Stability Due to KMC

Susan M. Ludington, RN, CNM, Ph.D., FAAN
Walters Professor of Pediatric Nursing CWRU, Cleveland, OH
Susan.ludington@case.edu; info@kangaroocareusa.org

Definitions of Stability

- Statistical 1: within 2 standard deviations of the mean
- Statistical 2: range (variance) is little around the mean

- Clinical: Remains within clinically acceptable range

- Research: Score on Scrip Scale (Bergman NJ et al., 2004 Randomized controlled trial of skin-to-skin contact from birth versus conventional incubator for physiological stabilization in 1200- to 2199-gram newborns. *Acta Paediatrica 93*(6), 779-785. (Fischer CB et al., 1998. Cardiorespiratory stability of premature boys and girls during Kangaroo Care. *Early Human Development, 52*(2), 145-153)

- Other: No different than what is clinically acceptable as "common, normal" -no change from baseline/pretest

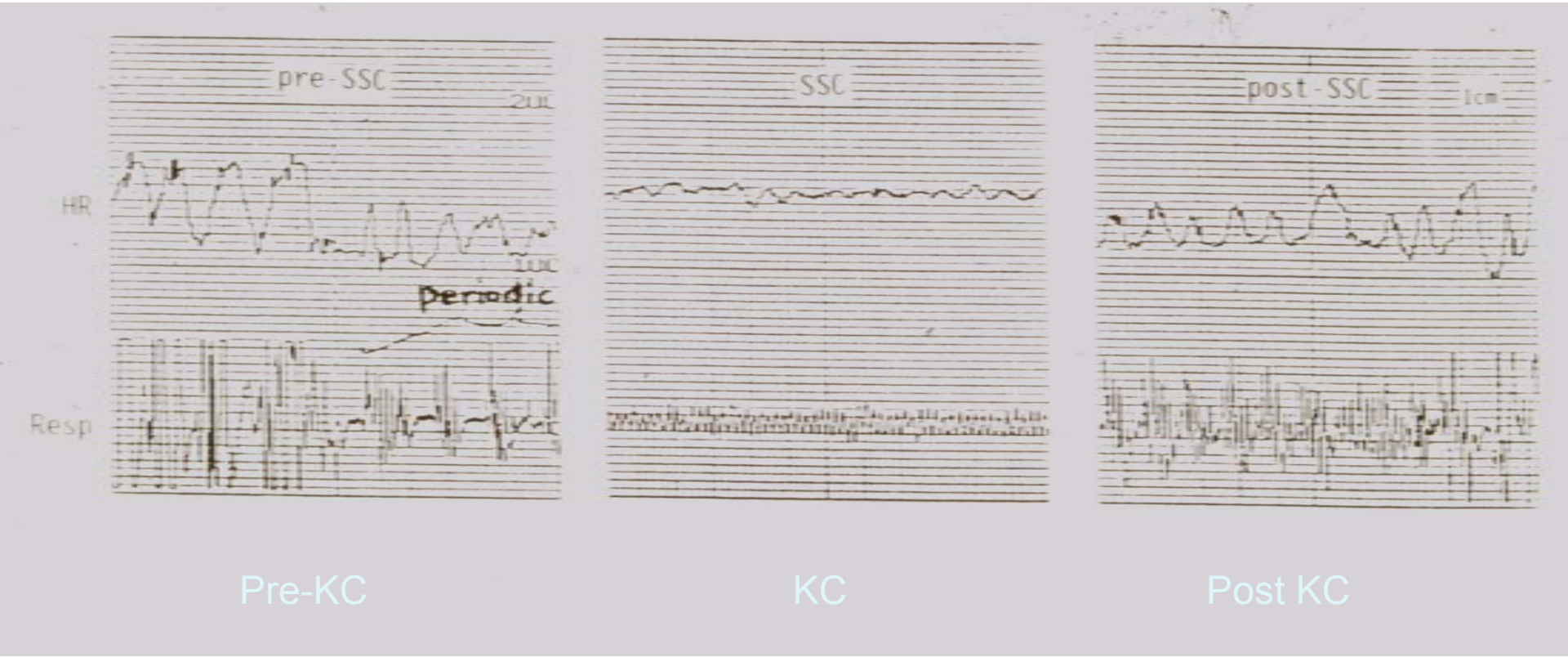
- Theoretical: Supports/sustains homeostasis and neuronal homeostatic plasticity

CARDIO-RESPIRATORY

- CARDIO INDICATORS: Heart rate, BP, heart rate variability, bradycardia

- RESPIRATORY INDICATORS: Respiratory rate, breathing patterns, apnea, oxygen saturation, fiO2, pulmonary function tests, cerebral oxygenation, cerebral blood flow, cerebral activation

Cardio Respiratory Changes



Pre-KC KC Post KC

Heart Rate

- Stable – in 25-27 weekers stays same as in incubator (Bauer et al., 1997; 1998, 2005; Kaur 2004; Maastrup et al.,2010), in 28 wks+ stays same (Begum 2008, 2009; Chwo & Hang, 2002; kadam et al. 2005; Lai 2005; Mori et al., 2011)
- Stable in first hours of life with KMC (Ludington-Hoe et al. 1999; Bergman et al. 2004)
- Can increase by 5-10 beats per minute due to warming (Ludington-Hoe & Dorsey 1998 meta-analysis; Fohe et al., 2000; Heimann et al. 2010),
- remains within clinically acceptable range (de Oliveira Azevedo et al., 2011; van Zanten et al., 2007- in vent KC & Harrison, 2010 with CHD infant)

Heart Rate

- The sooner KC starts after birth, the greater the likelihood of stability of Heart Rate (Takahashi et al, 2011)

Blood Pressure

- Infant BP (MAP): in quasi-exp 1 grp vented KC vs. incubator period, no difference between periods, MAP increased by 0.4 mmHg during KC, but within clinically acceptable range. STABLE VS (de Oliveira Azevedo, 2011)

- Maternal BP: Also causes drop in maternal BP (Handlin et al., 2012; Henderson 2011)just as BF does (Jonas et al. 2008), so use for PIH postpartum is under trial in USA with Melchor as PI at Loma Linda

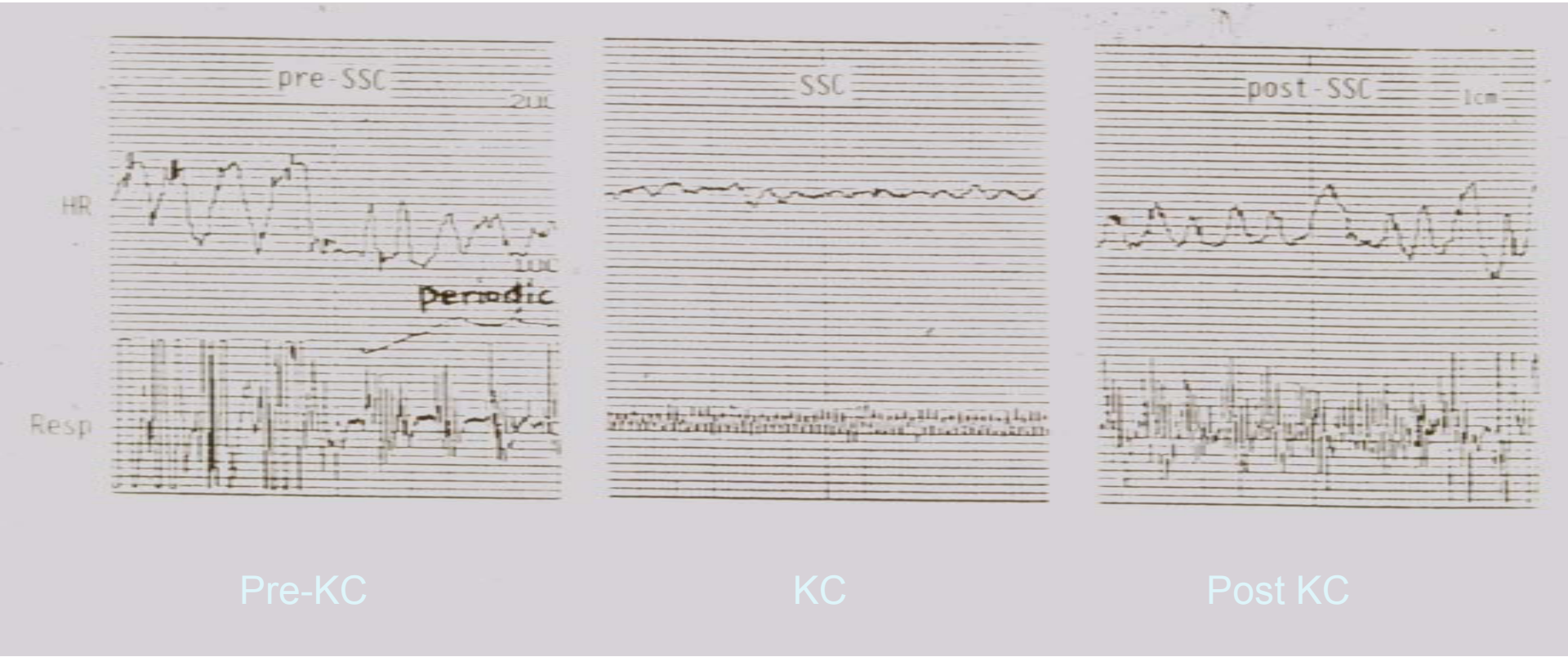
Heart Rate Variability

- HRV is sign of which autonomic nervous system is in control of functions- High Frequency = parasympathetic, Low Frequency =sympathetic, and LF/HF ratio is dominant NS
- During KC parasympathetic dominates (Begum 2008, 2009; McCain et al., 2005; Morgan et al., 2011) and sympathetic activation accompanies separation (Morgan et al., 2011). KC matures parasympathetic NS faster than incubator (Feldman et al. 2003;Harrison, 2010)
- IN KC VENT, no diff betw/ incubator and KC (Smith, 2003), and more stable in KC(Cong, Cusson et al., 2012; Cong et al., 2009)

Bradycardia

- No diff betw/ incubator & KC (Bohnhorst et al., 2001, 2004; de Leeuw et al. 1991; Heimann et al. 2010),
  - even for ventilated (intubated KC) (Van Zanten et al.2007)
- Decreased in KC but not in incubator (Tornhage et al., 1999)
- None in KC grp, but controls had bradies (Ludington-Hoe et al., 2004; Clifford & Barnsteiner, 2001)
- KC transfusion = 0;non-KC transfusion = 6 (Kirsten & Wyers, 2006; Hall & Kirsten, 2008)
- Brady =contraindication for KC (Nyqvist 2005, 2009)

Cardio Respiratory Changes



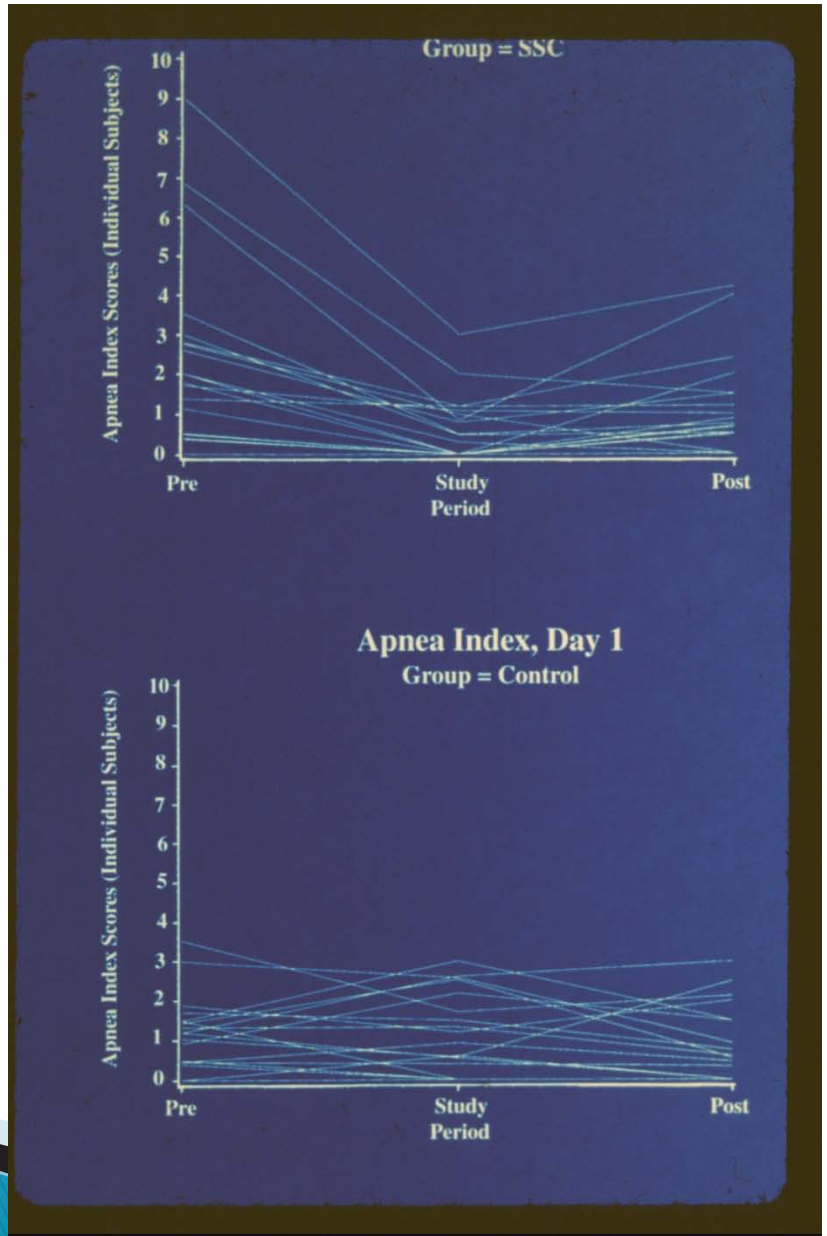
Pre-KC KC Post KC

Respiratory Rate & Patterns

- No diff betw/ incubator & KC (Bohnhorst et al., 2004; de Oliveira Azevedo et al.,2011;Fischer et al., 1998' Kaur, 2004; Lai et al., 2006; Maastrup & Greisen, 2010)
- More stable than in incubator (Bergman et al., 2004; Ludington-Hoe et al., 1991, 2004; Parmar 2009)
- More stable than in controls (Bouloumie et al., 2008; Ludington-Hoe et al., 1991, 2004)
- Decreases/increases by 3-5 breaths per minute but is Within Normal Limits (Boju et al., 2011)
- Irregular patterns decrease during KC (Hadeed et al., 2005;

Nasal thermistor close-up

Apnea reduction by 75% during KMC



Ludington-Hoe et al
Neonatal
Network 1994

Oxygen saturation

- Remains within clinically acceptable range: de Oliveira Azevedo et al, 2011 (vent KC)
- No changes from incubator-KC (Begum 2009, Bohnhorst et al., 2004, Harrison 2010; Heimann et al., 2011, Niimbalkar et al., 2012)
- Meta-analysis shows stability (Mori et al., 2011, Dodd, 2005, Ludington-Hoe & Dorsey, 1998)
- Change may be up to 0.6% -3%- not much
- FiO2 has dropped (de Oliviera Azevedo et al., 2011; Ludington-Hoe et al., 1998) and has increased in 2nd hour (Smith 2003). UNCLEAR FiO2 effect.

Pulmonary Function Tests

- No difference in C20/C compliance, Resistance of Airway, pressure/volume loops between intubated in incubator and intubated in KC (Ludington-Hoe et al., 1998).

- No difference in PEEP, PIP either (de Oliveira Azevedo et al., 2011)

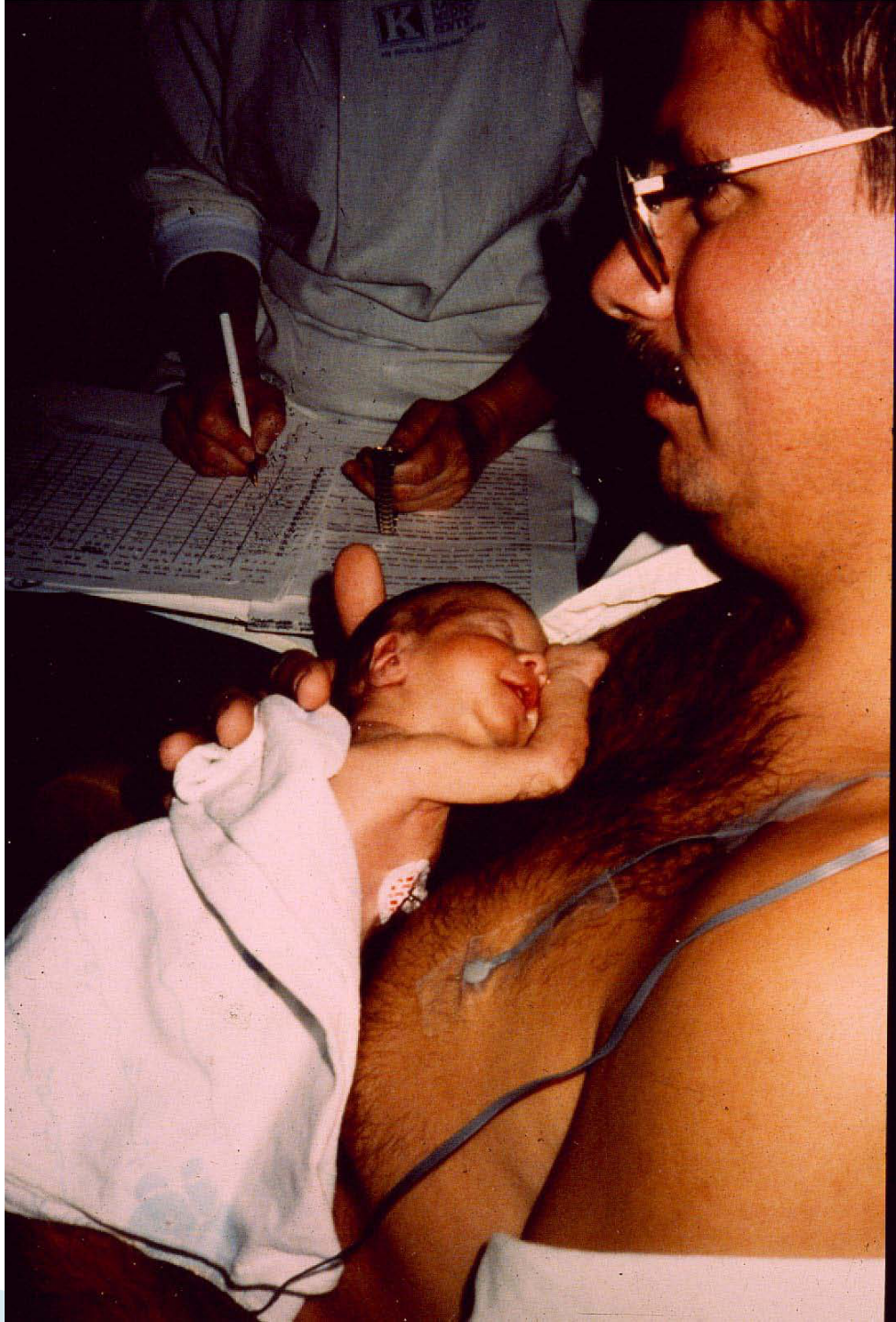
Cerebral Oxygenation/Activation

- Brain activation, a sign of stress denoted by increased cerebral oxygenation, is less with KC than in an incubator in 1 group, pretest-test-posttest design (Begum et al., 2008, 2009; Martin & Ludington-Hoe, 2010) .

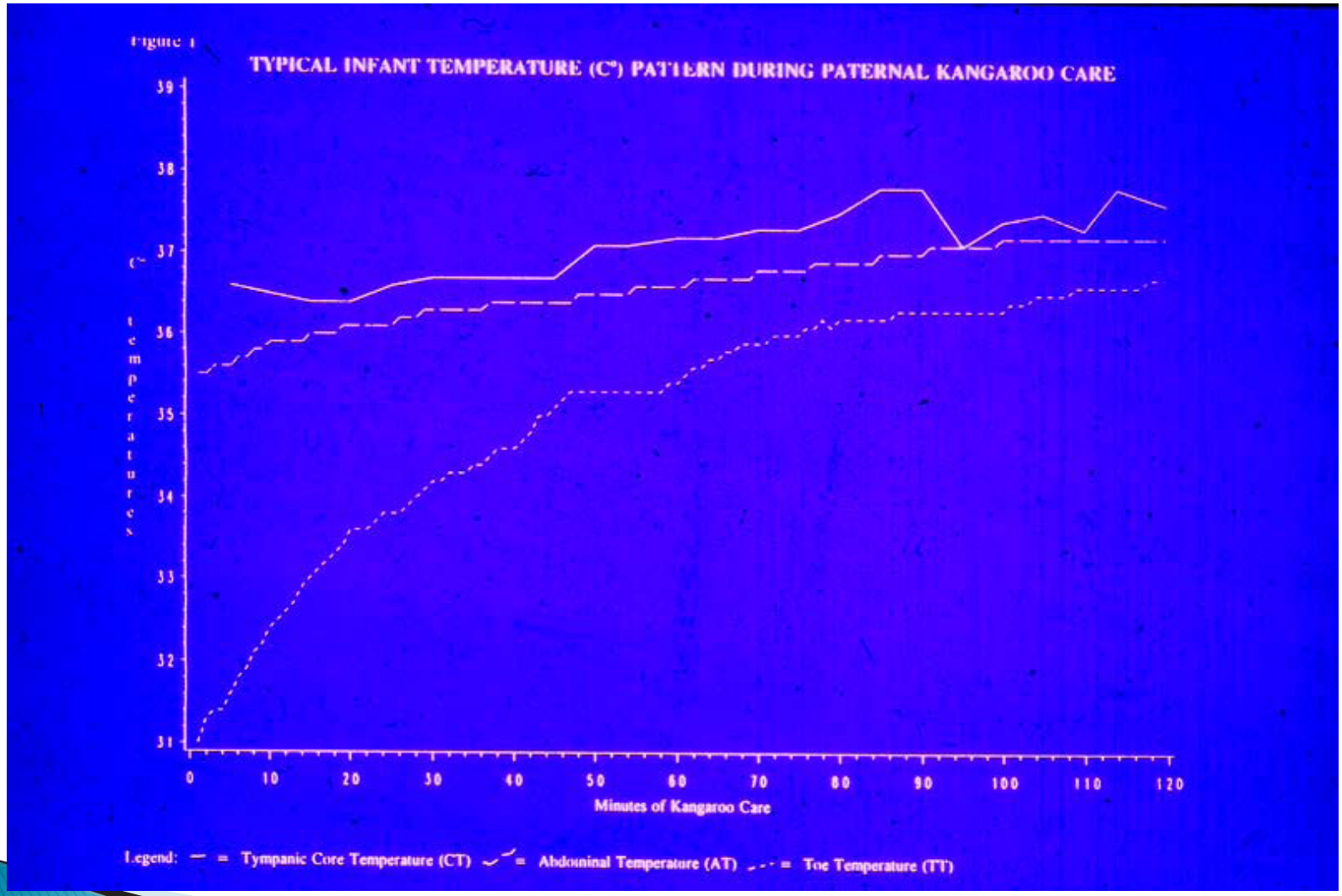
Temperature

- More than 100 studies have confirmed that **infants are warmer in KC than anywhere else** because maternal breasts heat up to THERMOREGULATE
- Mother conducts heat to infant (Karlsson 1996), fathers do too & too much (Ludington-Hoe et al., 1992)
- Transfer of heat from parent to infant is sufficiently high to compensate for the increase in evaporative and convective heat loss (Karlsson et al., 2012)

Note the infant's smile in PKC



Temperature changes in Paternal KC



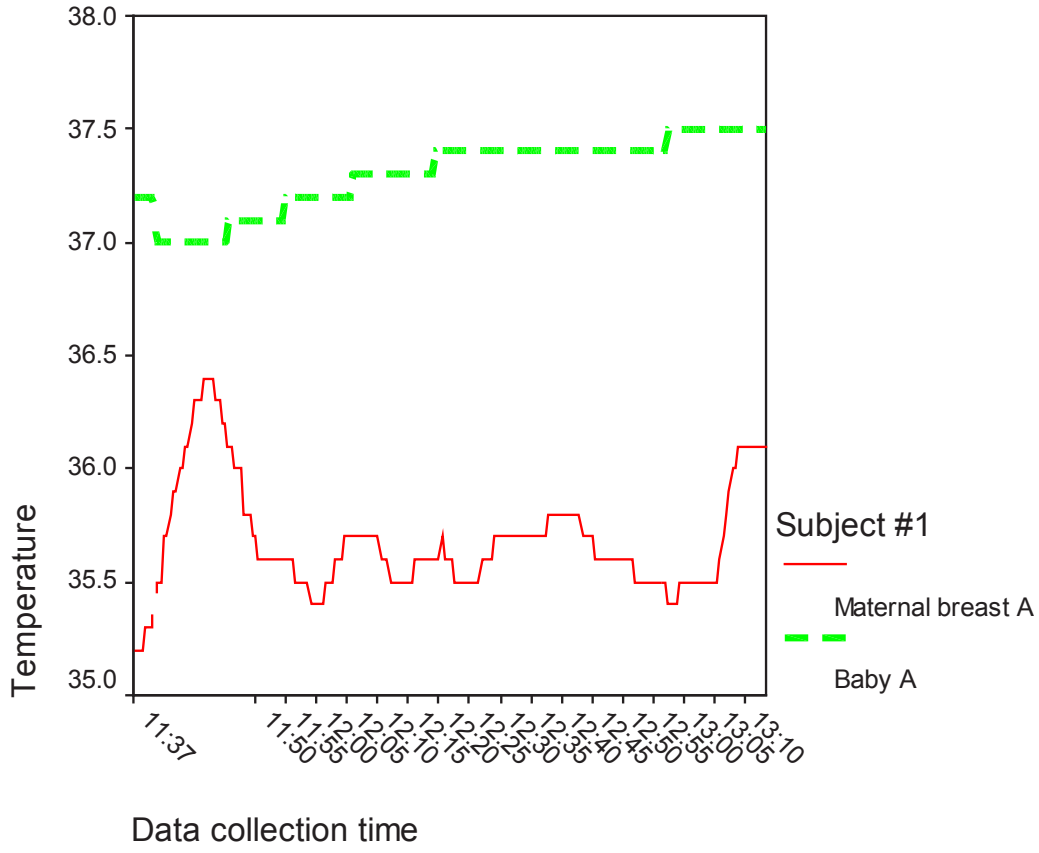
Ludington-Hoe et al Developmental Physiology 1992

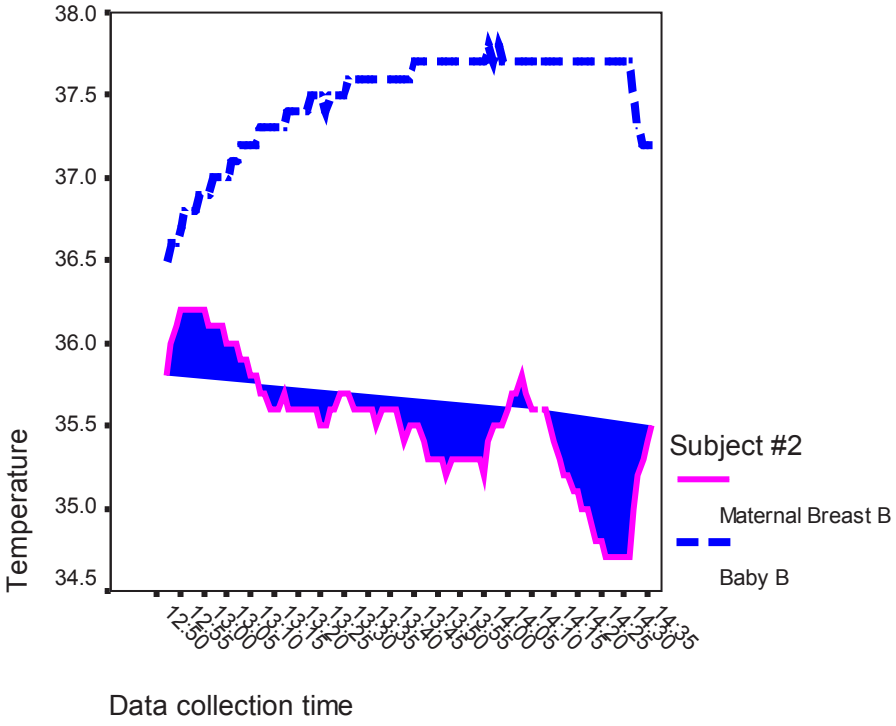
Asleep and still on the breast

SHARED KC and Temperatures

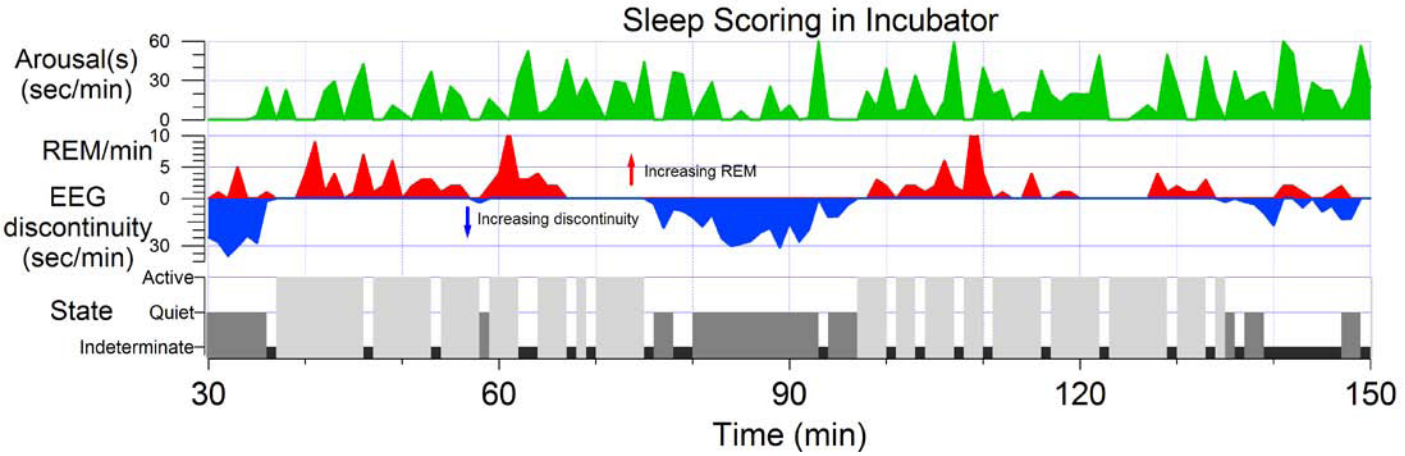
- Up to three infants can be safely Kced and be kept warm by maternal breasts due to two hypothalamic set points for temperature in maternal brain

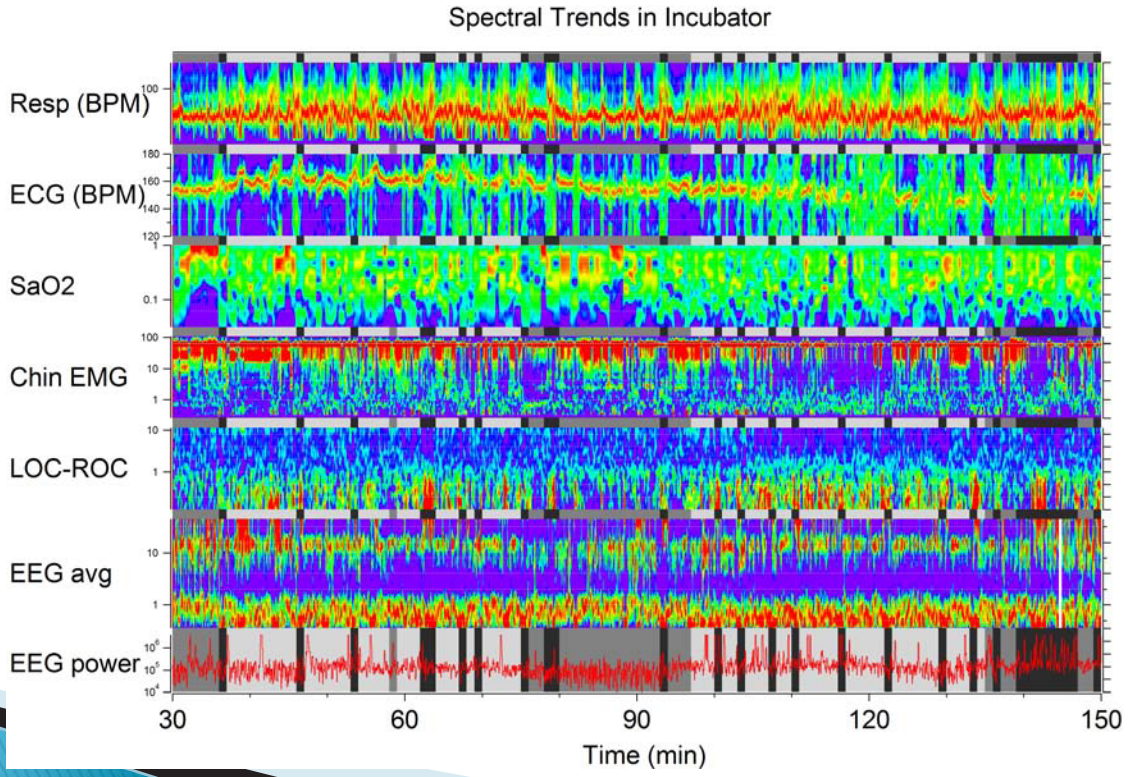
- Each breast acts independently of the other (Ludington-Hoe et al., 2007) and each twin is kept warm and not too warm (Abouelfettoh & Ludington-Hoe, in press)

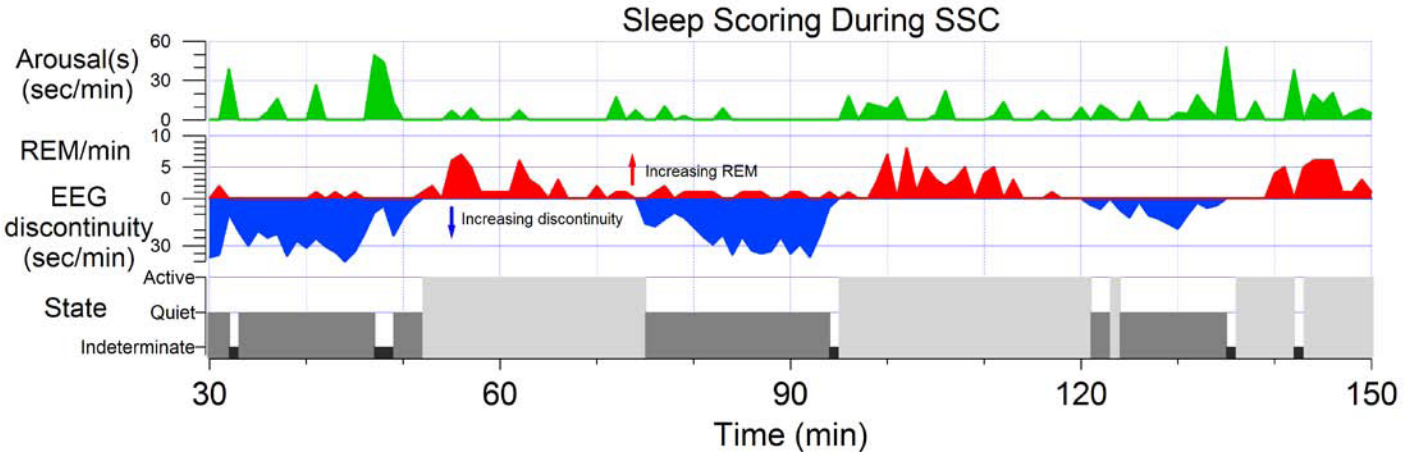

38.0
37.5
37.0
36.5
36.0
35.5
35.0
Temperature
11:37
11:50
11:55
12:00
12:05
12:10
12:15
12:20
12:25
12:30
12:35
12:40
12:45
12:50
12:55
13:00
13:05
13:10
Data collection time
Subject #1
Maternal breast A
Baby A

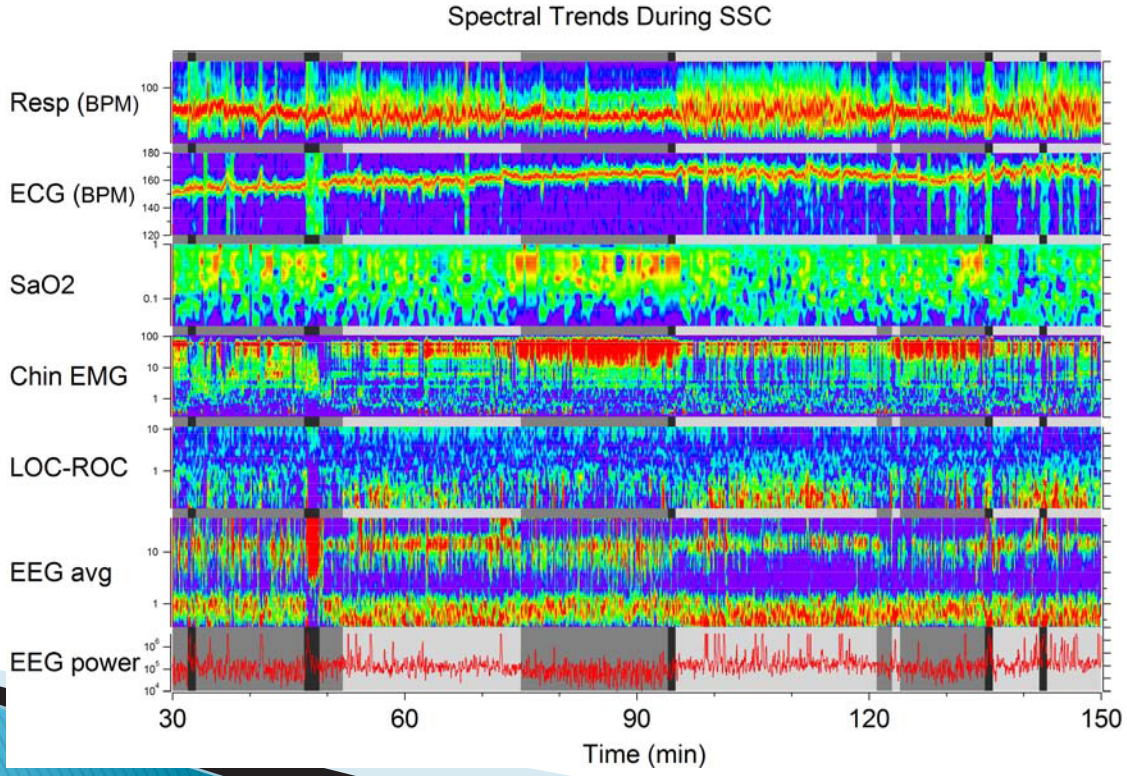

38.0
37.5
37.0
36.5
36.0
35.5
35.0
34.5
Temperature
12:50
12:55
13:00
13:05
13:10
13:15
13:20
13:25
13:30
13:35
13:40
13:45
13:50
13:55
14:00
14:05
14:10
14:15
14:20
14:25
14:30
14:35
Data collection time
Subject #2
Maternal Breast B
Baby B

Sleep- an important physiologic finding (Ludington-Hoe et al. 2006)


Sleep Scoring in Incubator
Arousal(s) (sec/min)
60
30
0
REM/min
10
5
0
EEG discontinuity (sec/min)
30
Increasing REM
Increasing discontinuity
State
Active
Quiet
Indeterminate
30
60
90
120
150
Time (min)


Spectral Trends in Incubator
Resp (BPM)
ECG (BPM)
SaO2
Chin EMG
LOC-ROC
EEG avg
EEG power
30
60
90
120
150
Time (min)

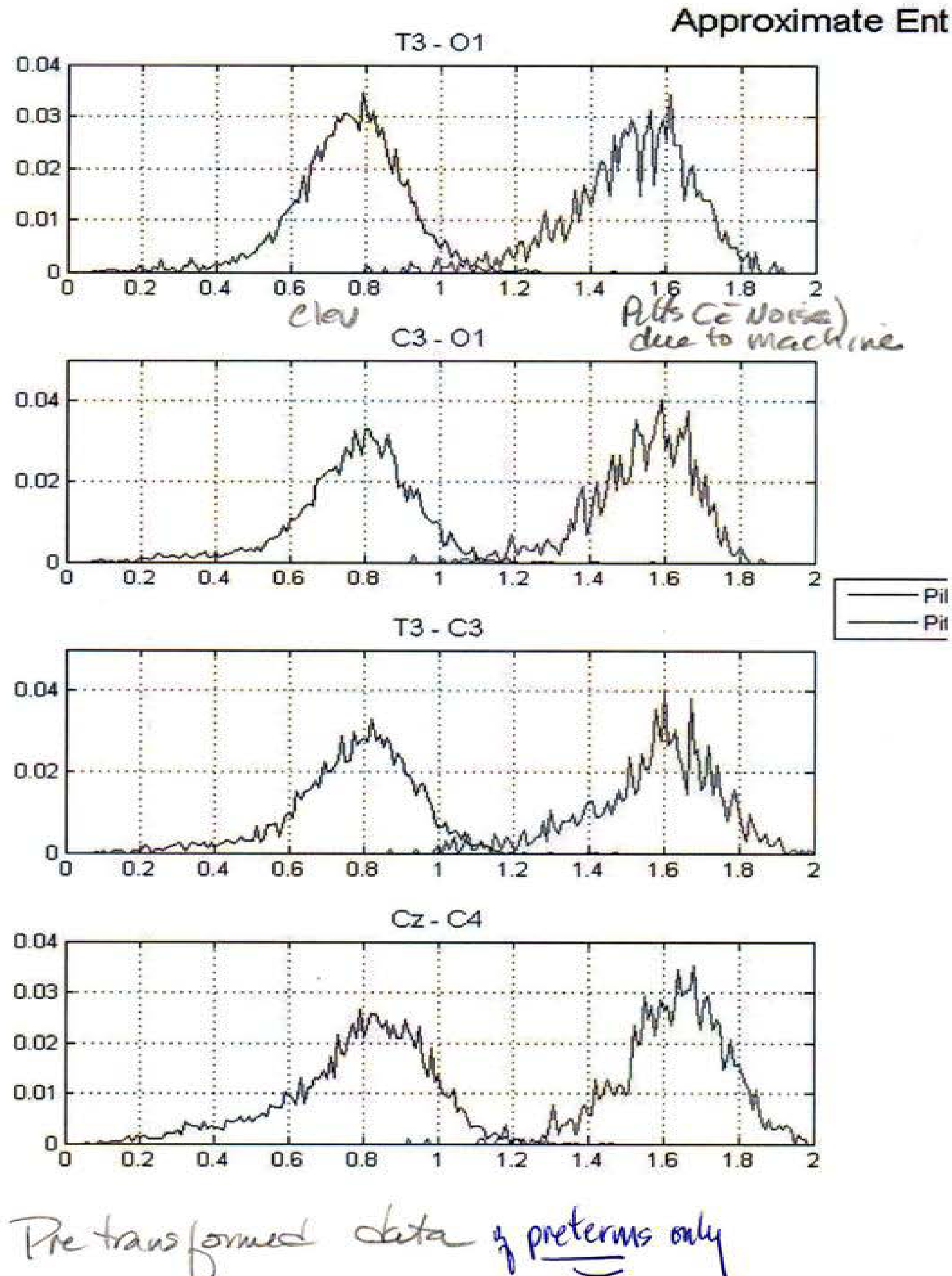

Sleep Scoring During SSC
Arousal(s) (sec/min)
60
30
0
REM/min
10
5
0
EEG discontinuity (sec/min)
30
Increasing REM
Increasing discontinuity
State
Active
Quiet
Indeterminate
30
60
90
120
150
Time (min)


Spectral Trends During SSC
Resp (BPM)
ECG (BPM)
SaO2
Chin EMG
LOC-ROC
EEG avg
EEG power
30
60
90
120
150
Time (min)

Brain Maturation from EEG

- 3 hours of KC once **increased maturation of five sensorimotor areas of right cortex** in KC group but not in control group (Scher, Ludington-Hoe et al., 2009)

- 1.5 hours of KC/day for 4 days/wk from 32-40 wks pma **increased brain maturation** in KC preterms but not control preterms (Scher, Ludington-Hoe al. 2011) and increased brain complexity & connectivity (Kaffashi, Ludington-Hoe et al., in press)


Approximate Ent
T3 - O1
C3 - O1
T3 - C3
Cz - C4
due to machine
Pre transformed data of preterms only

Stability Summary-1

- "Much more physiologic stability in KC than elsewhere" (Boukydis, 2011)
- "Better physiologic stability with **transport** in KC than in an incubator" (Sontheimer et al., 2004)
- "Maintaining respiratory and physiologic stability is essential in reducing risk of brain injury, so KC is needed to protect the brain"(Badr & Purdy, 2007)
- Much better cardiorespiratory stability with **pain** when in KC (Johnston et al., in press Cochrane of over 24 Pain trials)
- **Better stability for Neonatal Abstinence Syndrome** infants (Ludington-Hoe & Wagner, in press for Feb. 2013 Adv Neon Care)

Stability Summary -2

- Better physiologic stability with KC (Meta-Analyses) (Ludington-Hoe & Dorsey, 1998; Mori et al., 2011)
- Better stability than in incubator,
  - crib,
  - swaddled holding and
  - when in twin (Abouelfettoh et al., in press; Bonner, 2008; Cleary 1997; Lutes, 2006)
  - and triplet (Kambarami, 2002, Swinth et al., 2000)
  - AND **RIGHT AFTER BIRTH** (Ludington-Hoe et al. 1999; Bergman et al., 2004) and "Better stability over the **first days of life** with KMC" (Bouloumie, 2008)

Six minutes old

Twins

Baby in KC with a fiber-optic bili-blanket

Stability Comes From Contact with Mother

- She is integral to her infant's homeostasis
- And contact with her infant makes her a better mother, too

- So, if we hate to separate a mammal animal from her newborn, we shouldn't do it to a human mother and her newborn, because if we do…..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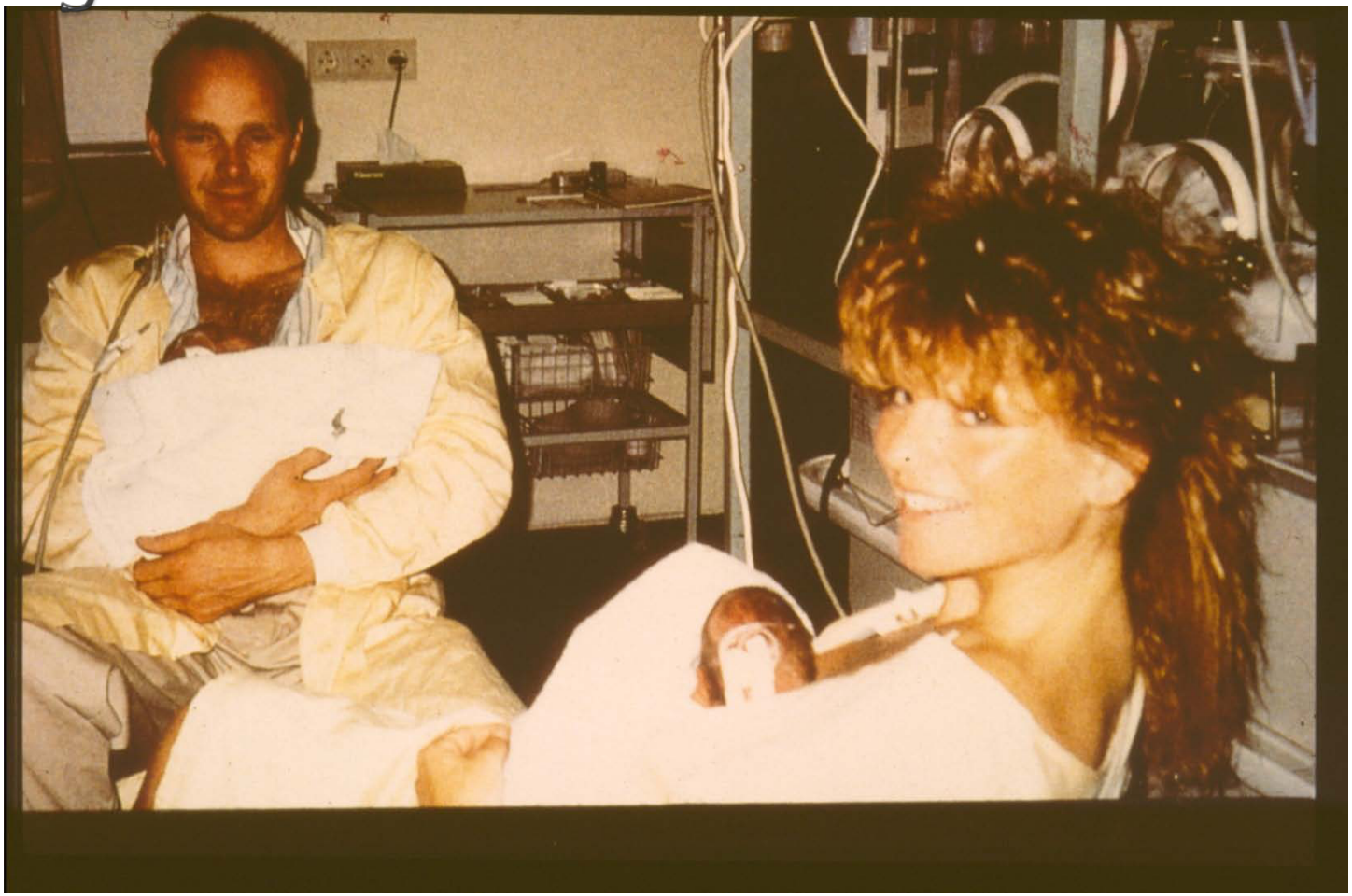
Embrace maternal and paternal Kangaroo Care



- This slide presentation will be available for all to download from the United States Institute for Kangaroo Care website:

- www.kangaroocareusa.org and go to Resources page.
- The Kangaroo Care bibliography of >594 studies of Kangaroo Care can be found there also for free downloading.
- THANK YOU