



Follow-up Care of the Premature Infant

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April 8, 2021

- I have no disclosures.

Learning Objectives

By the end of today's session, you will be able to describe:

1. How the nutritional needs of the premature infant differs from those of a term infant
2. The projected growth and developmental trajectories for premature infants
3. The importance of multi-disciplinary follow-up programs in the post-discharge care of at risk infants.

WHY Follow-up: The importance of follow-up planning for all high-risk neonates

- Advances in neonatal intensive care have improved the survival of high-risk premature and critically ill full-term infants
- Continue to need **comprehensive and multisubspecialty clinical care** after discharge from the neonatal intensive care unit (NICU)
 - **Medical**
 - **Nutritional**
 - **Developmental**
 - **Surveillance**



WHY Follow-up: The importance of follow-up planning for all high-risk neonates

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Policy Statement, 2008 (reaffirmed 2018)
Hospital Discharge of the High-Risk Neonate

“To ensure continuity of care after discharge, infants with unresolved medical issues that persist after their hospital stay should be comanaged by a neonatologist or other medical subspecialist from the hospital at which most of the care was provided.”

“Most high-risk infants should also be enrolled in a follow-up clinic that specializes in the neurodevelopmental assessment of high-risk infants. This neurodevelopmental follow-up is sometimes integrated with the child's visits to the neonatologist. Standardized assessments should be performed in the follow-up clinic at specific ages through early childhood.”

WHY Follow-up: A focus on growth

- Growth impairment during early infancy can have ***permanent detrimental effects***.
 - Preterm infants are at risk for poor growth while in the neonatal intensive care unit (NICU) ***and after NICU discharge***.
 - Abnormalities in growth during this time period may persist into adulthood, ***especially in patients who were born premature***.

All premature infants require nutrition monitoring & intervention



What our
premature
infants
missed
in the
third trimester

Period of major nutrient mobilization for growth and development:

- IUGR
- EUGR
- Mineral deposition
- Poor neurodevelopmental outcomes

Maturation of gastrointestinal tract:

- Decreased motility
- Reduced enzyme activity
- Malabsorption

Nutritional needs of the premature infant...

- Exceed those of the full term infant
- Feeding choice is important:
 - Increased caloric and mineral requirements
 - Human milk recommended
 - Human milk fortifier (HMF) for preterm infants weighing <2kg at birth (24kcal)
 - Preterm formulas (e.g. Similac Special Care High Protein 24kcal) up to 2.2kg or 36 weeks
 - Transitional formulas/fortification(e.g. Enfacare, Neosure) for discharge home
- Some infant populations require higher caloric density (BPD, CHD, etc.)
- Timing of transition to term formula depends on individual growth velocity:
 - Common to continue transitional formula until infant is gaining weight steadily, taking oral feedings well, and self-regulating intake (4-9 months).
 - Some providers will continue use until the infant has reached at least the 10-50th percentile weight for corrected age.

All preterm infants should stay on human milk and/or formula until 12mo corrected age

Breast(milk) is best...

Current guidelines:

- Recommended for the first 6 months of age and up to age 1
 - WHO, AAP
- Reduces risk of
 - Infection
 - Hospitalizations
 - Chronic disease
 - Non-specific gastroenteritis
 - NEC



Things to consider for premature infants:

- BM is lower in iron & vitamin D, kcal, protein, vitamins and minerals than formula
- Increased nutrient and calorie needs
- Less coordinated suck/swallow
- Tire easily, less endurance

Premature Infant

Calories	110-130 kcal/kg
Protein	2.5-3.5 g/kg
Fat	4.8-6.6 g/kg
Vitamin D	400-1000 IU/day
Iron	2-3 mg/kg
Calcium	120-200 mg/kg
Sodium	69-115 mg/kg
Potassium	78-195 mg/kg

Term Infant

Calories	108 kcal/kg
Protein	2.2 g/kg
Fat	31 g/day
Vitamin D	400 IU/day
Iron	0.27 mg/day
Calcium	200 mg/day
Sodium	120 mg/day
Potassium	400 mg/day

Nutrition Composition Comparison

Nutrition	Breastmilk	Fortified BM	Preterm Transitional Formula
Calories (kcal/oz)	13-20	24	24
Protein (g/100 kcal)	1.5	2.8	3.0
Iron (mg/L)	0.35	X	14.6
Calcium (mg/100 kcal)	41	175	168-182
Phosphorus (mg/100 kcal)	21	98	84-101

Iron & Vitamin D Supplementation

- 14% preterm infants develop iron deficiency between age 4-8 months
- Iron deficiency is associated with
 - Poor neurocognitive development
 - Lower Bayley Psychomotor Developmental Stores

GOAL:

Iron: 2 mg/kg/day

Vitamin D: 400 IU/day

Premature infants receiving breastmilk and fortified breastmilk:

- Supplemental multivitamin and iron
- Begin at 1 month of age
- Continue to age 1 year

Infants on Transitional or Term formulas:

- Likely meeting iron nutrient needs
- May need additional nutrients
- Should receive multivitamin if taking:
 - <800 ml of transitional formula
 - < 1000 ml term formula

Assessing Growth: Nutrition Assessment

- Growth trends
- Weight gain velocity
- Dietary intake and adequacy
- Feeding difficulties
- Developmental milestones
- Malnutrition



We need the
WHOLE picture!

Premature Growth & Feeding Milestones

Growth is corrected for prematurity until a corrected age of 2 years or until infants plot solidly on standard growth curves.

Tracking growth:

- Fenton (up to 50 weeks of age)
- WHO (50 weeks -2 years), corrected for prematurity
- CDC (beyond 2 years)

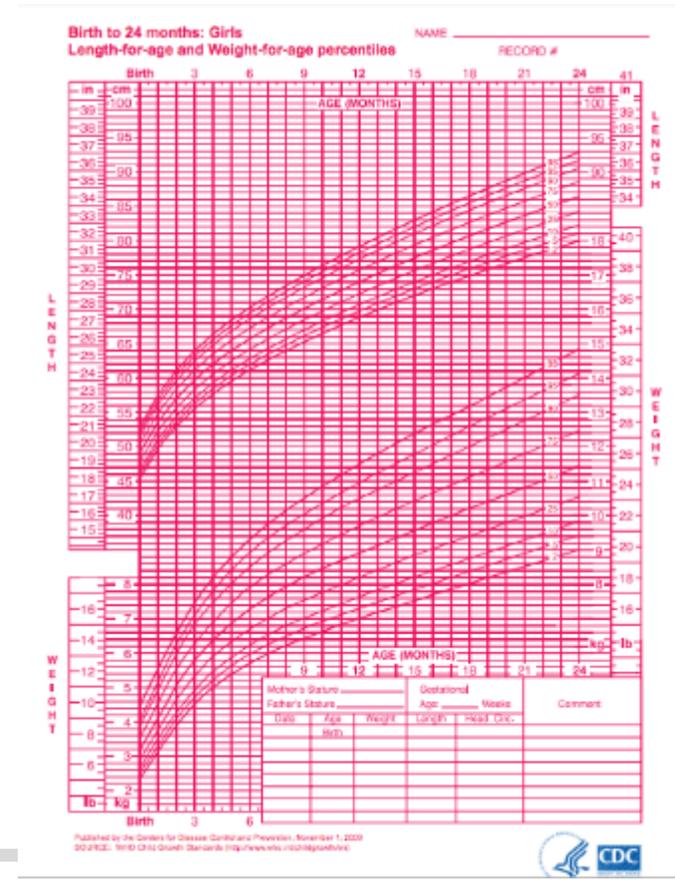
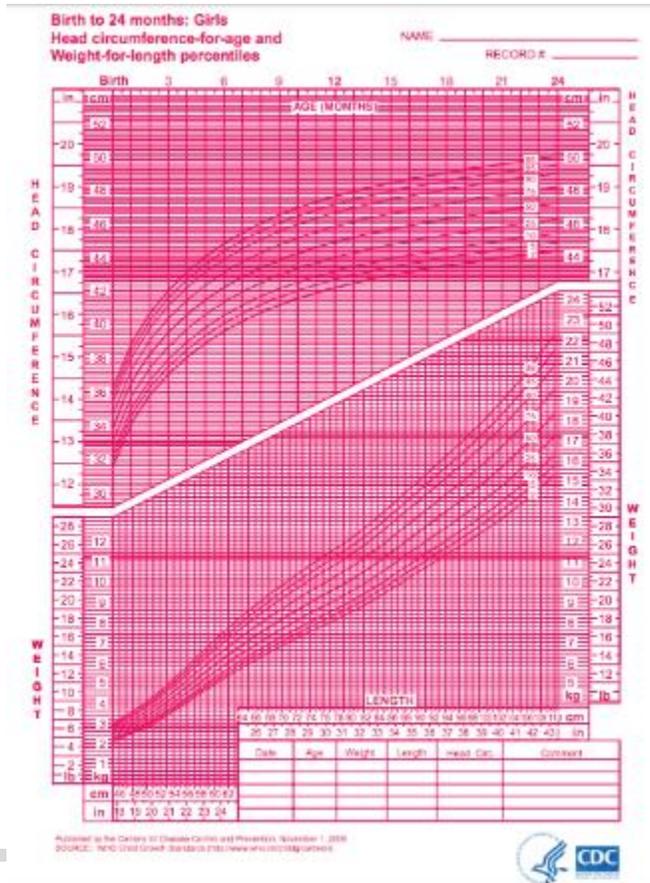
Track height, weight, head circumference and growth velocity

Monitor for abnormal catch-up growth patterns



Growth Charts - WHO

Girls 0-2 years Boys 0-2 years
 Height/age Weight/age Head circumference/age Weight/Length



Goals for Premature Growth

- **Ultimate goal** is to achieve the *same body composition* and be gaining at the *same weight and length velocity* as a full term infant of the same corrected age
- Time to reach this goal varies by patient
- Premature infants are expected to meet these goals until they have “caught up” with their term peers

Weight gain

15-50 g/day

Length gain

.17 cm/day

Head circumference

0.5-0.9 cm/ week

Catch-up Growth

“Catch-up growth” is a loose term, generally defined as an acute, accelerated growth velocity

- Infants needing catch up growth:
 - Below the 25thile weight/length or BMI/age (if 2+ y.o.)
 - Failure to meet weight and length gain velocities for corrected age
 - Weight/age trending <10thile (per discretion)
- Once infant meets these goals- we expect them to grow at the rate of a term infant of the same age

Growth velocity

Premature infants are expected to grow at the term equivalent for **corrected age**

Age	Weight (g/day)	Height (cm/d)
0-3 months	25-35	.10
3-6 months	15-21	.07
6-12 months	10-13	.05
1-2 years	10	.03
2-6 years	5-8	.02
7-10 years	5-11	.02

Ex. A 6 month chronological age (4 months corrected age) should be gaining 15-21 g/day



Healthy High-Calorie Foods



pistachios
1 tbsp. - 120 calories



bananas
100 calories



EGG
70 calories



wheat germ
1/4 c. - 120 calories



sweet potato
182 calories



dark chocolate
100g - 59 calories



peanut butter
1 tbsp. - 192 calories



olive oil
1 tbsp. - 120 calories



- Increase caloric density of formula
 - 22 kcal to 24, 27 kcal etc.
 - Reduces water intake
- Increase calories in diet
 - Added oils (1 tsp = 40 kcal)
 - High kcal foods (full fat dairy, cheese, heavy cream, peanut butter, avocado, eggs, etc.)
 - Nutritional supplement
 - Depends on age and intake
 - Toddler formula, Pediasure, Duocal, Benecalorie, etc.

Introduction of solids

Introduction of solids:

- Follow the same developmental readiness cues that one would use for term infants
- Most premature infants are not ready for solids until **4 to 6 months corrected age**.
- Families should be reminded regularly about growth and developmental expectations specific to their infants.



Early introduction may lead to:

- decreased intake of formula (can slow weight gain)
- excessive weight gain
- oral aversion
- intolerance

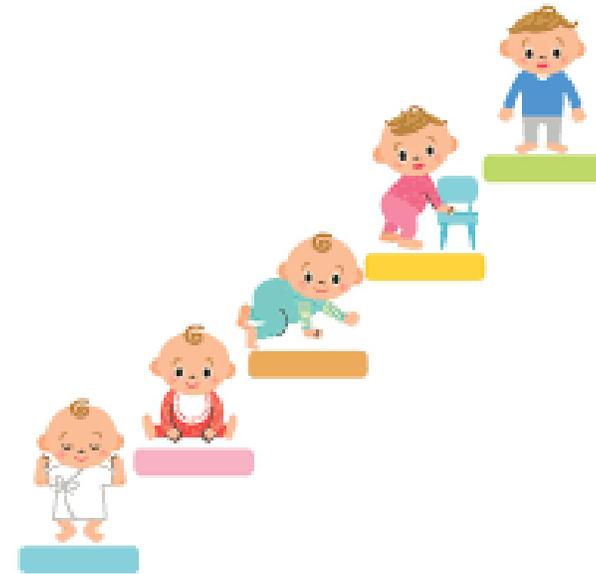
Late introduction may lead to:

- oral aversion
- delayed feeding milestones

WHY Follow-up: Focus on development

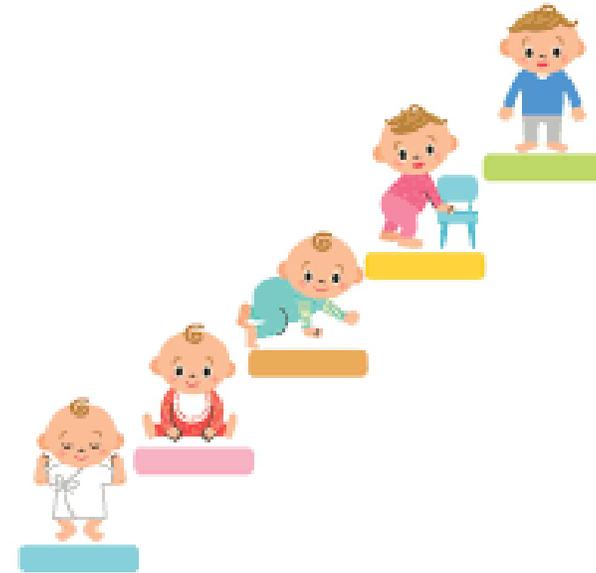
Developmental milestones are expected to occur based upon corrected age:

- Correct development for prematurity through 2-2 ½ years
- Motor, cognitive, language development
- Sleeping through the night, tooth eruption, colic, reflux, initiation of solids
- Not all areas mature at the same rate



WHY Follow-up: Focus on development

- Increased risk for impaired neurodevelopmental outcome
 - Cognitive, motor, language deficits
 - Cerebral palsy
 - Vision and hearing deficits
- More likely to develop psychological and behavioral problems
 - ADHD
 - difficulty in peer interactions
 - general anxiety and depression
 - autism spectrum disorder (ASD)
- School-age children born preterm are at increased risk for functional disabilities that impact managing daily activities
 - problems of motor coordination
 - social skills
 - executive function.



Developmental surveillance

- Development should be monitored at each visit throughout childhood
- Use developmental tools consistently and as designed
- Select screening tools that are practical
- Tools for Developmental and Behavioral Assessment:
 - Infant Development Inventory
 - Ages and Stages
 - Denver Developmental Screening
 - Vineland Adaptive Behavior Scales
 - MCHAT
- Monitor for externalizing behaviors/ADHD, atypical social-communication behaviors/autism
- Identify areas for increased vigilance and/or refer for further evaluation by subspecialists

Neuromotor Development and Assessment

- Preterm infants, especially those born at less than 1500 grams, may have abnormal findings on muscular and neurologic exam for the first 12-18 months.
- Typical findings near term corrected age and post-discharge:
 - Extensor bias
 - Truncal hypotonia, head lag
 - Extremity hypertonicity (heel cords, hips, shoulders) –“loves to stand!” but not yet sitting
 - Jitteriness
- Preterm infants with abnormal tone are typically late walkers and may have a certain degree of toe walking
- Majority of tone issues resolve, but it is difficult to predict in whom.

Neuromotor Development and Guidance

- Demonstrate supportive positioning techniques
- Early intervention is recommended to minimize the effects of the abnormal patterning on the normal progression of development.
- Advised to not use walkers, standers, or jumpers since they encourage extensor posture.
- Confirm types and frequency of services (Birth to three vs outpatient OT/PT)
- Serial exams → transient dystonia vs. concern for cerebral palsy

Additional Screening Recommendations

Hearing:

...all infants who received care in a NICU for more than 5 days should be referred for diagnostic audiological assessment at least once by 9-12 months corrected age (2019 Position Statement of the Joint Committee on Infant Hearing)

Vision:

Infants diagnosed with ROP have up to 10 times the risk for refractive errors than their same gestational age peers as well as a higher incidence of other visual disorders including strabismus, amblyopia, and cataracts in preterm infants.

...all infants born <1500g should have an ophthalmology examination 8-10 months after discharge (AAP 2018 Policy Statement on ROP)

Overview of the Yale NICU GRAD Program (est. 2013)

YALE NICU GRAD Program



- **The NICU GRAD Program** is a comprehensive, multidisciplinary medical and developmental follow-up program designed specifically to provide a continuum of care for at-risk infants and young children due to conditions faced in the newborn period.
- **Our Mission:**
 - *“...to provide family-centered, post-discharge medical and developmental care to support high risk infants and their parents during the transition from the hospital to home.”*

Who is GRAD? (We can't do this work alone!)

- Neonatologists
- Physician Assistant
- Nurse Coordinator
- Occupational Therapists
- Dietitian
- Yale Child Study Center Psychologists
- Social Work
- Trainees:
 - Neonatal-Perinatal Fellows
 - Yale Child Study Center Psychology Fellows
 - Developmental Behavioral Pediatric Fellows
 - Yale Pediatric Residents
 - Yale Medical Students
 - NP students



Who is GRAD: Meet our team!

- **Angela M. Montgomery, MD, MEd**
Director, Neonatologist
- **Christie J. Bruno, DO**
Associate Director, Neonatologist
- **Soo Hyun Kwon, MD**
Neonatologist
- **Alexis Rodriguez, MD**
Pediatric Hospitalist
- **Sarah Beres, MS, PA**
- **Eleanor Blythe, PA**
- **Stephanie Fiorentino, PA**
- **Dana Carman, MS, RD, CD-N**
Dietitian
- **Amanda Lowell, PhD**
- **Angie Maupin, PhD**
- **Kelly K. Powell, PhD**
Psychologists
- **Caitlin Condon, OTR/L**
- **Sara Cave, OTR/L**
- **Kim Gramlich, OTR/L**
Occupational Therapists
- **Lisa Giard, RN**
Nurse Coordinator

Who is GRAD: Meet our patients!

Birth weight \leq 1500 grams	Hypoxic ischemic encephalopathy
Gestational age \leq 32 weeks	Seizures
Bronchopulmonary dysplasia	Meningitis
Pulmonary hypertension	Hydrocephalus
Congenital diaphragmatic hernia	Intrauterine growth restriction/SGA
Infants treated with ECMO	Congenital cardiac defects
Intraventricular hemorrhage	Other congenital malformations requiring surgery (i.e. esophageal atresia, tracheoesophageal fistula, gastroschisis, omphalocele)
Periventricular leukomalacia	Neonatal Abstinence Syndrome
Neonatal Stroke	Other medically complex conditions



WHERE is GRAD: Locations

Locations:

Yale-New Haven Children's Hospital
Pediatric Specialty Center
One Long Wharf Drive, 2nd Floor
New Haven, CT 06511

Yale-New Haven Hospital
Old Saybrook Medical Center
633 Middlesex Turnpike
Old Saybrook, CT 06475

Hours: Tuesday 8:30a-12:30p (Old Saybrook)
Thursday 8:30a-12:30p, 1-5p (Long Wharf)
Friday 12:30-4:30p (Long Wharf)



WHEN is GRAD: Schedule of visits

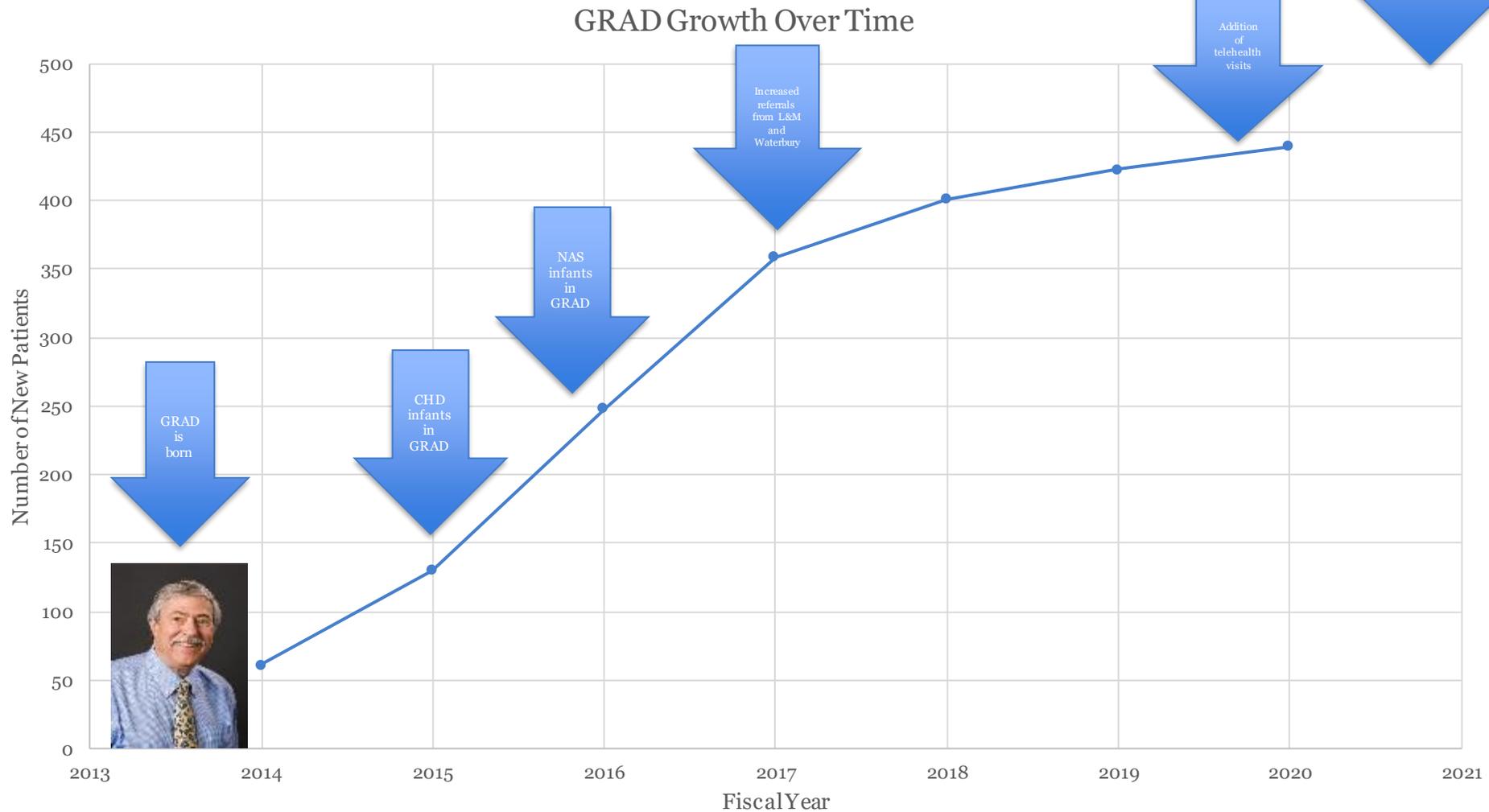
1 st medical visit	~ 1 month from discharge
Subsequent medical visits	Every 4 months over the 1 st year Every 6 months over the 2 nd and 3 rd years Every 8-12 months over the 4 th year for medically complex patients
Developmental visits	12 and 24 months corrected age (Bayley 3) 36 months actual age (Bayley 3) 4.5-5 years of age



What is GRAD: Services provided

- Medical management after hospital discharge (BPD, GERD, constipation, etc)
- Coordination of primary and subspecialty care
- Nutritional evaluation, recommendations and treatment
- Neuromotor assessment (HINE), recommendations and referrals
- Neurodevelopmental assessments/questionnaires
- Social work assessments as needed
- Referrals for services (Birth to Three, outpatient SLP/OT/PT and/or community-based programs)
- Referrals for developmental evaluations (autism, behavioral, etc)
- Referrals for recommended surveillance (audiology, ophthalmology)
- Training/teaching site for fellows, residents, PNP, and medical students
- Outcomes related research

GRAD Clinical Growth Over Time

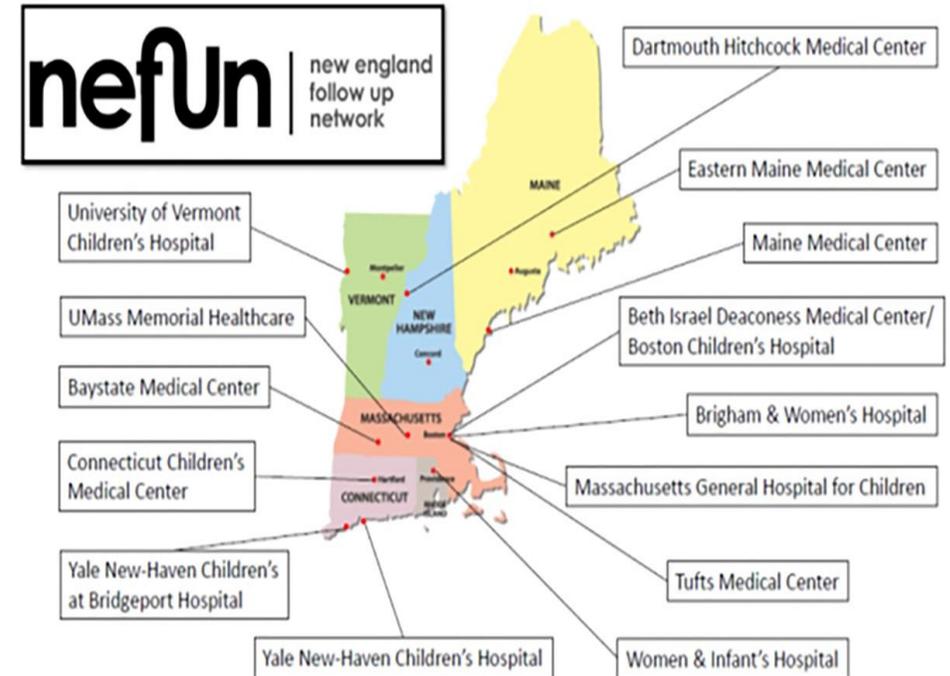


GRAD Clinical Collaborations and Initiatives

- 2015 - Yale Child Study Center psychologists join GRAD team
- 2015 – Follow-up of infants with CHD (Pediatric Cardiology)
- 2016 - Follow-up of infants with NAS cared for under Eat, Sleep, Console (Pediatric Hospitalists)
- 2018 – Management of infants with feeding difficulties (Aerodigestive Program)
- 2019 – Streamline referral of infants with cerebral palsy (Pediatric Orthopedics/Tone Clinic)
- 2020 – Integrate hearing screening into visits at both GRAD sites (Audiology)
- 2021 – Early identification of infants with cerebral palsy (Pediatric Rehab and Orthopedics)
- 2021 – Early identification of infants/toddlers with autism (YCSC)

GRAD Outcomes: New England Follow-up Network/VON

- We established the first regional quality improvement collaborative solely dedicated to follow-up care of high-risk infants after NICU discharge
- Goals:
 - Characterize extremely low birth weight (ELBW) follow-up in New England.
 - Determine site-specific differences in outcomes
 - Standardize approach to follow-up care across sites
- 14 follow-up programs in New England partnered with the Vermont Oxford Network (VON) ELBW project:
 - Collect information about the health status and developmental outcomes of infants born younger than 28 weeks at the 18–26 months corrected age follow-up visit.



GRAD Ongoing Quality Improvement & Research Projects

- 2015-2019 VLBW birth cohorts: Open bay vs single family room NICU outcomes (growth and development at 2 years)
- 2016-2018 NAS birth cohorts: 1 and 2 year follow-up of infants with NAS cared for under “Eat, Sleep, Console”
- 2017-2019 Early identification of autism in premature infants using the Communication and Symbolic Behavior Scales (CSBS)- pilot study completed
- New England Follow-up Network (NEFUN) in collaboration with the Vermont Oxford Network
- Extremely Low Gestational Age Network (ELGAN) Study
 - 2002-2004 Yale birth cohort
 - Completed 15 year old visits, ongoing analysis
 - Completing 17-18 year old visits as part of the NIH supported Environmental Influences on Child Health Outcomes (ECHO) Consortium

GRAD: How to contact us

Referrals:

- For new referrals, please use the [New Patient form](#) found on the Yale NICU GRAD website:

<https://medicine.yale.edu/pediatrics/perinatal/grad/>

- For questions regarding the NICU GRAD program, please contact Lisa Giard (GRAD nurse coordinator) at lisa.giard@ynhh.org or at **203-988-8925**.

Questions or
comments???