that is it helps bridge that gap before families can get established in the community, especially our families coming out to have WIC support and sometimes getting to WIC, and getting those appointments and getting set up, there's a bigger gap than you would anticipate.

We used to do it for a few days, and we now have done it for longer because the gap to get to those services is actually broader. One of the second waves we worked on was working with our WIC office directly so that when we write our WIC prescription for those particular specialty products that are traditionally hospital-based, our WIC office now knows how to order them directly from the company that provides them. In our state, it is a state where if we order it on a WIC prescription, it will get provided, and the state would cover that need.

Again, it was some partnership between our representatives for our product support and directly with the WIC office to have them work on, essentially, the logistics of how you order this product from the company, what's the order number, etc.

Preterm Nutrition Through Discharge: A Case-Based Challenge

There has been a pretty significant amount of logistical work we have put in to working with our local WIC and our local community providers. I have to say the relationship with our product representatives out in the community has been a strong link to help us continue to get the right nutritional support to our families. This has been a process we've worked on for the last 5 to 6 years to get some of the hurdles worked out.

✧ What criteria is useful for describing to parents why their baby is high, moderate, or low risk for nutritional deficits?

Dr. Tara Bastek: We—thinking of it from the medical perspective—have used a combination of birth weight and growth velocity while in the NICU, so really small vs well-grown, and whether you are struggling to grow or whether you have gotten a good growth velocity. Those are 2 of the big metrics that we use. But I appreciate that families... sometimes the words we use and the impact we have is really meaningful. It's common at discharge—it's a celebratory time and everyone wants to be excited about going home—it's hard to continue to hear you're still high risk for anything.

In our conversation with families, and often it's reviewing the growth trajectory that they've been in the hospital, and really underscoring that it's such a success to have come as far as they've come and that we want to maintain that success. So, we're placing a high priority on focus for this, and shifting some of that language around for them. At the face of it, it's not always possible to escape that being born young and little still puts you at risk even outside the NICU walls.

✧ How long do you instruct parents to continue adding calories to their milk or keep giving higher calorie formulas?

Karen Varga: We really look at it based on follow-up in our developmental clinic. But most of our preterm babies need some support through the first year of their life. If it is something that needs to be monitored closely, as far as a preterm formula or human milk fortifier, we'd certainly be following them monthly in our follow-up clinic. And taking it at 4-week intervals. Most of them are off it within the first month. I'd say up to maybe 12 weeks at most. Then they've transitioned to a preterm discharge formula or a formula that better meets their needs as far as if they're having any constipation or reflux. Most babies, to continue that growth velocity and that nice trajectory towards the growth chart to hopefully catch up to the same size as their peers within the first year to 2 years, need fortification or some caloric support for about the first year of life.

✧ Why are growth charts preferable over targeted goals of weight, length, and head circumference?

Karen Varga: I would answer this question that they are both valuable tools and can be used in combination. I think the growth charts are very helpful to illustrate the course that the babies had in the NICU. I think if we just use target goals, we get caught up in the numbers and the percentage. Are they meeting that goal for that timeframe? We forget to look at the big picture. We need to be able to see the big picture as in a preterm growth chart.

What did the baby's course look like while they were growing within the NICU? Were they

faltering all throughout, and we have a big job ahead of us in that discharge phase to catch them back up, or did they grow well in the NICU and now we're transitioning big picture to that WHO growth chart? That shows us what we have ahead of us. What do we need to accomplish over the first year of life, (hopefully by the first year of life, if not by year of life 2) to catch up? I think knowing the data that each of those provide you and using them simultaneously can give you great tools to help make sure that this baby is on track.

Dr. Tara Bastek: I will tag on that to say that Karen's framework of the NICU growth, let's argue Fenton compared to the outpatient, the WHO growth, the framework of looking at it as this is where we've been, and this is where we're going, has been extraordinarily helpful for me. Actually, as a provider in our practice, we do not only [provide] NICU-based care, but we are seeing our patients in our developmental follow-up clinic, our Special Infant Care Clinic, which is why you saw SICC abbreviations everywhere. We do a lot of the nutritional and neurodevelopmental follow-up.

That framework for me, thinking about this is where we've been, and this is where we're going, has been extraordinarily useful for my own mind, but also in framing it for families, especially in the clinic setting where you can show them by the time we're 2, we want to look like everybody else around us. We still need to be thoughtful about where we're going, and that good human body growth takes time. **We can get fat fast. I think everybody knows that, but it's harder to do lean muscle mass, good body composition growth, and that you can't do that overnight.** Framing it that way seems to help our families hang in there and understand why this is still a thing they have to think about, as opposed to NICU issues are in the rear-view mirror, and it's done. I have really found that framework very helpful, the one that Karen talked about.

✧ Is fortified formula used exclusively in the NICU if mother's milk is unavailable, or is human donor milk always used with supplemental fortification?

Dr. Tara Bastek: I think it's an excellent question asking about the way in which NICUs can utilize all of the different resources available to us, that's mom's own milk, that's a use of donor human milk, as well as the preterm formulas that exist. I don't know that it's always an either/or. In our NICU, if mom's own milk is not available or there's a limited supply, we would approach the family and have a conversation about using donor human milk as a conjunction. Mom's own or donor milk would be fortified, as is appropriate.

We are a NICU that still uses a consent-for-donor-milk approach as opposed to an assumption of donor milk with a refusal consent, essentially. There are sometimes families where, for a variety of reasons, the concept of using human milk other than their own makes them uncomfortable and is not something that they wish to do. Because we don't starve babies, and they need to be fed, in those cases, the preterm formulas are then used to supplement with mom's milk to whatever capacity her milk supply exists.

The real answer is we use all of them and in different combinations. I would say the most common is beginning with human milk, often

mom's own milk. Her supply may not sustain itself through the length of a NICU course, and we would be transitioning to donor milk or then off of human milk, as they get older, to a preterm formula. Sometimes the answer is we do all of them for a single infant in a single NICU stay.

✧ **Are you using 100% human milk-based fortifier at your facility? And if yes, how are you handling poor growth? Are you adding cream to this?**

Dr. Tara Bastek: We are not using 100% human milk in all variations of products in our neonatal ICU, although there is value out there and certainly there are pros and cons to any of the approaches we take. This idea of the individual fortification and tailoring it to each individual and being able to have the flexibility to use every sort of product that's out there, at the benefit of each individual infant, is a strategy we have chosen to adopt, as opposed to starting with an across the board, it must be a human milk product, and we will not alter the pro and the cons that come with that.

We have chosen a broader way to look at how do we provide everything that medicine knows to the benefit of these individual infants for whatever their particular need might be. Some of them may have different growth needs. Under individual fortification and flexibility, we use essentially all the things in lots of different ways as we can tailor it to the family's and the infant's needs.

⊙ To complete this course and claim credit, click here,
or go to:
https://pnce.org/Postdischarge-Cases

Preterm Nutrition Through Discharge: A Case-Based Challenge

Abbreviations

Alk phos	alkaline phosphatase	**IVF**	intravenous fluids
ARA	arachidonic acid	**LHMF**	liquid human-milk fortifier
CGA	corrected gestational age	**LHMF**	liquid human-milk fortifier
DHA	docosahexaenoic acid	**NEC**	necrotizing enterocolitis
DOL	day of life	**NPO**	nothing by mouth
EHP	extensively hydrolyzed protein formula	**PT RTF**	preterm ready-to-feed formula
ELBW	extremely low birth weight	**SICC**	Special Infant Care Clinic
EUGR	extrauterine growth restriction	**TPN**	total parenteral nutrition
HMF	human milk formula	**VLBW**	very low birth weight
HP RTF	high-protein, ready-to-feed, preterm formula	**WIC**	women, infants, and children
IUGR	Intrauterine growth restriction		

References

1. Stoll BJ, Hansen NI, Bell EF, et al. Trends in care practices, morbidity, and mortality of extremely preterm neonates, 1993-2012. *JAMA*. 2015;314(10):1039-51. doi:10.1001/jama.2015.10244
2. Lapillonne A, Griffin IJ. Feeding preterm infants today for later metabolic and cardiovascular outcomes. *J Pediatr.* 2013;162(3 Suppl):S7-16. doi:10.1016/j.jpeds.2012.11.048
3. Ehrenkranz RA, Dusick AM, Vohr BR, Wright LL, Wrage LA, Poole WK. Growth in the neonatal intensive care unit influences neurodevelopmental and growth outcomes of extremely low birth weight infants. *Pediatrics.* 2006;117(4):1253-61. doi:10.1542/peds.2005-1368
4. Hay WW Jr. Nutritional support strategies for the preterm infant in the neonatal intensive care unit. *Pediatr Gastroenterol Hepatol Nutr.* 2018;21(4):234-247. doi:10.5223/pghn.2018.21.4.234
5. Young BE, Krebs NF. Complementary feeding: Critical considerations to optimize growth, nutrition, and feeding behavior. *Curr Pediatr Rep.* 2013;1(4):247-256. doi:10.1007/s40124-013-0030-8
6. Baker RD, Greer FR; Committee on Nutrition American Academy of Pediatrics. Diagnosis and prevention of iron deficiency and iron-deficiency anemia in infants and young children (0-3 years of age). *Pediatrics.* 2010;126(5):1040-50. doi:10.1542/peds.2010-2576
7. Koletzko B, Poindexter B, Uauy R. Recommended nutrient intake levels for stable, fully enterally fed very low birth weight infants. *World Rev Nutr Diet.* 2014;110:297-9. doi:10.1159/000360195
8. Adamkin DH, Radmacher PG. Current trends and future challenges in neonatal parenteral nutrition. *J Neonatal Perinatal Med.* 2014;7(3):157-64. doi:10.3233/NPM-14814008
9. Roggero P, Liotto N, Menis C, Mosca F. New insights in preterm nutrition. *Nutrients.* 2020;12(6):1857. doi:10.3390/nu12061857
10. Lapillonne A, Bronsky J, Campoy C, et al. Feeding the late and moderately preterm infant: A position paper of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* 2019;69(2):259-270. doi:10.1097/MPG.0000000000002397
11. Collado MC, Cernada M, Neu J, Pérez-Martínez G, Gormaz M, Vento M. Factors influencing gastrointestinal tract and microbiota immune interaction in preterm infants. *Pediatr Res.* 2015;77(6):726-31. doi:10.1038/pr.2015.54

Preterm Nutrition Through Discharge: A Case-Based Challenge

12. Miller J, Tonkin E, Damarell RA, et al. A systematic review and meta-analysis of human milk feeding and morbidity in very low birth weight infants. *Nutrients*. 2018;10(6):707. doi:10.3390/nu10060707
13. Fenton TR, Anderson D, Groh-Wargo S, Hoyos A, Ehrenkranz RA, Senterre T. An attempt to standardize the calculation of growth velocity of preterm infants—Evaluation of practical bedside methods. *J Pediatr.* 2018;196:77-83. doi:10.1016/j.jpeds.2017.10.005
14. World Health Organization. The WHO child growth standards. Available at https://www.who.int/tools/child-growth-standards/standards
15. Fenton TR, Kim JH. A systematic review and meta-analysis to revise the Fenton growth chart for preterm infants. *BMC Pediatr.* 2013;13:59. doi:10.1186/1471-2431-13-59
16. Uauy R, Koletzko B. Defining the nutritional needs of preterm infants. *World Rev Nutr Diet.* 2014;110:4-10. doi:10.1159/000358453
17. Agostoni C, et al. Enteral nutrient supply for preterm infants: commentary from the European Society of Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* 2010;50(1):85-91. doi:10.1097/MPG.0b013e3181adaee0