BREASTFEEDING: A Neurobehavioral Approach

Dr Nils Bergman
"M.D., D.C.H., M.P.H., Ph.D."
Cape Town, South Africa

www.kangaroomothercare.com

Presentation objectives
Birth Skin-to-Skin Contact
Ongoing SSC
Breastfeeding behaviour
Breastfeeding wiring
BREASTFEEDING
Sensory stimulation
State organization
Sleep cycling
Feeding frequency
Brain nutrition
BRAIN WIRING

Animal literature does not talk about mammalian lactation, it talks about mammalian birth.
Ruин the birth – and there is no lactation
With a good birth, lactation follows
Diane Weissinger

R Shore

Critical period concept:
"Windows of opportunity in early life when a child's brain is exquisitely primed to receive sensory input in order to develop more advanced neural systems."

BREASTFEEDING IS A BEHAVIOUR OF THE NEWBORN
Not the mother!!
The newborn may appear helpless, but skin-to-skin contact stimulates prolactin ensuring nutrition, stimulates oxytocin ensuring protection, stimulates cholecystokinin ensuring wellbeing bonding.

FOLLOW-UP STUDY

RCT of skin-to-skin contact from birth versus conventional incubator care for physiological stabilisation in 1200- and 2199-gram newborns.


Bergman et al 2004

The first hours after birth are a CRITICAL PERIOD mutual psycho-neuro-physiological care of caregivers

Centrally released oxytocin coordinates the onset of maternal nurturing behavior at parturition and plays a role in mother-infant bonding.

Ross 2009

Presentation objectives

Birth Skin-to-Skin Contact
Ongoing SSC Breastfeeding behaviour
Breastfeeding wiring

BREASTFEEDING

Sensory stimulation
State organization
Sleep cycling
Feeding Frequency
Brain nutrition

BRAIN WIRING

SENSATIONS THAT WIRE BRAIN

SEES Mum’s eyes
SMELLS Mum’s milk
TASTES Mum’s milk
Hand TOUCH Mum’s skin
Skin-to-skin CONTACT

Ear HEARS Mum’s voice
MOVES with Mum’s
Back FEELS Mum’s arm holding
WARMED on Mum’s front
... the activity occurring during neonatal REM sleep (or active sleep) seems to be particularly important to the developing organism (Marks et al., 1995).

The ability to appropriately control the level of sleep and arousal.

KMC babies oscillate slowly in safe zones

Separated babies oscillate erratically to danger zones
Compared to incubator babies, KMC babies have:

- less deep sleep (when apnoea occurs)
- more quiet sleep (when growth occurs)
- less active sleep (wastes calories)
- more alert periods (promotes bonding)
- much less crying (which is harmful)

Not so much duration, or density of any sleep stage, or number of sleep stage episodes, but, cycling between quiet sleep and active sleep is what is important.

Rest-activity cycle is 60-90 minutes long (Ludington 2006)

This is a healthy sleep pattern.

This is a very good cycling pattern.

(Thanks to Susan Ludington-Hoe)

So in every hour, you would like to see an EEG pattern that shows this:

1st hour

2nd hour

REM Sleep is supposed to be somewhat active, so HR increases and RR is irregular.

Sleep cycling - separation vs contact

In separation:
- Dissociated state
- No cycling, chaotic pattern
**SLEEP CYCLING** – Separation vs contact

In SSC:
- Normal cycling
- Non-chaotic pattern

48 hour baseline chaotic pattern of activity and quiet HR & RR

**PREMATURE BREASTFEEDING**

**SELF ATTACHMENT.**

The newborn should **NOT** be separated at birth, *specially if premature*!!

**Sequence human newborn breast-feeding**

Pre-requisite = habitat

- hand to mouth
- tongue moves
- mouth moves
- eye focuses nipple
- crawls to nipple
- latches to nipple
- suckles

(Widstrom et al 1994)

“The newborn may appear helpless, but displays an impressive and purposeful motor activity which, **without maternal assistance**, brings the baby to the nipple.”

(Michelson et al 1996)

**BREASTFEEDING THE PREMATURE**

The **ABILITY** to breastfeed is INNATE. The physical **CAPACITY** to breastfeed may however be **insufficient in prematures**.

Full term babies need no help
Premature babies will need help.

**KERSTIN HEDBERG-NYKVIST:**


**PIBBS**

Preterm Infant Breastfeeding Behaviour Scale

- rooting: 0 - 2
- areolar grasp: 0 - 3
- latch (and fixation) time: 0 - 3
- sucking: 0 - 4
- longest sucking burst: 1 - 6
- swallowing: 0 - 2
**Gut hormones.**

(Uvnas-Moberg 1989)

20 different hormones work in the gut - regulated by the vagal nerve.

Each has a specific function.

SOMATOSTATIN:

inhibits the good hormones, contributes to slow weight gain.

At high levels also inhibits release of growth hormone.

**SOMATOSTATIN:**

inhibits the good hormones, contributes to slow weight gain.

At high levels also inhibits release of growth hormone.

It takes 30 to 60 minutes to lower somatostatin and other stress hormones.

SLEEP

VITAL !!!

**PIBBS**

Preterm Infant Breastfeeding Behaviour Scale

- Nutritive sucking = >5ml swallowed
- Full breastfeeding = exclusive Brf

**EARLIEST OBSERVATION:**

(weeks PMA) 28 29 30 31 32 33 34 35 36

- rooting 90%
- grasp 50%
- latch 95%
- sucking 90%
- swallow 90%
- burst

Full breastfeeding 33w
DISSOCIATED INFANT WILL NOT SHOW FEEDING CUES

Premature babies will need help.

BERLITH PERSSON has provided that help ...

PERSSON’S WHEEL!

Step 1  SKIN-TO-SKIN

Continuous skin contact

The newborn must be in the right environment for the behaviours that it is capable of to be expressed. It requires protection from stress and provision of warmth.

KMC provides the “maternal nest”

Ideally this should be done on prematures AT BIRTH. However it can be done later, even with nasogastric tube providing expressed breast milk in the meantime.

Step 2 and 3  Olfactory

The first steps in sequence require smell of the nipple which may take longer in the premature, and then the smelling of milk.

Babies can identify smells and tastes from their time in the uterus in the mother’s milk!

Step 4  Taste

This is re-inforcing the smell.

Fullterm seems to skip this!

Step 5  Rooting

These are mouth movements the normal sequence described in the full-terms.

Here the premature requires help, with position and “sipping” = feeling milk in mouth.

Step 6  First suckling.

Key step, builds on steps 1 to 5.

Must be awake and alert.

Alert period is maximal at birth, and lasts 45 - 90 minutes.

If missed then, will require feeding, and several hours delay.
Step 6    First suckling.

Note difference suckling vs sucking!
“… myographically distinct”

For late premature lactation, allow suckling to develop in successive alert periods, while feeding by tube.

Breastfeeding & Suckling

From 16 or 20 weeks gestation, the fetus is swallowing.
From 26 or 28 weeks gestation the fetus can SUCKLE.
From 36 weeks gestation the fetus is able to SUCK.

SUCKING and SUCKLING sound same, but VERY different.

Step 7    Latching & swallowing

Premature is too physically weak to crawl to nipple, but if held to nipple will at this stage latch on.
Once latched, suckling follows.
Suckling squirts a controlled dose of milk to the back of throat, which is safely swallowed without any interference of breathing. This is INNATE.

Step 8    First breast milk meal

Steps 1 to 7 and on take place rapidly in the fullterm. They can occur in the first alert period after birth in a premature if allowed to, but may require a longer period of defined steps in successive alert periods. For late prem lactation, step 8 is the first time milk is swallowed enough to feed the baby.

Step 9    Frequent feeding

In utero, baby is feeding continuously.
Demand feeding is NOT SUITABLE for prematures.
Feeds should be at most 2 hours apart.

Step 10 Together continuously

The wheel is not round,
Turns slow at first,
but then picks up speed!
**Breastfeeding a Premature**

**Step 1**: SSC

**Step 2**: Allow time

**Step 3**: State organisation: alert awake

**Step 4**: Smile

**Step 5**: Taste

**Step 6**: Latch

**Step 7**: Suckle

---

Babies need to have had a good sleep first. They will only have a good sleep if given continuous skin-to-skin contact. Baby should be allowed to get to a state of awake and alert by itself. Allow time → ...

---

**Position baby for eye to eye contact, and close the nipple for smelling.**

"Feeding cues" are any movements that make up the global behaviour of breastfeeding.

In this ultrasound image, the fetus is Practising hand to mouth movements: training for breastfeeding behaviour!

---

**The Newborn**

Also has a larynx that meets the uvula, designed to separate the respiratory tract from the gastrointestinal tract, enabling the newborn to feed and breathe simultaneously.

---

**Emma's Cat**: "Zig-Zag Thomas"  
Ziggy ... is able to eat and purr (and breathe) at the same time!  
Larynx meets uvula, separate airway & foodway

---

Apes (and all mammals) have a high larynx separates airway from "foodway"

Human newborn also!!

---

Only at 18 months does larynx start migrating, and ability to make more sounds develop → speech

From "Origins Reconsidered"  
Richard Leakey
Meier 1988
BOTTLE AND BREASTFEEDING IN PREMATURE
Prematures babies weighing 1300g and 34/40 PCA, given alternating bottle and breastfeeds.

<table>
<thead>
<tr>
<th>Bottle</th>
<th>Breast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucking burst</td>
<td>Sucking continuous</td>
</tr>
<tr>
<td>Rest</td>
<td>Non-nutritive</td>
</tr>
<tr>
<td>Takes longer</td>
<td></td>
</tr>
</tbody>
</table>

Baseline pO2

Start feed | Ends feed | 10 min later
---|---|---

Suckling and swallowing uncoordinated, baby gets hypoxic, so bad the heart slows.

Bottle feeding requires SUCKING, which requires completely different muscles, and does NOT allow co-ordination between swallowing and breathing. Bottle feeding causes STRESS in prematures, and relative post-prandial hypoxaemia.

SUCKLING - in and of itself; apart from nutrition intake - has beneficial effects on both mother and baby.

SENSORY STIMULATION ....

Suckling induces simultaneous endocrine effects in the gut of both mother and child

there is a physiological symbiosis between them.

Breast feeding also has psychic effects; CCK is produced, which induces sedation and sleep.

Sucking a pacifier while fed by nasogastric tube:

feed enters stomach faster, stomach empties sooner, somatostatin levels lowered.
Presentation objectives

- Birth Skin-to-Skin Contact
- Ongoing SSC
- Breastfeeding behaviour
- Breastfeeding wiring
- BRASTFEEDING
- Sensory stimulation
- State organization
- Sleep cycling
- Feeding frequency
- Brain nutrition

BRAIN WIRING

TRAWL for IQ genes in 7000 children

Article Preview

‘Intelligence genes’ reveal their complexity

29 November 2007    Andy Coghlan       Magazine issue 2632

Something as subtle and complex as intelligence was never going to be pinned on just a handful of genes, as a huge trawl across the human genome seems to confirm. Although it did turn up hundreds of genes that make a contribution, their individual effects are so small that for the most part they are barely detectable. This does not mean, however, that intelligence is not inherited.

The research, led by Robert Plomin of the Institute of Psychiatry in London, identified six genes that were strongly associated with high or low intelligence, but even the most powerful of these accounted for just 0.4 per cent of the variation in intelligence between individuals. The six together accounted for about 1 per cent of the variation in intelligence.

Alternatively:

there is no gene for intelligence !!!

Published online on November 5, 2007, 10.1073/pnas.0704292104

PNAS | November 20, 2007 | vol. 104 | no. 47 | 18860-18865

TRIGLYCERIDE

Left: glycerol,
Right: palmitic acid,
oleic acid, alpha-linolenic acid

In phosphoglycerides, glycerol molecule some two fatty acids esterified

Phospholipids are a major component of all biological membranes,
Sphingomyelin particularly concentrated in BRAIN major part of MYELIN.

BUT: there is a gene for breastfeeding to improve intelligence !!!

Caspi 2007

TRIGLYCERIDE

MYELIN

FATTY ACIDS ARE SPECIES SPECIFIC

Dendrification and myelinisation peaks occur at 2 and 6 months
is maximal at one year ....

At one year: human milk has less protein, but MORE TRIGLYCERIDE !!!
Up to 6 months, milk is 7.4% fat, but after 12 months it is 10.7%.

Be sure the wet nurse has plenty of milk because if she lacks it she may give the baby milk of a goat or sheep or some other animal, because the child ... nourished on animal milk does not have perfect wits like one fed on woman’s milk and always looks stupid and vacant and not right in the head.

14th century Tuscan text

Caso-morphines sedate for “cache” care

**SCHEMA OF HUMAN MILK NITROGEN CONTENT** ...

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Protein</th>
<th>Nitrogen Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Taurine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glutamine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nucleotides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oligosaccharides</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Nutrition & Protection**

**HUMAN**

- 75% Protein
- Urea
- Taurine
- Glutamine
- Nucleotides
- Oligosaccharides
- Bioactive peptides
- Immunoglobulins
- Immunostimulants
- Immunosuppressives

**COW**

- 25% Non-Protein Nitrogen
- 8% Casein
- 8% Milk Fat
- 8% WHEY
- 67% Protein

**CASEINS ➔ BIOACTIVE PEPTIDES** unique and essential effects:

- Phosphopeptides: absorbing calcium and zinc
- Opioid peptides: regulating gastric and intestinal motility
- Milk mucins: against all pathogenic bacteria
- Glycoproteins: against specific bacteria
- Secretory IgA: against pathogenic bacteria
- Cell adhesion molecules: prevent necrotising enterocolitis
- Lactoferrin: growth factor, iron absorption, anti-inflammatory factor, immuno-modulating factor
**Nutrition & Protection**

**NON - PROTEIN NITROGEN**

In cows this is 2 - 4%.
In humans 20 - 25%

This is a critical component for the baby!!
Over 200 irreplaceable chemicals...

**Results:** The experimental intervention led to a large increase in exclusive breastfeeding at age 3 months (+3.3% for the experimental group vs 6.4% for the control group; P < .001) and a significantly higher prevalence of any breastfeeding at all ages up to and including 12 months. The experimental group had higher means on all of the Wechsler Abbreviated Scales of Intelligence measures, with cluster-adjusted mean differences (95% confidence intervals) of +2.7 (+0.8 to +1.4) for verbal IQ, +2.9 (-3.3 to +0.1) for performance IQ, and +5.9 (-1.0 to +12.8) for full-scale IQ. Teachers’ academic ratings were significantly higher in the experimental group for both reading and writing.

**POST - TEST ....**

**Georgetown University, Washington D.C.**
212 babies <1500g, prospectively followed:

Infection rate for formula fed 47.2%
Infection rate for human milk fed 29.3%

Conclusion:
* being human milk fed decreased the odds of infection by 57%.*
* being cow fed increased the odds of infection by 61%.*

**NON - PROTEIN NITROGEN**

Urea conditionally essential nutrient
Taurine aminoacid required neonatal brain, eyes, kidney
Glutamine for stress and sepsis
Nucleotides repair of injury, specially gut immunological processes improve cellular immunity
Oligosaccharides bacteria-specific interactions anti-inflammatory effects

**NATURE VS NURTURE**

**GENETIC ENVIRONMENT FACTORS**

**STIMULATION BEHAVIOUR EXPERIENCE**

**POST - TEST ....** Example of paradigm

Conclusion:
* being human milk fed decreased the odds of infection by 57%.*
* being cow fed increased the odds of infection by 61%.*

The first statement assumes that being cow fed is the normal.
Would you introduce a new feed which increases odds of infection?
This website is designed to provide information on milk banking and how to contact a milk bank to donate milk or to order donor human milk. This site is also a resource for health care providers and others who are looking for information on HMBANA's resources and services.

http://www.hmbana.org/

"Where it is not possible for the biological mother to breastfeed, the first alternative, if available, should be the use of human breast milk from other sources. Human milk banks should be made available in appropriate situations."

World Health Organization/United Nations Children's Fund

http://www.breastmilkproject.org/

Presentation objectives

- Birth Skin-to-Skin Contact
- Ongoing SSC
- Breastfeeding behaviour
- Breastfeeding wiring
- BRASTFEEDING
- Sensory stimulation
- State organization
- Sleep cycling
- Feeding frequency
- Brain nutrition
- BRAIN WIRING

"I have finally cum to the conclusion that a good reliable set ov bowels iz worth more to a man than enny quantity of brains."

Josh Billings

http://www.vivo.colostate.edu/hbooks/pathphys/digestion/stomach/anatomy.html

STOMACH VOLUME

In adult human:

- 50 ml when empty.
- 1000 ml after ordinary meal... but can
- 4000 ml of liquid

http://www.vivo.colostate.edu/hbooks/pathphys/digestion/stomach/anatomy.html
WHAT IS THE STOMACH VOLUME OF THE NEONATE ???

Generally accepted to be 75ml (60–80 ml) (e.g. Zangen et al 2001)

Popularly described as the size of ping-pong ball

Recently:
a ping-pong ball established to be 22.27 ml
an extra large chicken egg is 60-80ml

STOMACH VOLUME

FEEDING INTERVAL

1 = FEEDING FREQUENCY

Assumption: 3kg baby requiring 160 ml/kg/day daily requirement = 480ml

Standard CARE: 3-hourly schedule

Breastfeeding and mother’s own expressed milk: There is strong and consistent evidence that feeding mother’s own milk to pre-term infants of any gestation is associated with a lower incidence of infections and necrotising enterocolitis, and improved neurodevelopmental outcome as compared with formula feeding. Feeding unsupplemented mother’s own milk to pre-term infants <1500 g resulted in slower weight and length gains, but the implications of this slower growth are unclear and there is not enough evidence to assess if it increased the risk of malnutrition. Long-term beneficial effects of breastfeeding on blood pressure, serum lipid profile or pro-inflammatory levels have also been reported for pre-term infants. There are limited data on most outcomes in term LBW infants; the available data suggest that improved infection and neurodevelopmental outcomes associated with feeding mother’s milk in pre-term infants are also seen in this group.

Breastfeeding and mother's milk: Strong and consistent evidence
Cup feeding versus bottle feeding: Cup feeding higher breastfeeding greater stability

Only case series ... Insufficient evidence
No mention of stomach capacity

EVIDENCE FOR STOMACH CAPACITY ????

Naveed et al
Fetal stomach appears 4 weeks GA. By 11 weeks, wall capable of muscular contraction.

Hassan BB et al Patterns of antropyloric motility in fed healthy preterm infants
Arch Dis Child Fetal Neonatal Ed 2002 87(2):F95-9

... the neuroregulatory mechanisms responsible for the coordination of antropyloric motility and gastric emptying are well developed by 30 weeks of PMA.
Chymosin is an enzyme whose role is to curdle or coagulate milk in the stomach, a process of considerable importance in the very young animal.

If not coagulated, it would flow through stomach, missing the opportunity for initial digestion of its proteins.

Chymosin efficiently converts liquid milk to a semisolid like cottage cheese, allowing it to be retained for longer periods in the stomach. Chymosin secretion is maximal during the first few days after birth, and declines thereafter, replaced in effect by secretion of pepsin as the major gastric protease.

Chymosin makes the milk into "cheese" halfway between liquid and solid stomach empties in 60 minutes.

BRAIN CYCLING

Goldstein and Sase data:
Stomach capacity at term 10 - 15 ml

Formula for calculation of stomach capacity (Charles Bradshaw, UCT)
Assumptions: the stomach can be approximated by dividing into three sections, namely a ellipsoidal hemisphere, an ellipsoidal cylinder, and a skewed ellipsoidal cone.
Variables: a = anteroposterior radius, t = transverse radius, l = length stomach
Relations: the height of the cone and the hemisphere are both the same as ‘a’.

Ellipsoid = \( \frac{4}{3} \pi a^2 t \)

Cylinder = \( \pi a t (l - 2a) \)

Skewed cone = \( \frac{1}{3} \pi a t (l + a) \)

Total volume = \( \frac{4}{3} \pi a^2 t + \pi a t (l - 2a) + \frac{1}{3} \pi a t (l + a) \)

Goldstein and Sase data:
Stomach capacity at term 10 - 15 ml
Assumption: 2.5 kg baby 33wGA, requiring 160 ml/kg/day = 400 ml

45 MIN CYCLES
12 ML PER CYCLE = 384 ml

The CAPACITY of a low birthweight prem from 20ml / 3000g = 0.007 x BWt (g)
1kg x 0.007 = 7mls
2kg x 0.007 = 14mls

PROPOSAL: The CAPACITY of a week old baby's stomach is approx 20 ml.

Known references with data:
Scammon and Doyle 1920 quoted in Silverman 1961

Physiological capacity was determined by weighing before and after feeding
"infants were breastfed 5 times per day"
INFEERENCE?? If fed 5 x per day and daily requirement 160 ml x 3kg = 480 Required volume: 480 / 5 = 96 mls

American Journal of Diseases of Children 1920 Vol 20 p516-538

Reviewed other investigators post-mortem studies
Anatomic capacity was determined in post-mortem studies

30 - 35 ml at birth - almost regardless of birth weight
75 ml at two weeks

Note: postmortem allows for control at antrum and pylorus

Only recent study located: “Autopsy” capacity was determined in Indian post-mortem studies

Naveed et al
Indian J Gastroenterol 1992; 11(4):156-158

13 ml at birth = stillborns
16 ml “early neonatal death”
for plot: say 3 days = “mean ENND”

POSSIBLE INTERPRETATION

Reflects milk availability from breasts, NOT CAPACITY of stomach

TERMINOLOGY PROPOSALS

“Functional capacity”
= 10 – 15 ml at birth
stretches slowly to
= 20 ml at day 3 or 4

“Functional capacity” equivalent to “expectation volume”, for which optimal pepsin / acid is made does not cause distention allows adequate time for curdle allows protein breakdown allows controlled pyloric passage

TERMINOLOGY PROPOSALS

FUNCTIONAL CAPACITY
PHYSIOLOGICAL CAPACITY
RECEPTIVE CAPACITY of stomach
INGESTIVE CAPACITY of BABY
**TERMINOLOGY PROPOSALS**

**Physiological capacity**
Maximal amount stomach can handle without undue stress.

"Receptive capacity" of STOMACH
maximal amount stretched organ holds

"Ingestive capacity" of BABY
amount baby or infant swallowed,
(note, excess not in stomach)

---

**Imagine a study!!**

Let us measure the stomach capacity with a balloon ... at end of NGT
Test the pressure on adults
must not be uncomfortable

Once the pressure starts to rise:
→ there is risk for reflux
→ to be avoided - expected physiology

**THIS SHOULD BE THE STOMACH CAPACITY**

---

**Imagined study was done!!**

Zangen S et al 2001
Rapid maturation of gastric relaxation in newborns

Tested the pressure on adults →

---

**Imagined study was done!!**

Zangen S et al 2001
Rapid maturation of gastric relaxation in newborns

Tested the pressure on adults →

Used two weeks of pressures that had been proven to cause pain!
"stopped at 30mmHg or when baby grimaced"

---

In healthy neonates, the volume of feedings in the first days of life is 60–100 mL/kg per day or about 20–40 mL per feeding. After a few days, the healthy neonate ingests approximately 150 mL/kg per day, or about 75 mL per feeding. The
Pressures (mmHg)

Adult senses at 23
pain/discomfort 26

In study: Max
= 30 mmHg !!
(motivation:
200 mmHg when
vomiting ????)

17 healthy infants
"within the first week of life"
fed every 4 hours, swaddled,
breast or bottle fed (not factored in regression)
lax balloon in stomach

Number of feeds &
gastric compliance → positive correlation

PRESUME: each feed
approximately 75 mls

BUT ....... !!!

Hassan BB et al
Patterns of antropyloric motility in fed healthy
preterm infants
Arch Dis Child Fetal Neonatal Ed 2002 87(2):F95-9

... the neuroregulatory mechanisms
responsible for the coordination of
antropyloric motility and gastric
emptying are well developed by
30 weeks of postmenstrual age.

Paradigm: “in the philosophy of
science, a generally accepted model
of how ideas relate to one another,
forming a conceptual framework
within which scientific
research is carried out”

BASIC ASSUMPTION:
* INFANTS FEED 3 HOURLY

Paradigm Construct

Pressures (mmHg)
Balloon inflates to
15 ml no increase
functional capacity
Rapid maturation of gastric relaxation in newborns

Pressures (mmHg)

Balloon inflates to

15 ml no increase
20 ml pressure OK

*physiological capacity* ....

---

Pressures (mmHg)

Balloon inflates to

15 ml no increase
20 ml pressure OK
25 ml discomfort
30 ml "ethical" limit

---

Number of feeds & gastric compliance → positive correlation

*PRESUME: each feed approximately 75 mls*

*receptive capacity*

---

Number of feeds & gastric compliance → positive correlation

*PRESUME: each feed approximately 75 mls*

*ALTERNATIVELY: the more often you stretch the stomach, the bigger it soon becomes (76 mls)*

---

75 ml per feeding ... ?? ASSUMPTION

**IMMATURE ???? OR OVERWHELMED !!!**

---

Adults interpret the actions, words and expressions of children through the distorting filter of their own beliefs.

In many cases these misinterpretations can be destructive. The most dramatic example occurs when the impact of traumatic events on infants and young children is minimized.

Perry et al 1995
“It is an ultimate irony that at the time when the human is most vulnerable to the effects of trauma – during infancy and childhood – adults generally presume the most resilience.

Perry et al 1995

"Environment" can be
BENIGN
MALEVOLENT
UNSUITABLE

RESILIENCE IS REQUIRED
Gene expression
Altered phenotype
Shorter lifespan
Early & rapid reproduction

EEA Distance genome assesses actual from ideal
ADAPTABILITY
PHYSIOLOGICAL CAPACITY
RECEPTIVE CAPACITY of stomach
INGESTIVE CAPACITY of BABY
Burping a baby can reduce spitting up and relieve bloating caused by swallowed air. Here are some tried-and-true methods.

**WHERE IS THE MILK?**

What happens when my baby spits up?
Babies spit up when they’ve eaten too much or when they’re burped. It can also happen when your baby is drooling.

*Splitting up is not vomiting.* Babies usually don’t notice when they spit up, while vomiting is forceful and painful. Spitting up is a common occurrence for most babies.


Copyright © 1996-2007 American Academy of Family Physicians

Zangen S et al
Rapid maturation of gastric relaxation in newborns

A balloon in stomach can fill to 76 mls

What does the stomach – without a balloon – do to 76 mls?

**REFLUX !!!**

PRESUME: each feed approximately 75 mls
**WHAT IS THE DIFFERENCE BETWEEN “SPITTING UP” AND REFLUX ????”**

**HYPOGLYCAEMIA**

A babies stomach empties in **60 minutes**.

Blood sugar may fall ... after 90 minutes ...

Options?

**Blood sugar may fall ... after 90 minutes ...**

“There is a reason behind everything in nature” Aristotle

Would nature allow this?
Sucking a pacifier while fed by nasogastric tube:

- Feed enters stomach faster,
- Stomach empties sooner,
- Somatostatin levels lowered.

**BUT:** DO WE WANT THIS??
Are we hastening hypoglycemia?

---

**ALLOSTATIC LOAD**

- Ideal
- Benign
- Malevolent
- Unsuitable

**Weight gain 1st week:**

.predicts OBESITY
at 30 years

**Large volume feeds:**

- Stretched stomach=
- Doubled absorptive capacity as adult

**Importance:**

- Programming - early life chronic disease
The Fetal Matrix: Evolution, Development and Disease
Peter Gluckman, Mark Hanson

Genome and fetal programming
Predictive adaptive responses (PAR's)

Assume low resilience
(use functional capacity)
Assume proportionality

The \textbf{CAPACITY} of a low birthweight prem from 20ml / 3000g
= \( 0.007 \times \text{BWt} \) (g)
1kg \( \times 0.007 = 7\text{mls} \)
2kg \( \times 0.007 = 14\text{mls} \)
Standardised from 20ml capacity for 3kg baby ( x 0.007)

Baby weight; freq; req'd size → actual
2kg baby: 4hrly ~ 320 ml/6 ≈ 53ml → 14ml
1.5 baby: 3hrly ~ 240 ml/8 ≈ 30ml → 10ml
1.0 baby: 2hrly ~ 160 ml/12 ≈ 13ml → 7ml

Necrotizing enterocolitis?
Stomach has pH 2, 3 – 4 pylorus (pancreatic/ biliary)
Jejenum pH 8
UNPREPARED BOLUS?
  duodenitis ??
  colic ??

RCT feeding tolerance bolus feed vs continuous
(Dollberg et al 2000)
Continuous compared to 2-3 hrly
NEC 2 (17) vs 3 (19)
(no difference, common)

Cochrane review: “continuous vs intermittent bolus ...”
(Premji & Chessell 2003)
"every 2 or 3 hours" used in all studies
"No evidence of a difference in the incidence of NEC"

Feeding strategies and necrotizing enterocolitis
(Berseth 2005)
"Overall incidence of NEC unchanged"
"Several studies ... safe to use small feeding volumes early in life" (Berseth 2003)
But “full enteral feedings” presumed to be as per Edmond (2 - 3 hourly)
Necrotizing enterocolitis may be reduced by **ONE HOURLY FEEDS**

Peter Hartmann

has measured the volume of milk in a single let down reflex. Quit regardless of breast-size ... amazingly constant:

a let down of milk is 20 - 30 ml.

The volume of a single milk ejection reflex is **approx 20 ml**.

The volume of a week old baby's stomach is **maximum 20 ml**.

A normal sleep cycle for a premature is **60 minutes**

A baby's stomach empties in **60 minutes**.

One feed every 60 minutes = **24 feeds/ day**

24 feeds of 20 ml each = **480 ml**

480 ml per day for 3 kg baby = **160 ml/kg/d**

= requirement of baby.
**Proposed Management →**

**Unreasonable !!!**

All babies should be fed at least once an hour!!

---

**FREQUENT FEEDS !!!**

In anthropological studies, where infants are carried constantly, and have free access to the breast, they will breastfeed every hour.

Surmise – Cholecystokinin, oxytocin
- Behavioural synchrony.

---

The first Milk Ejection Reflex (MER) elicited in 2 minutes
works quickly
swallowed 1 minute
Feeding time 3 minutes
Repeat every 1 hour

---

The "normal" or usual and common breastfeed takes 15 minutes
discomfort after burping time 5 minutes
Feeding time 20 min
Repeat every 3 hours

---

The calculated daily requirement for a 3kg baby can be given without increase in pressure .... MINIMAL RISK

20 mls x 24 feeds = 480mls / day
PARENTS CAN DO SAFELY!

---

3 minute 20ml feeds x 24/d = 72 minutes
20 minute 60ml feeds x 8/d = 160 minutes

SMALL AND FREQUENT FEEDS ARE EFFICIENT !!!
FEWER NURSES NEEDED !!!
FEEDING VOLUME
Alexis 1700g
daily requirement
160ml x 1.7 = 272 ml
3 hrly feed = 34 ml
2 hrly feed = 22 ml
   = ping pong ball
1 hrly feed = 11 ml
   = stomach capacity

Presentation objectives
Birth Skin-to-Skin Contact
Ongoing SSC
Breastfeeding behaviour
   Breastfeeding wiring
   BREASTFEEDING
Sensory stimulation
   State organization
   Sleep cycling
   Feeding frequency
   Brain nutrition
   BRAIN WIRING

The brain is a
SENSORY ORGAN
BREAST - FEEDING
   =
BRAIN - WIRING
SOCIAL ORGAN

BIRTH
ON-GOING
S S C
STATE organization
   Feeding frequency
   SLEEP cycling

"the first three years are decisive"
PLAY
   (=Sensory acquisition)
should be EVERY HOUR
In the past, whether to breastfeed or not was a lifestyle choice.

Our new knowledge of the brain makes breastfeeding a public health issue.

(Gail Storr, Fredericton, NB)

Basic Biological Need

SLEEP

DEEP SLEEP (= Emotional connection) should be EVERY HOUR

Co-sleeping? SAFE SLEEP !!

Gentle self-waking (= REM memory formation) should be EVERY HOUR

Sensory “hothouse”

PLAY → FEED  PLAY → FEED

SLEEP → SLEEP

PLAY → FEED  PLAY → FEED

SLEEP → SLEEP

STATE organization  
Feeding frequency  
SLEEP cycling

SENSORY stimulation  
BRAIN nutrition
BIRTH

SSC

ON-GOING

SSC

STATE organization

Feeding frequency

SLEEP cycling

Breastfeeding behaviour

Breastfeeding WIRING

BREASTFEEDING

SENSORY stimulation

BRAIN nutrition

BRAIN

WIRING

SUMMARY !!

SKIN-TO-SKIN

(Regulation)

SLEEP

(Brain)

FEEDING

(Stomach)

LOVE!

("mind")

MOTHER

is the

Only

Appropriate

ENVIRONMENT

KEEP

US

TOGETHER

MOTHER'S

MILK is

the only

SKIN-TO-SKIN!

Appropriate

FOOD