

Anna Dusick, MD
Neurodevelopmental Pediatrician
October 28, 2011

When do infants begin to feed?

- It is not how “old” you are from birth, but how mature you are from conception.

Gewolb, IH *Dev Med Child Neur* 2001

When do infants begin to feed?

- To answer this question, we can evaluate the components of feeding.
- It is helpful to define the age in terms of Postmenstrual Age (PMA).
- Postmenstrual Age correlates better with feeding than postnatal age.

Early Oromotor Reflexes

- Gag Reflex
- Transverse Tongue Reflex
- Rooting Reflex
- Biting

Early Oromotor Reflexes

- Gag Reflex – stimulus to the posterior tongue results in a swallow at 18 weeks PMA.
- Transverse Tongue Reflex – light touch to the lateral aspect of the tongue results in ipsilateral tongue deviation, anterior-posterior tongue movements and mouth closing beginning at 28 weeks.

Early Oromotor Reflexes

- Rooting Reflex – perioral light touch results in head orientation to the stimulus, mouth opening, lip arching, tongue protrusion and grooving, and labial grasping (“the latch”).
- Beginning at 28 weeks the rooting reflex matures by 38 weeks.

Shephard JJ *Child Dev* 1984

Early Oromotor Reflexes

- Bite Reflex – First described in 1959. Stimulus of light touch to the biting surface of molar, mandibular gingiva will elicit a bite down. (Mysak '59)
- Opinions vary as to whether the reflexes play a role in developing voluntary behaviors, or whether they must wane before voluntary behaviors can occur.

Shephard JJ *Child Dev* 1984

Components of Feeding in the Infant

- Non-nutritive sucking
- Nutritive sucking
- Swallow
- Breathe

Three phases of Swallowing

- Oral preparatory phase
- Pharyngeal phase
- Esophageal phase

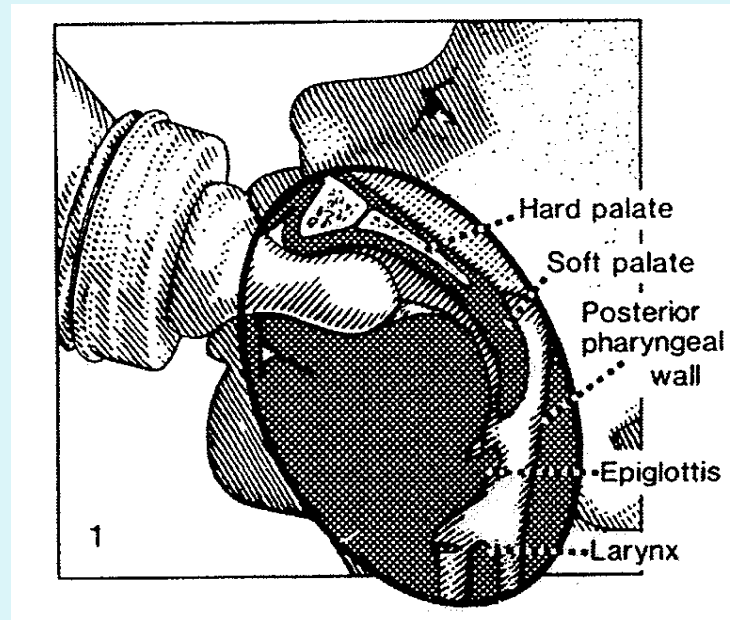
Oral preparatory phase

- Includes suck in the infant
- Intraoral cylinder
- Food is propelled to the posterior of the tongue
- Swallow is activated by reflex response to pressure, touch, fluid
- The gag is diminished

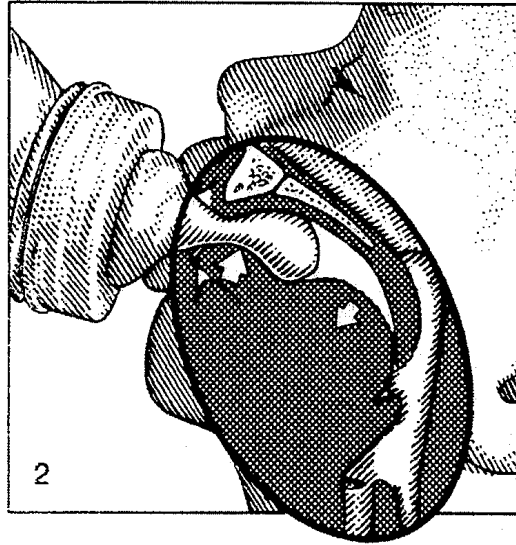


Oral preparatory phase

- A single bolus of food is taken into the mouth,
- or food is formed into a single bolus by the muscles of the tongue and cheek
- It is positioned in the center of the tongue
- Then, propelled to the posterior tongue
- In the infant lip closure and the fat pads of the cheeks keep the liquid in the mouth until the buccinator muscle is developed
- The gag is diminished



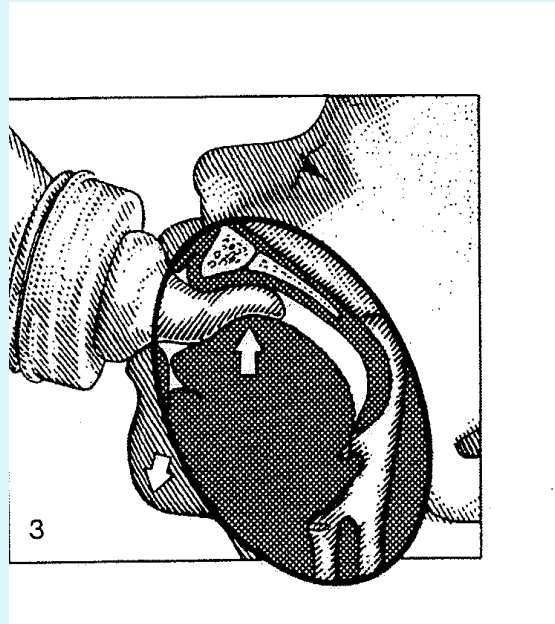
1. Resting position. Teat is held firmly within mouth, with tongue beneath teat. Soft palate is relaxed and nasopharynx is in continuity with trachea. Laterally, tongue and buccal mucosa form seal around teat to roof of mouth.



2. This view is approximately 0.25 sec later than 1 (similar interval separates subsequent views). Lower jaw is elevated, compressing base of teat, while front of tongue moves upward, initiating expression of milk from teat: back of tongue is depressed, leaving space for milk to collect.

Pharyngeal Phase

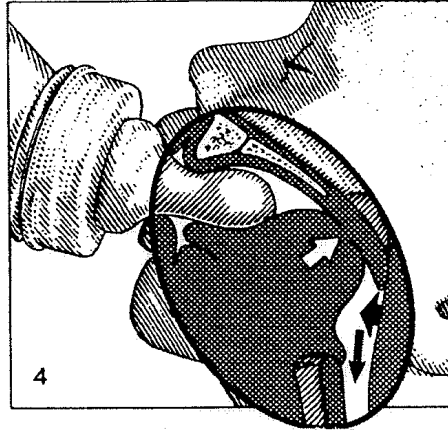
- During the Pharyngeal Phase multiple functions occur resulting in the reflexive swallow
- Velar, soft palate elevates and closes the velopharyngeal port
- The airway closes by bringing together the true vocal folds, the false vocal folds and the aryepiglottic folds
- The Epiglottis closes over the airway
- Respiration ceases
- Reflexive swallow



3. Wave of upward movement of tongue progresses backward, further expressing milk from teat into mouth. This is facilitated by negative pressure generated by downward movement of back of tongue and of lower jaw.

Esophageal Phase

- Upper esophageal sphincter opens as the
- Cricopharyngeous muscle relaxes
- The larynx moves upward and forward
- Opening the anterior wall of the sphincter
- Moving the cricoid cartilage away from the pharynx.
- Food passes down the esophagus via peristalsis



4. The Swallow. As Wave of tongue contraction sweeps off back of teat, it impinges on soft palate, thus sealing milk within oropharynx. Swallowing is triggered, levator muscles of palate contract and nasal cavity is sealed off from milk, provided by contraction of muscles of posterior pharyngeal wall. Upward movement of laryngohyoid complex, approximation of arytenoids and movement of epiglottis effectively closes off airway. Only at this point in feeding cycle is interrupted. Milk is then propelled into upper esophagus, whence it is expelled into stomach by peristalsis.



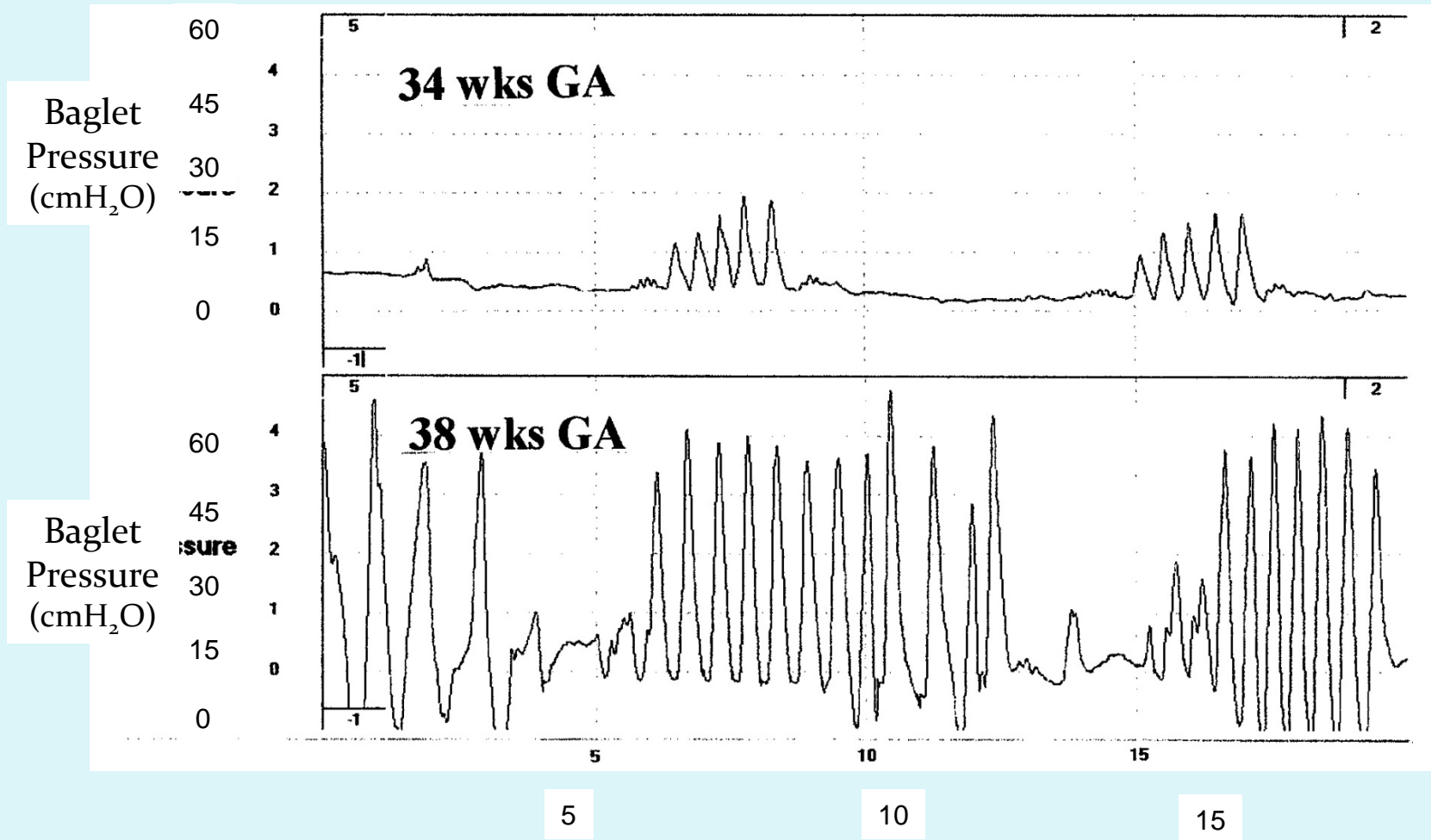
Non-Nutritive Sucking

- Earliest pattern of sucking
- No ingestion of milk
- 2 sucks/second
- No timing of swallow and breathe
- Matures with age to 'mature' at 37-38 wks PCA or DOL 3

Non-nutritive Sucking

- Is seen in a burst-pause pattern.
- The bursts lengthen with age.
- The pauses are less variable with age.
- Strength of the suck matures with age.

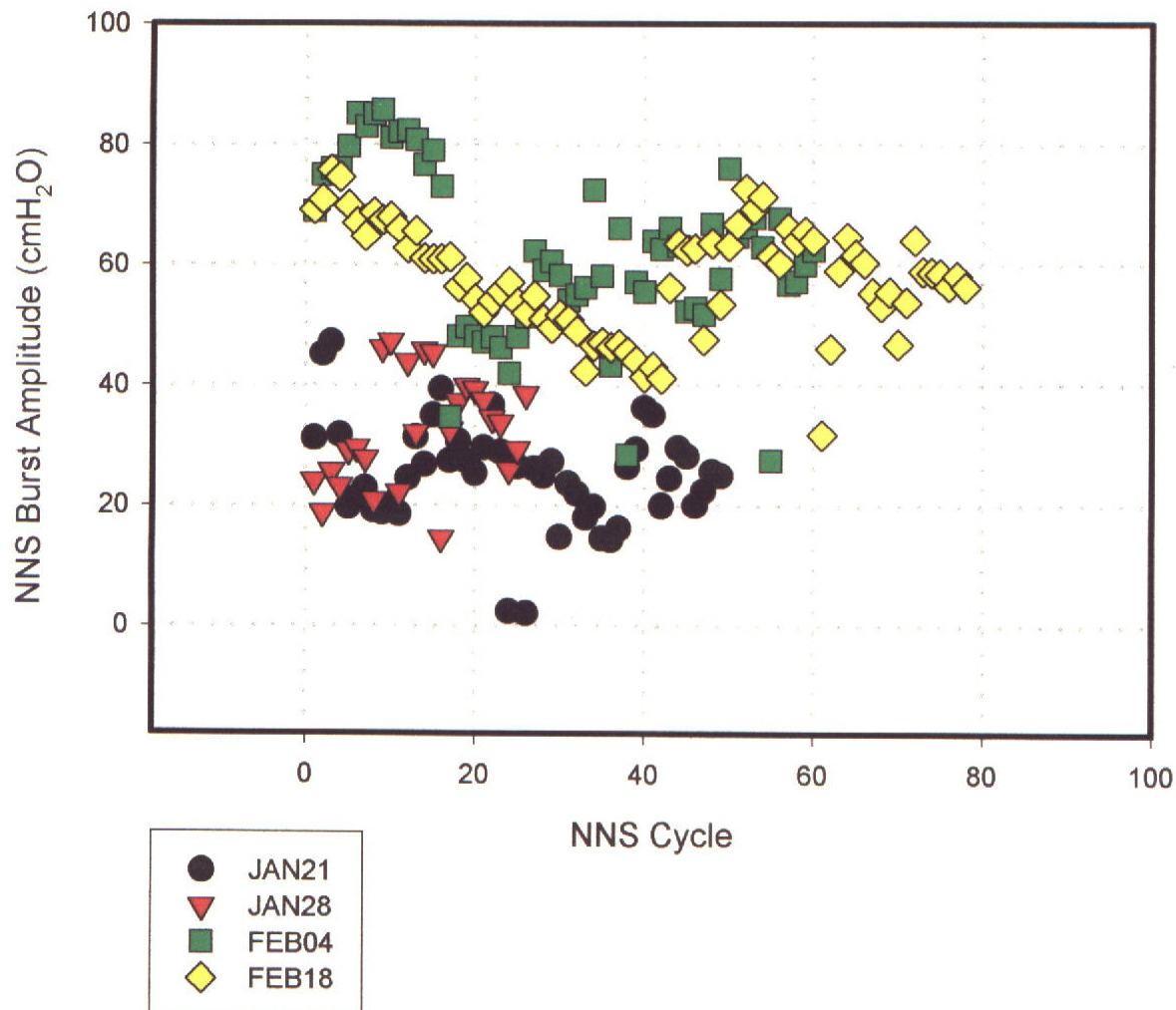
NNS 34 & 38 wks



TIME (seconds)

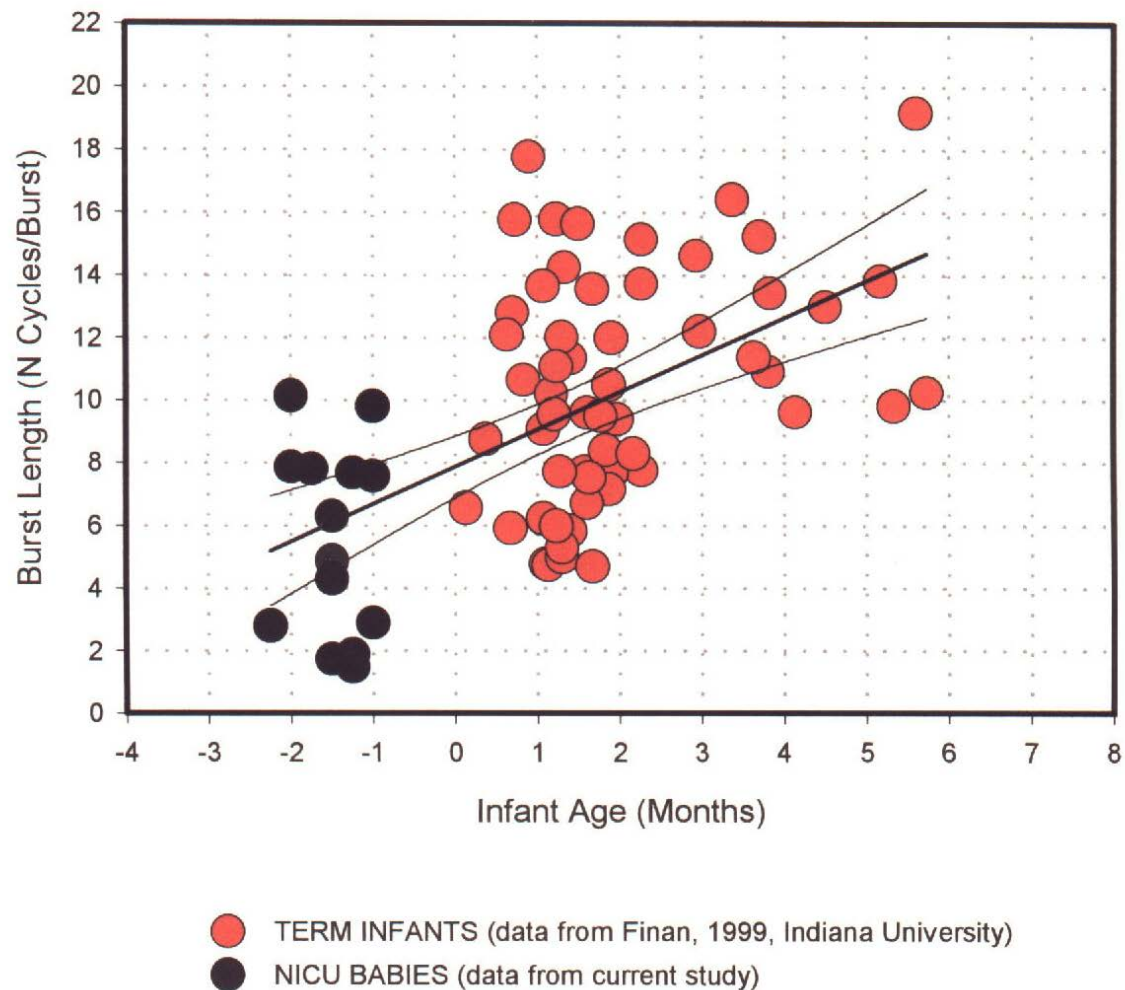
Dusick, 1999

Non-nutritive Suck Amplitude in One Patient 34-38 Weeks



Dusick, 1999

NNS Burst Length Ontogenesis



Barlow, Finan, Dusick 1999

Nutritive Sucking

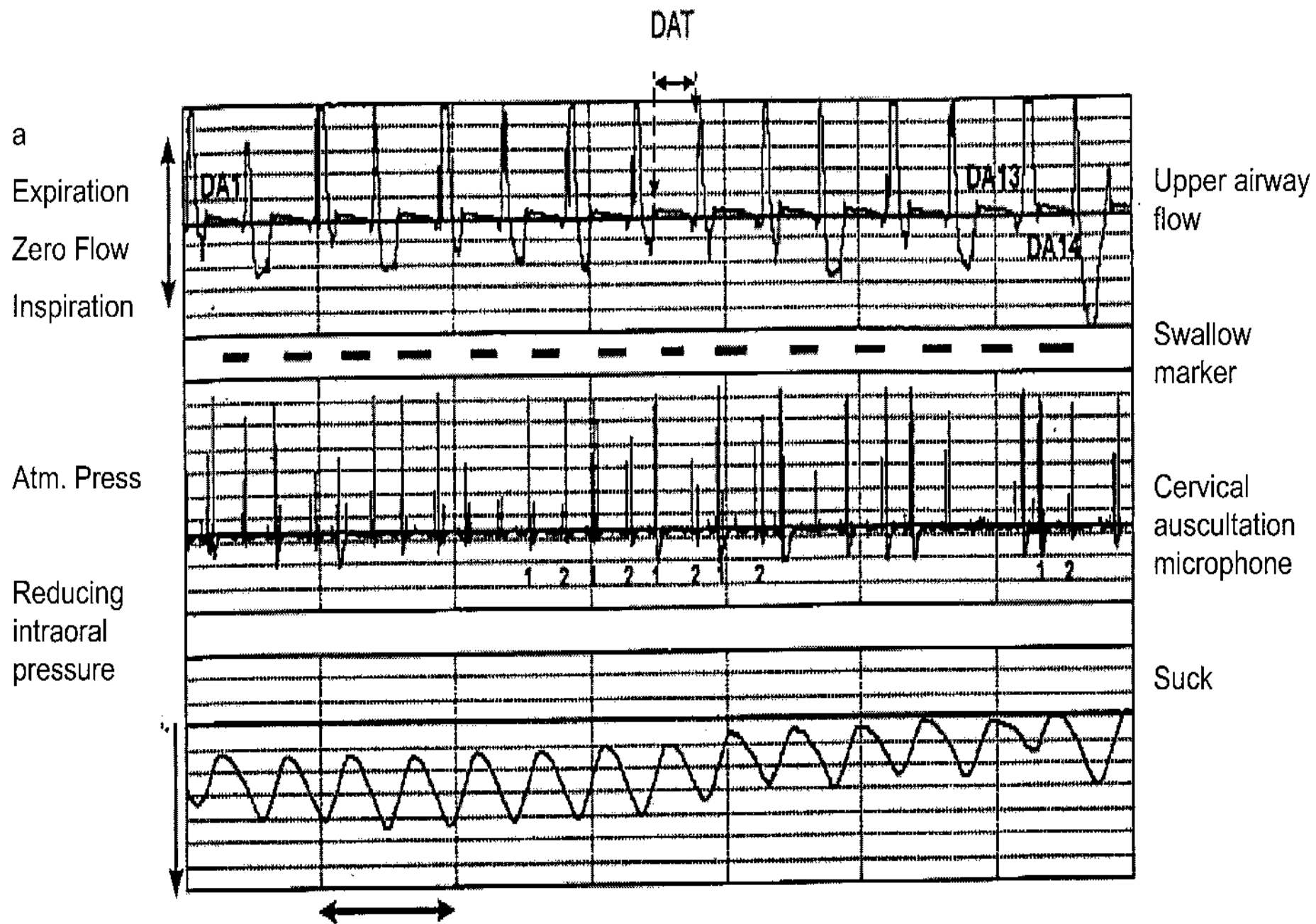
- Half the rate of non-nutritive sucking.
- Typically infants nutritively suck in a burst-pause pattern.
- The “burst” is number and strength of the suck before a rest or “pause”.
- Breathing is timed in the sequence.
- Mature nutritive sucking is 8-10 sucks/burst.

Expression

- Average expression – 0.2ml/suck.
- *Efficiency of expression increases with age.*
- Increased flow rate will decrease ventilation.

Swallowing and Breathing

- Ventilation ceases during swallow termed: deglutition apnea.
- Suck-swallow-breath cycle is typically 1/second at earlier PMA and increases to 2/second near maturity.
- Single swallow deglutition apnea is 350-700 ms.
- Following the swallow, the airway opens from upper to lower pharynx.



Swallowing and Breathing

- Preterm infants have greater deglutition apnea than term infants.
- This matures at term age equivalent.
- Percent time of multiple swallow apnea decreases with maturation.

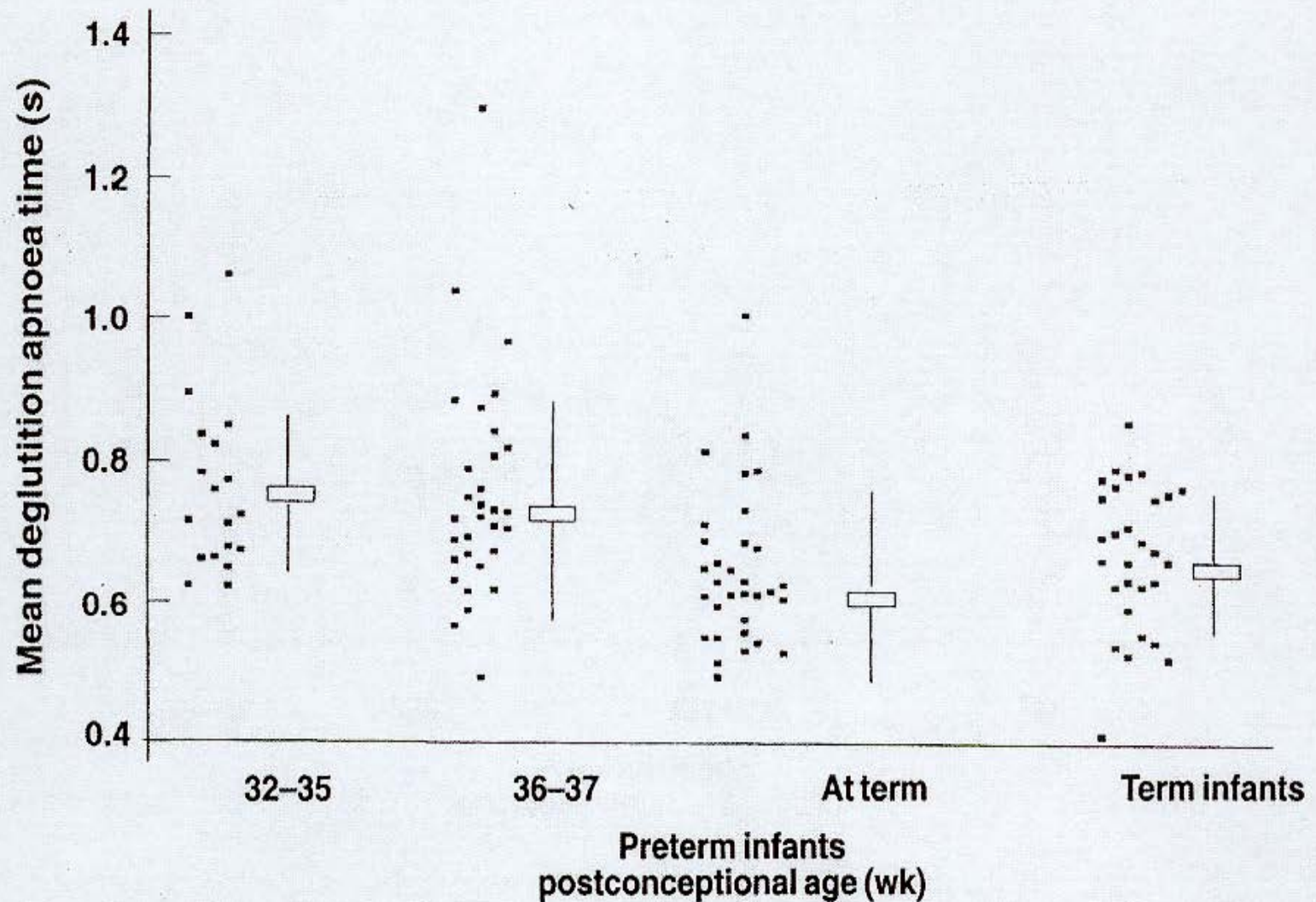


Figure 3: Mean duration in seconds of single-swallow deglutition apnoea for preterm infants at different postconceptional ages and the term comparison group. Averaged data from three to five runs of 10 deglutition apnoeas during periods of rhythmic feeding pattern. Data reaveraged where an infant was tested more than once in a single postconceptional age period. Mean \pm 1SD bars shown for groups.

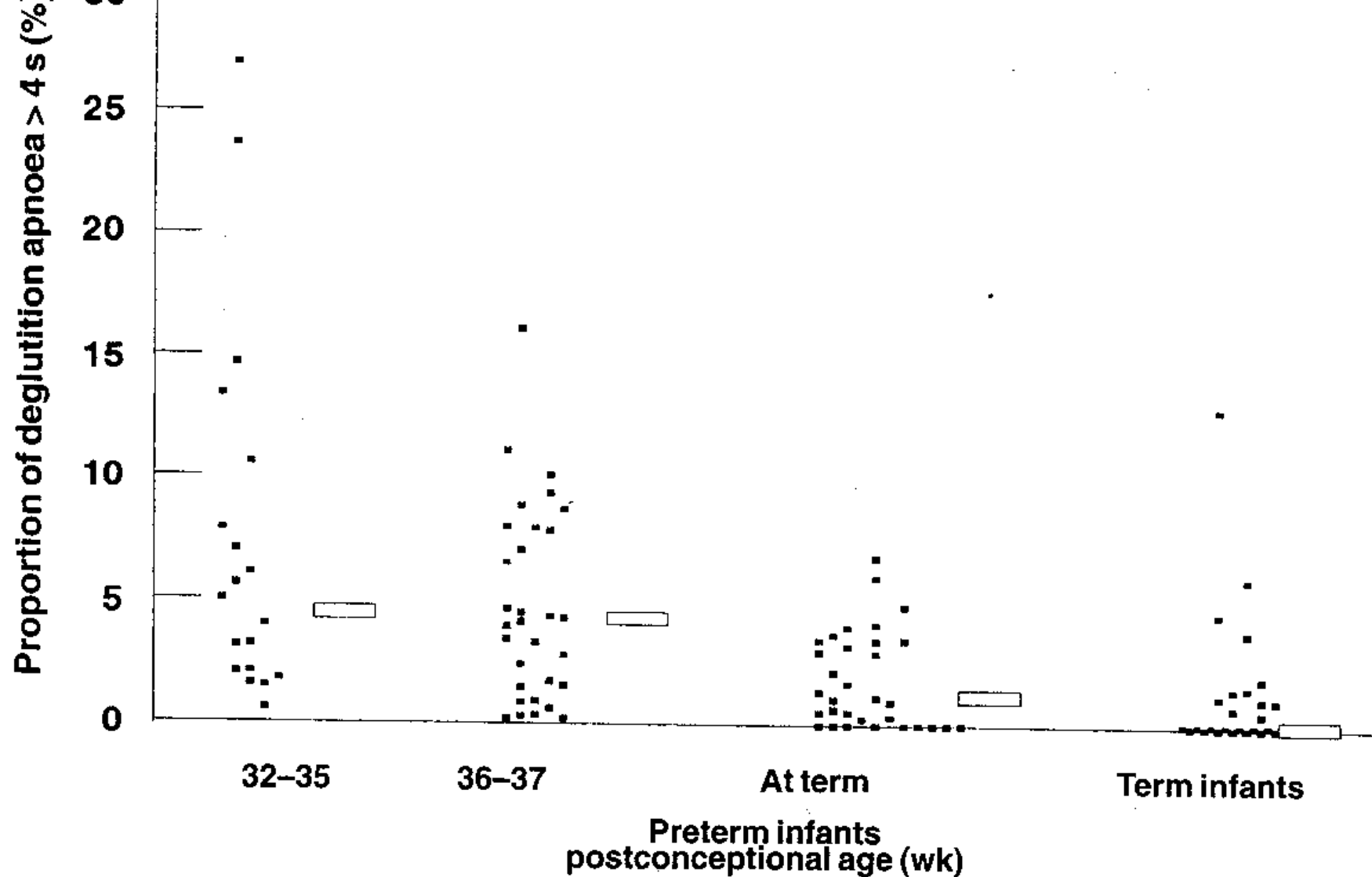


Fig. 6. Percentage of deglutition apnoeas that were longer than 4 seconds. Averaged for multiple tests as in Fig. 3. Medians shown for each group.

Assessment of Feeding

- Feeding skills can be assessed as immature/mature or normal/abnormal.
- The Neonatal Oromotor Assessment Scale will evaluate the feeding as Disorganized or Dysfunctional.
- If you are comfortable with skills/PMA one can use the terms Normal and Dysphagia.
- Dysphagia generally refers to a neurological cause for poor feeding.

Feeding Readiness

- Maturation
- Respiratory status
- Neurologic status
- Engagement cues
- Disengagement cues.
- Disorganized
- Dysfunctional
- Vital signs/O₂ sats



4 week old at breast



Slow motion



Feeding assessment

- Physical Examination: tone, head control, work of breathing, anatomy, mouth reflexes, GI
- Observation of Feeding:
 - Head position; jaw, tongue, movements
 - Rate, rhythm, efficiency of feeding
 - Symptoms of dysphagia

- Feed with the NG in place so that the remainder of the feedings can be given immediately and without further handling.
- Observe continuously for loss of posture, tone, state and motor control which will precede loss of autonomic stability.
- Observe the infant in the 30-40 minutes after the feeding as this is when feeding intolerance and autonomic instability is often seen.
- Record response to feedings as well as estimated time of nutritive suck.

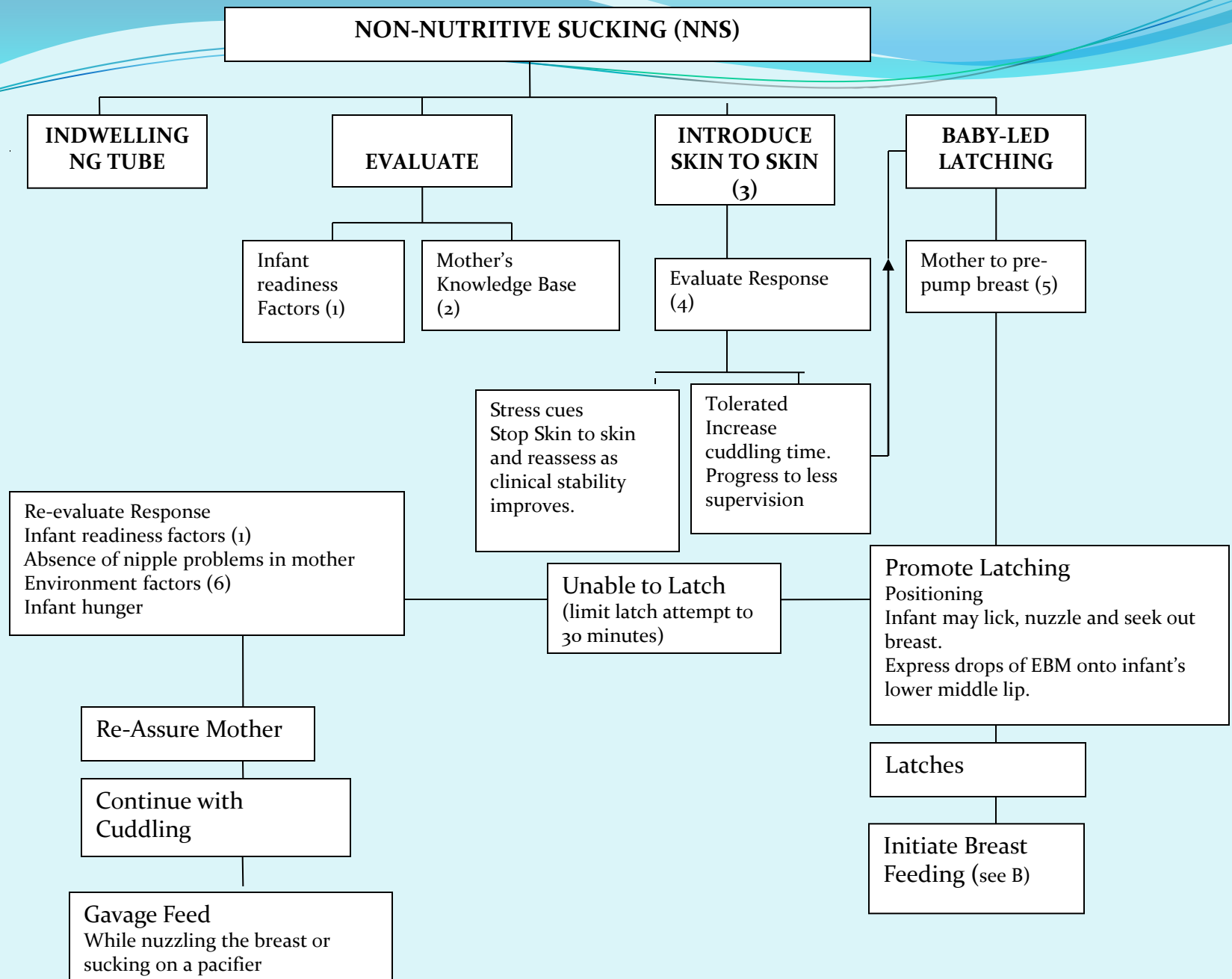


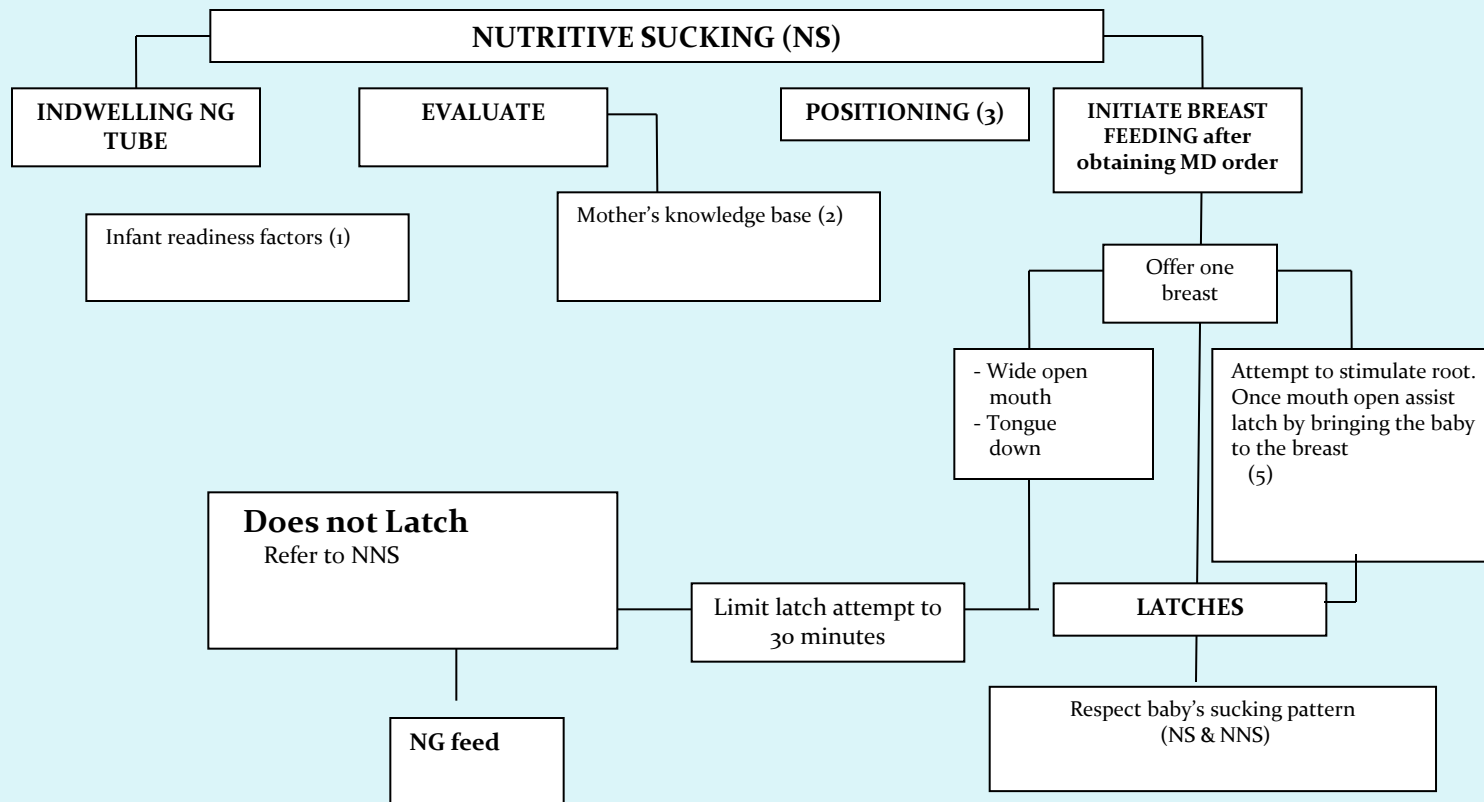


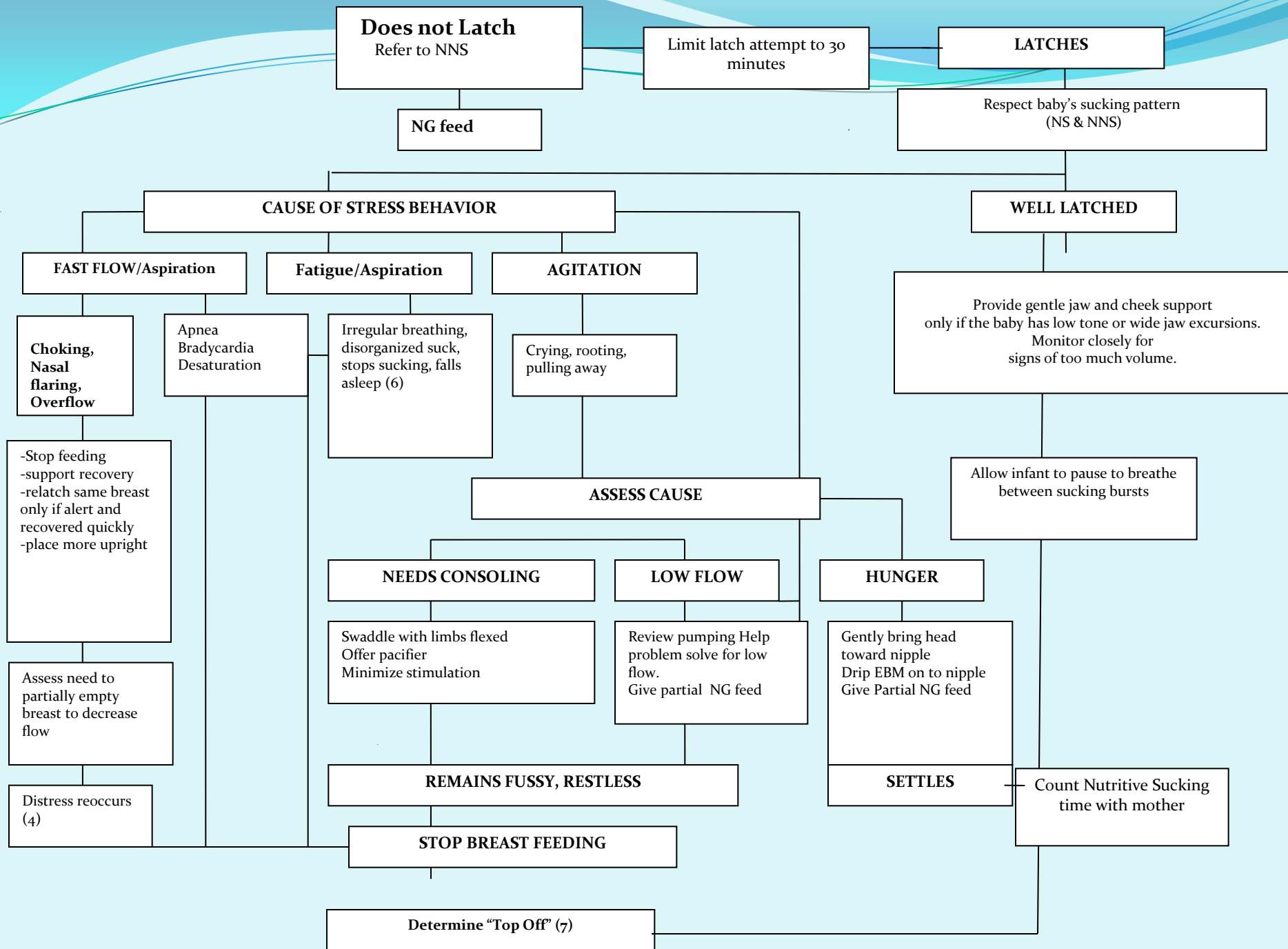
Determine “Top Off” (7)

- Nutritive suck <5 minutes: give total feed
- Nutritive suck 5 to 10 minutes: give $\frac{3}{4}$ feed
- Nutritive suck 10-15 minutes: give $\frac{1}{2}$ feed
- Nutritive suck 15-20 minutes: do not supplement











Chronologic age

Minus

Weeks preterm

20 wks – 14 wks = 6 wks

Rate of Wt Gain

- Current wt (2.85 kg) – discharge wt (2.40 kg)
= .450 kg
- Wt gain of .450 divided by days in interim since discharge (45 days) = 10 grams a day average daily gain

Anticipated Rate of wt gain 0-3 months

15-40 grams/day
(~5th to 95th percentile, Guo et 1991)

Calculate current caloric intake

- 50 ml (maximum) x 6 feeds/day= 300 ml
- 300 ml divided by 30 ml/oz= 10 ounces
- 10 ounces x 22 kcal/oz= 220 kcal
- 220 kcal divided by current weight (2.45 kg)= 90 kcals/kg

Calculate current fluid intake

- Free water intake is a minimum of 100 ml/ kg for babies up to 10 kg
- $2.45 \text{ kilos} \times 100 \text{ ml} = 245 \text{ ml}$
- Sara's intake totals 300 ml/day

Recommended Caloric intake

Infants 0-3 months


- Term infants who are healthy require
~ 100 kcal/kg/day for growth
(Fomon, p. 106, 1993; 2 – 3 months old)
- Preterm infants may require
~120 kcal/kg/day to support growth

Factors that are contributing to Sara's poor growth

- Respiratory concerns/chronic lung disease
- Poor oral motor skills
- Choice of diet

Caloric Intake Goal

- $120 \text{ kcal/kg} \times 2.45 \text{ kg} = 294 \text{ kcals}$ needed in a 24 hr period
- 294 kcal divided by 22 kcal/oz = 13.4 oz a day: intake goal unlikely secondary to Sara's poor respiratory reserves
- 294 kcal divided by 24 kcal/oz = 12.25 oz: may be a more reasonable goal and 24 kcal/oz formula is usually well tolerated

- 
- Increase the frequency of feeding to every three hours
 - Instruct Sara's mom to limit the sucking bursts to 3-5 sucks per burst
 - Avoid high flow rate nipples

Sara's feeding plan

- 12.25 oz a day times 30 ml/oz = 368 ml/day
- 368 ml divided by 8 feedings/day = about 50 ml a feeding!
- Increasing the caloric density and increasing the frequency of feeding should solve the problem
- Minimizing the respiratory demands during feeding also may assist in improving her rate of growth

Outcome measures

- Reweigh Sara in 7 days to evaluate plan
- Have mom keep a feeding diary during that time period
- If no improvement, consider oral-motor assessment by specialist and/or medical re-evaluation

Case 2 Lauren

- BW 775g
- GA 27 wks
- HELLP
- Apgars 1,3,6
- RDS Vent 20 days
- O₂ at 36 wks
- Apnea/Bradycardia

Term AA

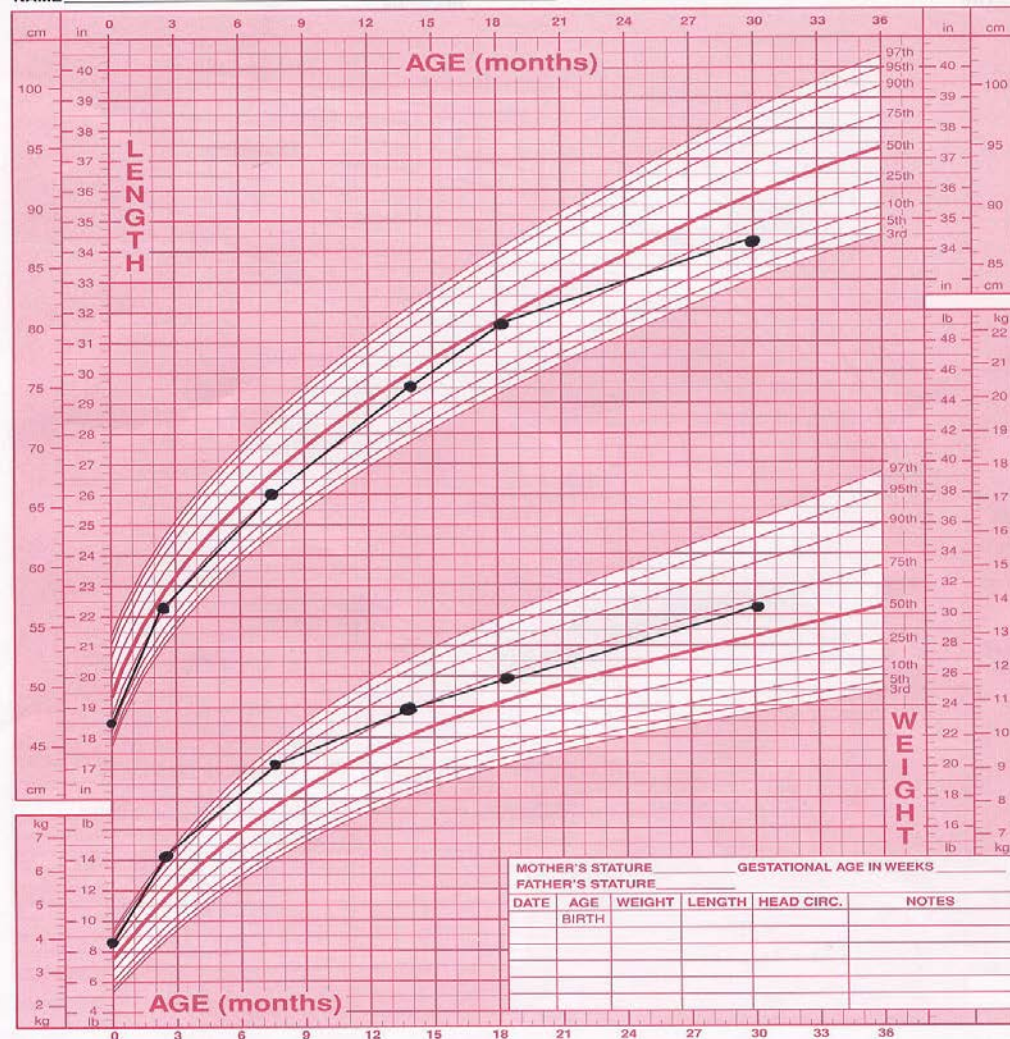
- CLD 1/2L O₂
- Improved oral feeds
- Mild Hypertonicity

GIRLS: BIRTH TO 36 MONTHS
Weight for Age and Length for Age

NAME _____

RECORD# _____

A



MOTHER'S STATURE _____ GESTATIONAL AGE IN WEEKS _____

FATHER'S STATURE _____

DATE	AGE	WEIGHT	LENGTH	HEAD CIRC.	NOTES
BIRTH					

RECORD#

A

Adjusted Age

- Needed for approximately 2 years.
- More so in growth than in development
- If overcorrected, may lead you to dismiss a true problem as “because of prematurity”

Average Gain/Day by Gender (50%ile, NCHS Growth Charts in g/day)

<u>Age</u>	<u>Male</u>	<u>Female</u>
1-3 mo.	31	24
3-6 mo.	20	20
6-9 mo.	25	15
9-12 mo.	12	11
12-15 mo.	8	8
15-36 mo.	6	6

Strategies to Improve Growth

- Specify number and quantity of feeding
- Increase calories in the formula
- Stop intake of water, juice, etc.
- Alter feeding techniques
- Provide formula before spoon feeding
- Increase calories in baby foods
- Supplement intake with tube feedings