In This Section

Potentially Better Practices

Tools

General Principles for Supporting the Nutrition of Very Low Birth Weight (VLBW) Infants

Introduction

Intensive care of the VLBW infant continues to advance and nutrition is a cornerstone of this care. Implementing evidence-based practice as the standard of care across NICUs will further enhance the daily clinical care that is provided. Various disciplines bring specialized expertise and can contribute to identifying potentially better practices (PBPs). Working together to create a cohesive approach will promote improved outcomes. Incorporating quality measures and learning where improvements can be made will assist all babies to reach their growth and neurodevelopmental potential.

POTENTIALLY BETTER PRACTICE #1

Establish consistent, comprehensive, multidisciplinary nutrition care standards of practice based on evidence, or expert opinion if evidence is lacking.

Background, Rationale, and Goals

- Nutrition is essential for growth, metabolism, immunity, and optimizing neurodevelopmental outcomes
- While there are some well-established evidence-based practices, practitioner variation may interfere with consistent application and implementation of evidence-based practice, depending on the infant's medical course.
- Recent review articles have eloquently pulled together expert opinions and evidence as excellent resources.[1-3]
- Proper nutrition is the only way to promote growth; however, illness, infection, genetics, and gender influence growth.6[,13,14]
- Poor growth, whether it occurs during antenatal or early postnatal life, is associated with increased risk to long-term health.[15-17]
- Rapid and/or excessive weight gain that follows a period of poor growth in utero or infancy increases development of chronic non-communicable diseases, such as type 2 diabetes mellitus, hypertension, overweight/obesity, and cardiovascular disease in adulthood.[18]

Recommendations, Guidelines and Algorithms

- Create an interdisciplinary nutrition team/ committee to review and implement evidence-based practice:
  - Potential members include clinical dietitians/ nutritionists, physicians/nurse practitioners/ physician assistants, lactation professionals, bedside nursing staff, pharmacy staff, developmental specialists, occupational and/or speech language therapists (who have expertise in oral feeding practices of neonates).
- Growth Standards:
  - Growth charts should be a part of every VLBW infant chart: Readily accessible (ideally electronic[4]), appropriate growth curves, including weight, length, and head circumference

See **TOOL #1** on page 10 for the Most Current and Common Growth Curves for VLBW Infants.[5-9]

- The American Academy of Pediatrics recommends growth at intrauterine growth rates.[10]
- The ideal rate of catch-up growth is unknown, therefore catch-up growth is not prescribed.
- An emerging method of monitoring extrauterine growth using a Growth Velocity Approach suggests that to parallel an ideal intrauterine growth of 17 g/kg/day, extrauterine growth needs to be closer to 19-20 g/kg/day.[11,12]
- **Head circumference growth** is used as a surrogate marker for brain growth and is highly correlated with neurodevelopmental outcomes.[19] IQ in adolescents born preterm are best predicted by white matter volume.[17]
- Studies indicate that **linear growth** indexes organ growth and may be a more accurate and earlier predictor of growth failure.[20-22]
  - While at the present time it is not standard to monitor BMI, Weight for Length, or other measurement of body proportionality or

composition, it may become more routinely monitored in the future.[23]

- **"Ideal" Growth Goals.**[24,25]
  - **Weight:** 19-20 g/kg/day (Measured daily, or as safe and able). Clinical judgment is important in determining weight gain goals considering the neonate's medical condition, genetic growth potential, and nutrient intake.
  - **Length:** 0.8-1 cm/week (Measured weekly, ideally done with length board for accuracy).
  - **Head Circumference:** 0.8-1 cm/week (Measured weekly, unless otherwise needed more frequently).

- **Calculating Growth Changes**[25-28]:
  - Growth restriction, disproportionate fat mass vs. lean body mass in preterm infants when they reach term age vs term infants at birth suggest that current practices are not consistently promoting optimal growth and body composition in preterm infants.[25]
  - Z-Scores are valuable to understand growth in relation to standard deviations above and below the mean.
  - Calculating weight changes from the infant's nadir weight (lowest weight measured), or from the day they re-gain their birthweight, (which is typically anywhere between day of life 8-14) may be a more realistic .approach than calculating weight changes starting with birthweight.[29]
  - The amount of weight gain needed to maintain weight z score varies with age, weight z score, and sex, so weight goals should be adjusted weekly.
    - Can use PediTools Preterm calculator to individually assess growth goals

- **Nutrition Provision:** Use established, standardized monitoring protocols with defined nutritional goals
  - TPN initiation, advancement, & duration
  - Enteral feeding initiation, advancement, & duration
  - Nutrition discharge planning

- **Laboratory Monitoring**[30]
  - There are no absolute standards, only guidelines/recommendations
  - Influences on laboratory monitoring include:
    - Laboratory processing capabilities
    - Volume needed to obtain results
    - Cost to hospital and potential for reimbursement
    - Clinical status/stability, and goals of care for the patient
    - Parent preference or religious belief

Refer to **TOOL #2** on page 11 for a Monitoring Schedule for VLBW Infants Receiving Parenteral or Enteral Nutrition Support.

- Document assessments by registered dietitians who specialize in neonatal nutrition
  - Within 24 hours of admission
  - At regular intervals, every 3-5 days & no longer than 7 days apart

Quality Improvement: Outcome/ Process Measures

- Are growth charts available in the hard copy or EMR?
- Are growth charts in the EMR auto-populated?
- Are perinatally-trained dietitians available in the NICU with standard orders for consultation?
- Are protocols available for monitoring growth laboratory measures?

POTENTIALLY BETTER PRACTICE #2

Establish standards of nutrition monitoring as an integral component of improving nutrition outcomes in the neonatal population.[3]

Background, Rationale and Goals

- There is no absolute approach to guarantee each and every baby will reach their growth and cognitive potential, yet we continue to strive to optimize those outcomes to the best of our ability.[1,31,32]
- Lack of financial and personnel resources, may impact the ability to implement nutrition monitoring.
- Advances in nutrition care for VLBW infants enhance survival and can minimize or modify long-term morbidity outcomes.

Recommendations, Guidelines and Algorithms

- Review current practice.
  - Often there may be a significant disconnect between assumed practice and reality.
- Identify outdated practices and other areas for improvement.

Quality and Process Improvement

- If not already available in your unit, explore hiring a registered dietitian and lactation consultant.
- Create standardized flow-sheets or charting tools to support daily calculations, trends, and facilitate analyses.
- Identify changes in your nutrition outcomes, and measure change in clinical practice (as in Plan Do Study Act "PDSA" Cycles).

Outcome and Process Measures:

- At a minimum, annual review of nutrition outcomes and compare to internal benchmarking &/or outside benchmarks (CPQCC, VON, etc.).

POTENTIALLY BETTER PRACTICE #3

Identify, diagnose, and monitor malnutrition.[25]

Background, Rationale and Goals

- The Academy of Nutrition and Dietetics (AND) and the American Society for Parenteral and Enteral Nutrition (ASPEN) have recently established recommendations and criteria for the identification and documentation of malnutrition related to undernutrition for both adult and pediatric populations
- Malnutrition can result in poor growth and may influence neurocognitive outcomes
- VLBW infants are at very high risk for malnutrition and undernutrition due to:
  - Decreased nutrient stores at birth
  - Immature absorption and organ function
  - Delayed initiation and advancement of both parenteral and/or enteral nutrition
  - Complications due to NEC/SIP, CLD, infections, parenteral and enteral nutrition access, and/or cardiac anomalies, etc.
- Primary indicators used to diagnose malnutrition in neonates:
  - Individual data are compared to appropriate reference standards
  - To make the diagnosis of malnutrition, use the most accurate data points to determine the classification/degree of malnutrition (Mild, Moderate, Severe)

Refer to **TOOL 3** on page 12 for diagnostic criteria.

- In some situations, diagnosing malnutrition may need to be deferred due to critical illness and patient instability, or it may become not necessary (such as end of life/comfort care).

Recommendations, Guidelines and Algorithms

- Accurate anthropometric data should be obtained routinely and compared to appropriate reference standards
- Initial malnutrition assessment/diagnosis should be done within the first 2 weeks of life
- Malnutrition assessment/diagnosis should be monitored and updated appropriately at least weekly during hospitalization
- Tracking malnutrition diagnosis, and classifications (mild, moderate, severe) should be recorded and reviewed at least annually for trends

Quality Improvement: Outcome/ Process Measures

- At least annual review for the staff of proper techniques to obtain the most accurate data.
- Track influence of routine malnutrition diagnosis on short and long- term outcomes.
- Assessment of malnutrition status may affect payor reimbursement.
- Audit charts to review and assess for accuracy of malnutrition diagnosis
  - Is the criteria appropriately being applied and accurately reflected in the degree of malnutrition diagnosed?

POTENTIALLY BETTER PRACTICE #4

Track nutritional continuous quality improvement (CQI) data, for the individual patient as well as the unit aggregate data, and use it to modify current practice.

Background, Rationale and Goals

- Evidence-based quality improvement efforts continue to demonstrate the importance of measuring current practice to improve future practice.[33,34]
- An individual database should facilitate the nutrition care of an individual patient.
- Collective analysis of nutritional processes and outcomes are needed for global NICU quality improvement and interventions.[2,33,35]
- Implementation and ongoing quality improvement activities may be impeded by lack of data collection and analysis capability and resources.

Recommendations, Guidelines and Algorithms

- Individual patient data tracking of key measures
- Collective key measure information gathered from all patients admitted during a defined period (typically 1 calendar year)

Refer to **TOOL 4** on page 14 for examples of measurement tools.

- Data updated and shared with staff regularly

Quality Improvement: Outcome/ Process Measures

INDIVIDUAL DATA

- Are the patient's nutrition goals being met?
  - Daily assessment and discussion on rounds
  - Daily volume, caloric intake, including protein, dextrose, fat calories
  - When appropriate, electrolyte, vitamin and trace element intake
- If not, why are they not being met? I.e. fluid restriction, tolerance, etc.
- Number of Days NPO
- Relative contribution of gavage vs. nipple vs. breastfeeding intake
- Consistent encouragement and appraisal of mother's milk supply
  - Prenatal education and parental decision-making, especially regarding breastfeeding
  - Pumping log
  - Discussion on rounds
  - Availability of lactation professionals
  - Timing of skin-to-skin contact, non-nutritive breastfeeding
- Track the use of breastmilk as the preferred nutritional source.
  - Was breastmilk given as the first feed?
  - Did the infant receive banked breast milk (BBM)?
  - How much BBM vs. Mom's own breastmilk (MBM)?
  - Fortification used and days on fortified feeds
  - Feeding any breastmilk at discharge
  - Breastfeeding at discharge
- Biochemical monitoring
  - Frequency of lab draws
  - Chemistries to monitor & trend

AGGREGATE DATA

- Develop a nutritional database
  - Nutrition reports pulled automatically from

the electronic medical record (EMR)
    - Trends over time (Monthly vs. Quarterly vs. Annually)
- Data may include, but is not limited to:
    - Average BW, GA
    - Amount of Amino Acids received in the first DOL
    - Average and range DOL feeding pathway starts
    - Average and range of DOL BW is regained
    - % of patients who received MBM as first feed
    - Average growth velocity
    - NEC rate
    - % of patients who are feeding breastmilk upon discharge
    - % of patients discharged with a feeding tube
- Comparison of center outcomes
    - % Extrauterine growth restriction (EUGR)
    - Weight at discharge decreased ≥ 1 SD from birthweight
    - % of infants AGA at birth who are SGA (<10th percentile) at discharge
    - CPQCC
    - VON
    - Children's Hospital Association
    - Within healthcare system networks (eg. Kaiser, MedNax)
    - Published data
    - Available benchmarks
    - Internally established metrics

TOOL #1

Current and Common Growth Curves for VLBW Infants

- Use hyperlinks to view each growth chart
- Source for access to most growth charts: PediTools Preterm

FENTON GROWTH CURVE

Where do I find it?	**Girls:** http://ucalgary.ca/fenton/files/fenton/fenton2013growthchartcolor-girls.pdf **Boys:** http://ucalgary.ca/fenton/files/fenton/fenton2013growthchartcolor-boys.pdf
Notes	• International Data • Combine WHO Growth Curve data points, which is to be used once former preterm infants correct to post-term
References	Fenton TR, Kim JH. A systematic review and meta-analysis to revise the Fenton growth chart for preterm infants. BMC Pediatr. 2013;13:59

GROWTH CALCULATOR

Where do I find it?	http://www.growthcalculator.org/
Notes	Newer, more conceptual theory that needs further investigation, validation, and long-term understanding; however, is an approach focused on a more personalized expectation of growth
References	Rochow N, Landau-Crangle E, Thommandram A, Fusch C. Individualized postnatal growth trajectory for preterm infants – online calculator. 2016.

INTERGROWTH 21st

Where do I find it?	https://intergrowth21.tghn.org/postnatal-growth-preterm-infants/#pg1
Notes	Limitations: small sample size <28 wk infants
References	Villar J, Cheikh Ismail L, Victora CG, et al. International standards for newborn weight, length, and head circumference by gestational age and sex: the Newborn Cross-Sectional Study of the INTERGROWTH-21st Project. Lancet. 2014;384:857-868. Villar J, Puglia FA, Fenton TR, et al. Body composition at birth and its relationship with neonatal anthropometric ratios: the newborn body composition study of the INTERGROWTH-21st project. Pediatr Res. 2017;82:305-316.

BMI CURVES FOR PRETERM INFANTS

Where do I find it?	http://pediatrics.aappublications.org/content/135/3/e572.figures-only
Notes	• To monitor proportionality of growth • Limitation is that it cannot delineate fat-free mass accumulation vs. fat mass[36]
References	Olsen IE, Lawson ML, Ferguson AN, et al. BMI curves for preterm infants. Pediatrics. 2015;135:e572-581.

TOOL #2

Monitoring Schedule for VLBW Infants Receiving Parenteral or Enteral Nutrition Support

	Parenteral Nutrition		Enteral Nutrition	
	Initial Phase	Stable Phase	Initial Phase	Stable Phase
Growth				
Weight	Daily	Daily	Daily	Daily
Length	Baseline	Weekly	Weekly	Weekly
Head Circumference	Baseline	Weekly	Weekly	Weekly
Intake and Output	Daily	Daily	Daily	Daily
Glucose				
Serum	As indicated	As indicated	Baseline	As indicated
Urine	1-3 times/day	As indicated	Baseline	As indicated
Electrolytes	1-3 times/week	Every 1-2 weeks	Baseline	Every 2-3 weeks
Calcium, magnesium, phosphorus	2-3 times/week	Every 1-2 weeks	Baseline	Every 2-3 weeks
Triglycerides	Daily during dose increase	Every 1-2 weeks	As indicated	As indicated
BUN/creatinine	2-3 times/week	Every 1-2 weeks	Baseline	Every 2-3 weeks
Serum proteins	Baseline	Every 2-3 weeks	Baseline	Every 2-3 weeks
Liver enzymes	Baseline	Every 2-3 weeks	Baseline	Every 2-3 weeks
Alkaline phosphatase	Baseline	Every 2-3 weeks	Baseline	Every 2-3 weeks
Blood cell count	Baseline	Every 2-3 weeks	Baseline	Every 2-3 weeks
Vitamin and trace mineral status or other specific tests	As indicated	As indicated	As indicated	As indicated

Initial Phase: Period in which PN solutions or enteral feedings are adjusted to meet the specific energy and nutrient needs of individual infants. This period general lasts for < 1 week for parenteral nutrition support and 7-10 days for enteral nutrition support.

Stable Phase: Period in when the infant is in a metabolically steady state. For clinically stable infants receiving an adequate nutrient intake with desired growth, the interval between laboratory measurements may be increase beyond the above recommendations.

Adapted from: Moyer-Mileur LJ. Anthropometric and laboratory assessment of very low birth weight infants: the most helpful measurements and why. Semin Perinatol. 2007;31:96-103.

Diagnostic Criteria for Malnutrition

Indicator	Mild malnutrition	Moderate malnutrition	Severe malnutrition	Use of indicator
Primary indicators requiring 1 indicator				
Decline in weight-for-age z score	Decline of 0.8-1.2 SD	Decline of > 1.2-2 SD	Decline of > 2 SD	Not appropriate for first 2 weeks of life
Weight gain velocity	< 75% of expected rate of weight gain to maintain growth rate	< 50% of expected rate of weight gain to maintain growth rate	< 25% of expected rate of weight gain to maintain growth rate	Not appropriate for first 2 weeks of life
Nutrient intake	≥ 3-5 consecutive days of protein/energy intake ≤ 75% of estimated needs	≥ 5-7 consecutive days of protein/energy intake ≤ 75% of estimated needs	> 7 consecutive days of protein/ energy intake ≤ 75% of estimated needs	Preferred indicator during the first 2 weeks of life
Primary indicators requiring 2 or more indicators				
Days to regain birth weight	15-18	19-21	> 21	Use in conjunction with nutrient intake
Linear growth velocity	< 75% of expected rate of linear gain to maintain expected growth rate	< 50% of expected rate of linear gain to maintain expected growth rate	< 25% of expected rate of linear gain to maintain expected growth rate	Not appropriate for first 2 weeks of life. May be deferred in critically ill, unstable infants. Use in conjunction with another indicator when accurate length measurement available.
Decline in length-for-age z score	Decline of 0.8 - 1.2 SD	Decline of > 1.2-2 SD	Decline of > 2 SD	Not appropriate for first 2 weeks of life. May be deferred in critically ill, unstable infants. Use in conjunction with another indicator when accurate length measurement available.

Adapted from: Goldberg DL, Becker PJ, Brigham K, et al. Identifying Malnutrition in Preterm and Neonatal Populations: Recommended Indicators. J Acad Nutr Diet. 2018.

TOOL #4

EXAMPLE: Data Collection Forms

INDIVIDUAL DATA COLLECTION FORM

Name:		MRN:		Birth GA:	
DOB:		Sex:		Admit PMA:	
Admit Date:		Diagnosis:			
Birth Wt:	g	%ile Wt at Birth:	%ile	% wt loss prior to regain:	%
Birth Length:	cm	%ile Length at Birth:	%ile		
Birth FOC:	cm	%ile FOC at Birth:	%ile		
Date BW regained:		DOL BW regained:			
Date of D/C:		LOS (d):		PMA at D/C:	
D/C Weight:	g	Date of D/C Weight:		%ile Weight at D/C:	%ile
D/C Length:	cm	Date of D/C Length:		%ile Length at D/C:	%ile
D/C FOC:	cm	Date of D/C FOC:		%ile FOC at D/C:	%ile
AA started DOL:		TPN start date:		Colostrum in 1st 24 hrs:	
Lipids started DOL:		TPN end date:		Tropic feeds started DOL:	
90 kcal/kg on DOL:		# d on TPN:		Type of milk for 1st feed:	
120 kcal/kg on DOL:					
130 kcal/kg on DOL:		DOL started MOM:		Peak Alk Phos:	
3.5 g/kg on DOL:		Date started MOM:		Date Peak Alk Phos:	
HMF type:		Date ended MOM:		DOL Peak Alk Phos:	
HMF started DOL:		# d total MOM:		Feeds at Peak Alk Phos:	
DOL started DHM:		DOL started Prolact+8:		DOL started Cream:	
Date started DHM:		Date started Prolact+8:		Date started Cream:	
Date ended DHM:		Date ended Prolact+8:		Date ended Cream:	
# d total DHM:		# d total Prolact+8:		# d total Cream:	
DOL started Vits:		DOL started Cow HMF:		DOL started Extra Protein:	
Date started Vits:		Date started Cow HMF:		Date started Extra Protein:	
Date ended Vitamins:		Date ended Cow HMF:		Date ended Extra Protein:	
# d total Vitamins:		# d total Cow HMF:		# d total Extra Protein:	
NEC Stage:					
Date of NEC:		Date of Perf:		D/C Feeds:	
DOL of NEC:		DOL of Perf:			
Feeds at NEC:		Feeds at Perf:			

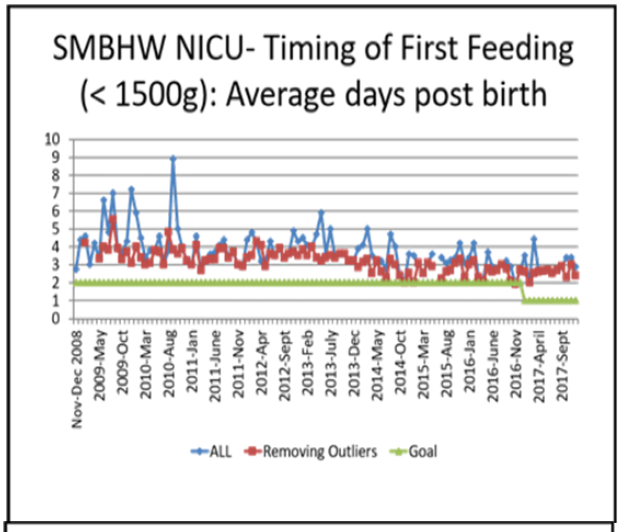
Collection examples from: Kelli Hawthorne MS, RD, LD via personal communication with the authors of this toolkit.

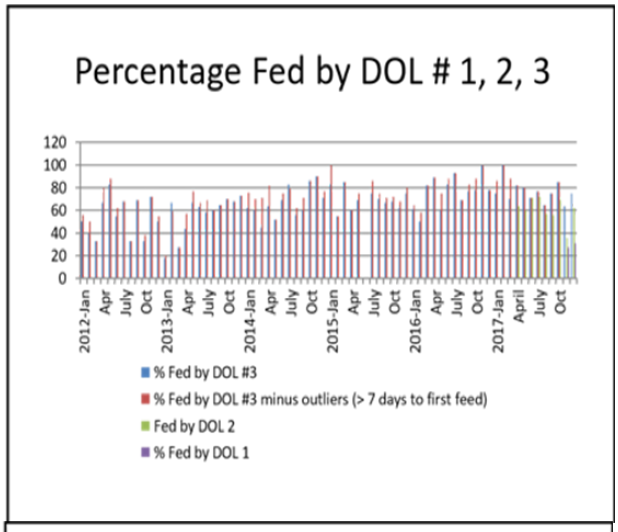
AGGREGATE DATA COLLECTION FORM

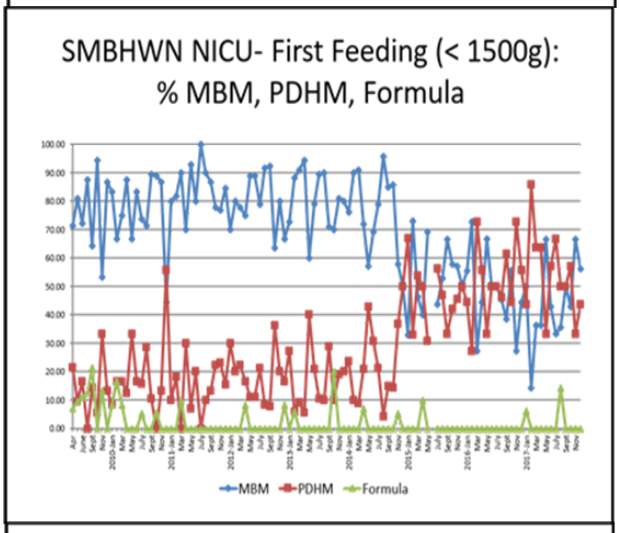
Name	MRN	DOB	Admit date	Birth GA	Admit PMA	Sex	Diagno-sis	Birth Wt	Birth Length	Birth FOC	Date BW regained	%ile Wt at Birth	%tile Length at Birth	% FOC at Birth	DOL BW regained	% wt loss prior to regain	Date of D/C	D/C Weight	D/C Length	D/C FOC

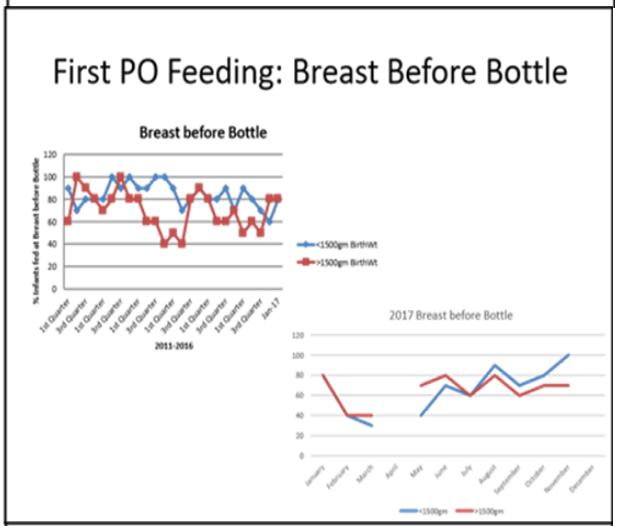
TOOL #5

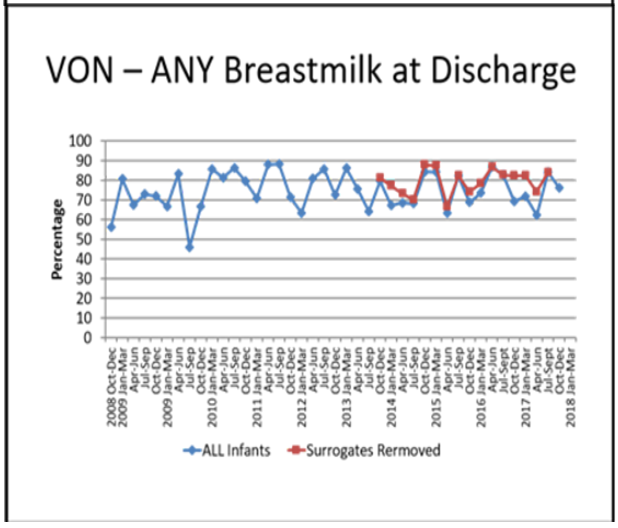
EXAMPLE CQI Data Charts

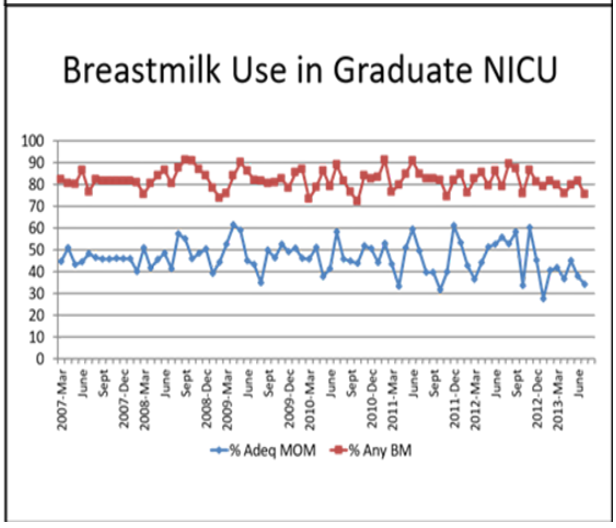












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