Developmental and Stress Reducing Effects of KMC

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Objectives:

- Review evidence that KMC affects mental and motor development of infants
- Overview of new emphasis on TOXIC STRESS/Trauma Care
- Can KMC reduce toxic stress? Evidence for decreased stress, anxiety, separation

KMC Effects on Brain Development

- Many BRAIN studies show better brain development with KMC
- Interpersonal skin contact is processed differently in the brain from similar soft touch applied through inanimate objects (Kress, 2011)
- KMC activates the pregenual anterior cingulated cortex, an area of the brain that reduces pain, anxiety, stress and increases sense of well-being (Lindgren, 2011)
- Scher et al., 2009 RCT KMC 1.5 hr/day X 4days/wk X 8 weeks (32-40 wks PMA)
    - 5 areas of brain matured faster in KMC preterm than in no-KMC preterms
    - Brain complexity was improved in KMC but not in non-KMC
    - brain maturation at term in KMC preterms was similar to FT infant's brain maturation

Brain Development Studies Continued

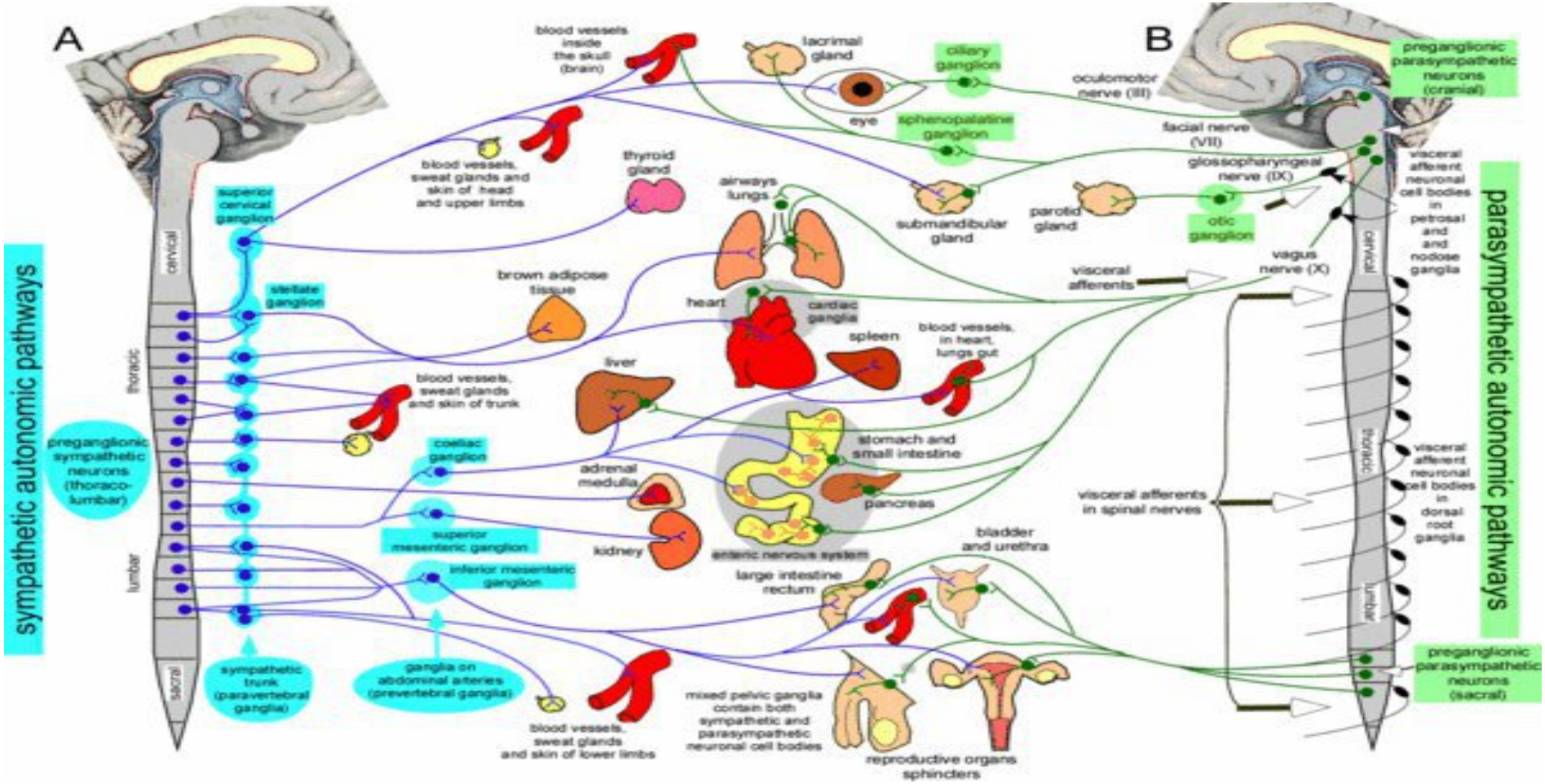
- Schneider et al 2012 PT, RCT FU @ 16 yr from Charpak's 1998, 2001 studies:
  - improved connectivity,
  - Improved synaptic plasticity,
  - Improved brain development of motor functions
- "Kangaroo Mother Care rescued these functions because KMC was given at a time when brain was receptive to this stimulation and formulated pathways for these brain functions" (Schneider et al., (2012-Oct). Cerebral motor function in very premature-at-birth adolescents: a brain stimulation exploration of kangaroo mother care effects. *Acta Paediatrica, 101*(10), 1045-1053).

KMC Effects on Autonomic Nervous System

- PT. Quasi-Experimental: KC improved autonomic nervous system (Feldman R, & Eidelman AI. (2003). Skin-to-skin contact accelerates autonomic and neurobehavioral maturation in preterm infants. Developmental Medicine and Child Neurology, 45 (4), 274-281).
- PT. Quasi-Experimental: KC improved autonomic functioning (RSA) in postpartum period (Feldman R, et al.,(2014-Jan). Maternal-Preterm Skin-to-Skin Contact Enhances Child Physiologic Organization and Cognitive Control Across the First 10 Years of Life. *Biologic Psychiatry. 75*(1), 56-64).
- Review of autonomic nervous system development: KMC improves development of vagal functioning (Porges, S.W. & Furman, S.A. (2011). The early development of the autonomic nervous system provides a neural platform for social behavior: A polyvagal perspective. Infant & Child Development. 20(1), 106-118).

CONG was 1st to show ANS change from Sympathetic to Parasympathetic control during KMC.

Autonomic Nervous System



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KMC Effects on Mental Development

- 1975 PT, RCT: KMC at birth improved **speech** in infants at **two years** (Kennell JH, Trause MA, & Klaus MH. (1975). Evidence for a sensitive period in the human mother. Ciba Found Symp. 1975(33):87-101.)
- 1975 FT, RCT: newborns who got birth KMC had better **mother-child speech** dyadic interaction at **two years** (Ringler NM, et al., (1975). Mother-to-child speech at 2 years--effects of early postnatal contact.J Pediatrics, 86(1):141-144).

- 1984: FT, RCT: infants with 20 min of KMC at birth had higher Gessell scores on 4/5 items at 12 months (De Chateau P, & Wiberg, B. (1984). Long-term effect on mother-infant behavior of extra contact during the first hour postpartum. Part III: Follow-up at one year. Scand J Soc Med, 12: 91-103).

KMC Effects on Mental Development

- 2001,2002 PT, Quasi-Exp: KMC group scored higher on orientation, motor performance, state range & regulation tasks on NBAS @ 6 months, higher Bayley Mental and Motor Scales @ 12 months. (Ogi S, et al.(2001). The developmental effects of an early intervention program for very low birthweight infants. No To Hattatsu, 33 (1), 31-36; Ohgi S et al., 2002. (2002). Comparison of kangaroo care and standard care: behavioral organization, development, and temperament in healthy, low-birth-weight infants through 1 year. *J. Perinatology, 22* (5), 374-379).
- 2002 PT, Quasi-Exp: KMCers more alert, less gaze aversion, higher Bayley Mental (96.39 vs 91.81 for controls) and psychomotor (KMC= 85.47; control 80.53) development at 6 months (Feldman R, et al.,(2002). Comparison of skin-to-skin (Kangaroo) and traditional Care: Parenting Outcomes and Preterm Infant Development. Pediatrics, 110(1 Part 1), 16-26).

- 2006 PT, RCT: When brain injury was controlled for by MRI, KMC infants did better in 12 month overall developmental quotient but not motor (Hickson A., et al. (2006). Neurological outcome of premature infants following a controlled trial of skin-to-skin contact. Early Human Development, 82(9), 631-632).

KMC Effects on Mental Development

- 2003: PT, RCT of KMC 24hrs/day till 37-38 wks PMA -@ 12mos KMCers had higher IQ & Griffiths scores, more significant the sicker the baby (Tessier R,et al. (2003). Kangaroo mother care: A method for protecting high risk, low birth weight and premature infants against developmental delay. Infant Behavior and Development 26 (3), 384-397).

- 2004: PT, Review of their RCTs: slight improvement in developmental indices, biggest improvement was in smallest sickest MICROPREEMIE infants. (Ruiz-Pelaez JG, et al., (2004). Kangaroo mother care, an example to follow from developing countries. British Med J,, 329(7475), 1179-1182).

KMC Effects on Mental Development

- 2014 PT, controlled trial: KMC infants surpassed controls at term & 12 months on motor and mental development (Bera, A., et al., (2014-June) Effect of Kangaroo Mother Care on growth and development of low birth weight babies up to 12 months of age. Acta Paediatrica ,103(6), 643-650).
- 2014 PT, Quasi-Exp: KMC enhances cognitive control over the first 10 years of life. (Feldman R, Rosenthal Z, & Eidelman AI. (2014-Jan). Maternal-Preterm Skin-to-Skin Contact Enhances Child Physiologic Organization and Cognitive Control Across the First 10 Years of Life. *Biologic Psychiatry.* *75*(1), 56-64.)
- 2017 PT, Correlational: Naturalistic amount of KMC in Tertiary NICU. The more KMC before 30 wks PMA, the better the language skills at 6 & 12 months. Gonya, J et al., (2017 in press). Amount of Kangaroo Mother Care and infant speech development. BMC Pediatrics

Not all studies show improvement in mental development:

- 1994 PT, descriptive follow up of 162 KMC (24/7) infants from 34-38 weeks pma at one year: KMCers had higher proportion of developmental delay (Charpak, N. et al.(1994). Rey-Martinez Kangaroo mother program: An alternative way of caring for low birth weight infants? One year mortality in a two cohort study. Pediatrics, 94(6 Pt1), 804-810.)

- 2003. PT, RCT, no differences in KMC and control group on development and memory tests at 1 year (Miles, R. et al., (2003). A controlled trial of skin-to-skin contact in extremely preterm infants. Pediatric Researcg 54: 569).

- 2006 PT RCT, No difference in KMC and control groups on Hammersmith Infant Neurological Examination and Revised Griffiths Mental Development Scale at 1 year age (Miles et al., 2006. A controlled trial of skin-to-skin contact in extremely preterm infants. *Early Human Development, 82(*7), 447-455_

No improvement in mental development - continued

- 2014: PT, Cochrane Meta-Analysis of 1736 infants: No difference in neurodevelopment in PT and LBW infants who received continuous KMC and those who did not (but got intermittent KMC) based on 1736 infants

- 2016: PT, Cochrane Meta-Analysis of 3042 infants: No difference on Griffith's Quotients for Psychomotor development at 12 months between KMC and control (incubator) groups

- In fact, all Conde-Agudelo et al. Cochranes (2004, 2007, 2011 etc) have reported same finding of no difference in mental and motor development at discharge and later due to KMC.

KMC Effects on Motor Development

- Several studies show that KMC has positive effects on motor development:
- 1984, FT RCT of 15-20 mins of KMC at birth: 4/5 Gessell developmental test scores were better for KMC group (De Chateau P, & Wiberg, B. (1984). Long-term effect on mother-infant behavior of extra contact during the first hour postpartum. Part III: Follow-up at one year. Scand J Soc Med, 12: 91-103).

- 1989 FT Follow-up of De Chateau's study of 15-20 minutes of KMC at birth in full term infants: At 3 years, KMC group had earlier daytime continence (Wiberg B, et al., (1989). Long-term effect on mother-infant behaviour of extra contact during the first hour postpartum. V. Follow-up at three years. Scand J Soc Med 17(2), 181-191).

KMC effects on motor development continued

- 2001, 2002 PT. RCT: at 12 month KMC infants had higher Bayley Mental and Motor Scales. KMC promotes neonatal behavioral organization and developmental outcome over 1st year of life. (Ogi et al., 2001 & Ohgi et al., 2002 cited above in mental effects).

- 2002 PT, Quasi-Exp: @6 months, KMCers had higher Bayley psychomotor (KC= 85.47; control 80.53) scores than PT who did not get KMC (Feldman R, et al., (2002). Comparison of skin-to-skin (Kangaroo) and traditional Care: Parenting Outcomes and Preterm Infant Development. Pediatrics, 110(1 Part 1), 16-26).

KMC effects on motor development

- 2004. FT, RCT: 60 minutes of KMC starting 15-20 mins postbirth resulted in more flexor movements and flexed posture, less extensor movements. KMC influences motor system modulation shortly after delivery (Ferber S.G., & Makhoul I.R. (2004). The effect of skin-to-skin contact (kangaroo care) shortly after birth on the neurobehavioral responses of the term newborn: a randomized, controlled trial. *Pediatrics, 113* (4), 858-865).
- 2006 PT, Correlational: motor development improved with 24/7 KMC infants but not in those with no KMC (Barradas.J. et al..2006. Relationship between positioning of premature infants in Kangaroo Mother Care and and early neuromotor development.Journal Pediatrics (Rio Journal),82(6),475-480)
- 2008. PT, Rcross-over to four conditions: during pain, KMC infants had decrease in disorganized motor movements. (Ferber SG, & Makhoul IR. (2008). Neurobehavioural assessment of skin-to-skin effects on reaction to pain in preterm infants: a randomized controlled within-subject trial *Acta Paediatr. 2008; 97*(2):171-176).

KMC effects on motor development continued

- 2012 PT RCT Follow Up: KMC infants who had KMC in hospital & for 28.6 days at home had motor connectivity like a full term infant and KMC definitely improved brain motor functioning (Schneider, C et al. 2012. Cerebral motor function in very premature-at-birth adolescents: A brain-stimulation exploration of kangaroo mother care effects. *Acta Paediatrica,* 101(10), 1045-1053).

- 2013, PT, Quasi-experiment: up to 96 hrs of Kangaroo Position in first week of life led to a growing increase in the **electromyographic** activity of preterm children's **biceps brachii.** Response persists until at least the 21st day after this period and flexor muscles were strengthened. These flexor muscles are important for anti-gravity control. (Diniz KT,et al. 2013. Effect of the kangaroo position on the electromyographic activity of preterm children: a follow-up study. *BMC Pediatr.* *13*(1):79)

KMC effects on motor development continued

- 2014 PT, controlled trial: KMC infants surpassed controls at term & 12 months age on Mental and **Motor** development in Indian infants (Bera, A.,et al., 2014. Effect of Kangaroo Mother Care on growth and development of low birth weight babies up to 12 months of age. Acta Paediatrica ,103(6), 643-650).

- 2014 PT vs FT, **comparative**: infant electromyographic brachii response was improved in KMC preterms due to flexed position & it was BETTER THAN FULL TERM INFANTS' response, due to flexion during KMC (Miranda RM et al. 2014. Electromyographic activity of preterm newborns in the kangaroo position: a cohort study. BMJ Open.4(10):e005560.)

Not all studies show improved motor development

- Other than Charpak et al.'s 12 month follow-up study in 2006 that showed that 19% of 206 KMC infants had neuromotor impairment compared to non-KMC infants,

- **FOUR COCHRANE META-ANALYSES** (2003,2007, 2014, 2016) showed no difference in motor development between KMC infants and controls. Cochranes were by Conde-Agudelo, Diaz-Rosello et al. on the KC bib available from www.kangaroocareusa.org on resources page.

Development Conclusions of Others:

- KC babies have higher Bayley Mental and Motor Scores at 6 and 12 months age (Canadian Paediatric Society, Fetus and Newborn Committee (2012). Practice Point. Kangaroo Care for the preterm infant and family. *Paediatrics and Child Health, 17*(3): 141-143)
- KMC is a cornerstone of neurodevelopmental care for LBW PT infants (Carbasse, A., et al. (2013). Safey and effectiveness of skin-to-skin contact in the NICU to support neurodevelopment in vulnerable preterm infants. *J. Perinatal Neonatal Nursing, 27*(3):255-62.
- KMC babies have higher Intelligence Quotients than non-KMC babies (Hall D & Kirsten G. 2008. Kangaroo mother care; a review. Transfusion Medicine, 18 (77-82).
- KMC is the FIRST SENSORY INTERVENTION to be used to improve development and has been tested at more Gas than music, massage, and other sensory interventions (Pineda R, et al., (2016-Oct). Enhancing sensory experiences for very preterm infants in the NICU: an integrative review. J Perinatol.2016 Oct 20. epub ahead print).

Development Conclusions of Others

- KMC promotes neonatal behavioral organization and developmental outcome over 1st year of life (Ogi S, et al., (2001). The developmental effects of an early intervention program for very low birthweight infants. No To Hattatsu, 33 (1), 31-36. ; Ohgi S, et al. (2002). Comparison of kangaroo care and standard care: behavioral organization, development, and temperament in healthy, low-birth-weight infants through 1 year. *J. Perinatology, 22* (5), 374-379).
- KMC improves the mental heath of LBW infants and their mothers (Badiee et al., (2014). Effect of Kangaroo Mother are on mental health of mothers with low birth weight infants. Advances in Biomedical Research 3, 214.)
- KMC provides BRAIN CARE (Tessier R, et al.. (2003). Kangaroo mother care: A method for protecting high risk, low birth weight and premature infants against developmental delay. Infant Behavior and Development 26 (3), 384-397; Tessier, R., Cristo, M., Nadeua,L., & Schneider, C. (2011). Prematurity and morbidity: Could KMC reverse the process? **Current Women's Health Reviews, 7**(3), 254-261)

Developmental Conclusions of Others

- KC is recommended as a positive interaction to enhance neuro behavioral development. (Perlman JM. (2003). The genesis of cognitive and behavioral deficits in premature graduates of intensive care. *Minerva Pediatrics, 55* (2), 89-101).

Developmental Effects Conclusions based on Evidence – Not so Rosy

The Cochrane Meta-analyses are the highest level of evidence, and indisputable, regardless of the high opinion in which we hold Kangaroo Mother Care. KMC may or may not promote development; enhanced mental and motor development should not be an expected outcome in all KMC babies. Boundy's 2016 correlational meta-analysis did not reveal any association between KMC and improved development (Boundy, E.O. et al., (2016-Jan). Kangaroo Mother Care and Neonatal Outcomes: A Meta-analysis. Pediatrics 137 (1), e20152238).

The Cochrane Meta-analyses do show that 24/7 KMC is more likely to advance development than intermittent KMC. This is the practice goal, then, if enhanced developmental outcomes are desired.

Toxic Stress – Levels of Stress in Neonates

- Eustress vs Stress (induces compensation mechanisms)
- Preterms' eustress level is <150nmol/L of circulating cortisol (a glucocorticoid steroid hormone)
- Preterms' stress level is usually very high, often exceeding 1500nmol/L Modi, N. & Glover, V. (1998). Non-pharmacological reduction of hypercortisolaemia in preterm infants. *Infant Behavior and Development, 21,* April 1998, Special ICIS issue, pg. 86.
- Acute event stress causes pulsatile release of cortisol and the ½ life is one full hour (Grunau RE, Holsti L, Daley DW, Oberlander T, Weinberg J, Solimano A et al., 2005. Neonatal procedural pain exposure predicts lower cortisol and behavioral reactivity in preterm infants in the NICU. Pain 2005, 113: 293-300)

Toxic Stress, AKA Trauma Informed Care

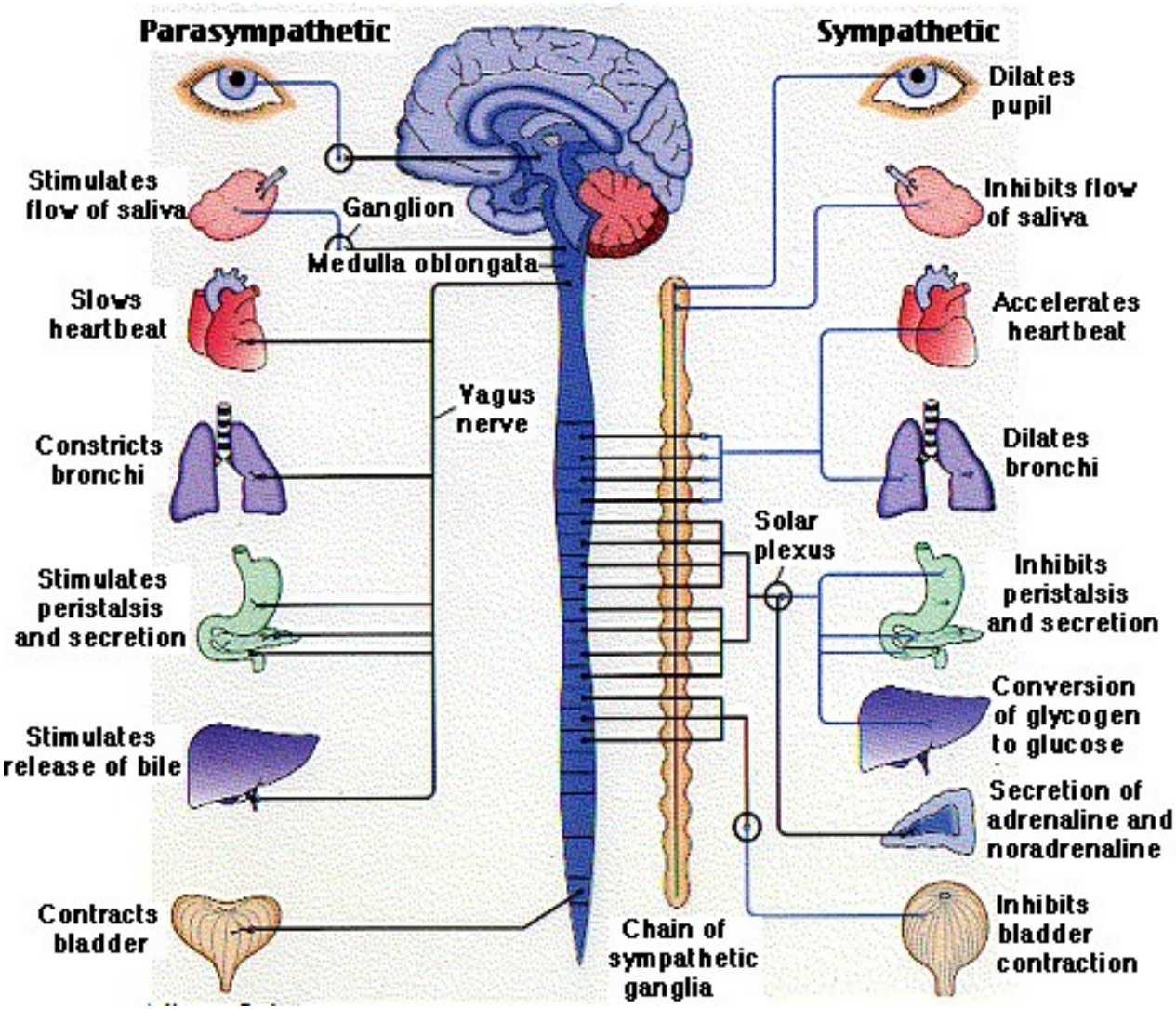
- **Definition:** Relentless exposure to stressful events that are NOT buffered by a sustaining human presence

- A **stressor** is any actual or potential encounter recognized by the brain as a threat to the individual's physiological, psychological, or emotional environment.

- Parasympathetic Dominance
- Fights TOXIC Stress

- Kangaroo care position switches the brain to parasympathetic dominance.

- Confirmed in many studies by Cong



Toxic Stress

- **INCUBATOR is a TOXIC environment** (Garner, A.S., & Shonkoff, J.P., Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care; Section on Developmental and Behavioral Pediatrics. (2012). Early childhood adversity, toxic stress, and the role of the pediatrician: translating developmental science into lifelong health. *Pediatrics 129*(1):e224-e231)

Toxic Stress

- Infants may not appear to be stressed, but their circulating cortisol levels are chronically high (Grunau et al. 1989) which creates many problems
- **HANDLING touch** can be stressful and noxious, but KMC is not! Noxious handling stimuli elicit generalized intense delta brush activity rather than localized cortical responses common to pain, and delta brush activity signals long term memory creation (Fabrizi, L, et al. (2011). A shift in sensory processing that enables the developing human brain to discriminate touch from pain. Curr Biol, 2011, 21: 1552-1558.)

- **Pain** and **separation** from mother are **CHRONIC STRESSORS** in the NICU

Effects of Stressors

- **AAP --- "*separation toxicity sets the infant up for many and most of the developmental delays and biological diseases that are common in NICU graduates*"**

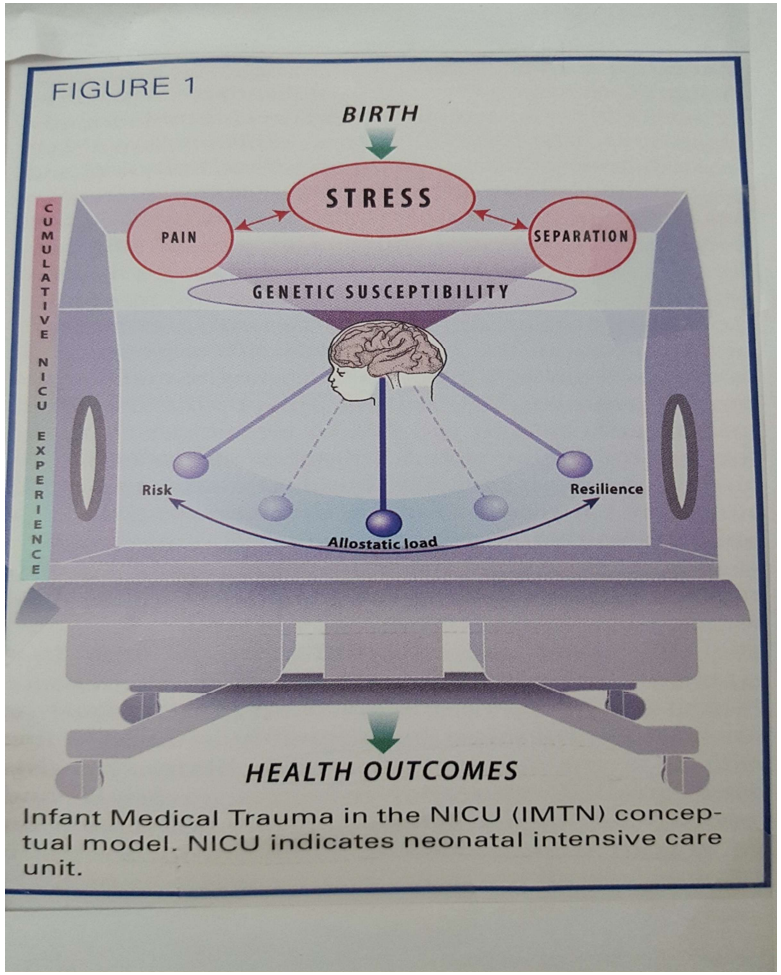
- (Shonkoff, J.P., Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care, Section on Developmental and Behavioral Pediatrics.(2012). Technical Report: The lifelong effects of early childhood adversity and toxic stress. *Pediatrics.129*(1):e232-e246; Shonkoff, J.P., Garner, A.S., Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care, & Section on Developmental and Behavioral Pediatrics.(2012). The lifelong effects of early childhood adversity and toxic stress. Pediatrics, 129(1), e232-246.)

Toxic Stress Effects

- Causes DNA methylation that is permanent and that has adverse effects on the brain's structure and functioning, especially the prefrontal cortex and hippocampus of the brain (Montirosso R & Provenzi L, 2015. Implications of epigenetics and stress regulation on research and developmental care of preterm infants. JOGNN, 44(2), 174-182; Smith GC et l., 2011.Neonatal intensive care unit stress is associated with brain development in preterm infants. Annals of Neurology, 70(4), 541-549).
- NICU stress increases risk of psychiatric disorders due to epigenetic changes and these transfer from one generation to the next (Babenko et al.., 2015. Neurosci Biobehav Rev. 48: 70-91).

- D'Agata 2016 reports study in progress at South Florida University examining stress in incubator and in KMC and effects on gut microbiome

NICU Trauma Model (D'Agata et al., 2016)



Infant Medical Trauma in the NICU (IMTN) conceptual model. NICU indicates neonatal intensive care unit.

Stress Reduction Strategies

- When parents are taught how to reduce infant stress (i.e. thru KMC), brain maturation and connectivity of white matter are significantly enhanced (improvement in cerebral white matter micro-structure development)(Milgrom J, Newnham C, Anderson PJ, Doyle LW, Gemmill AW, Lee K, Hunt RW, Bears M, Inder T. (2010) Early sensitivity training for parents of preterm infants, impact on developing brain. Pediatr Res 67(3): 330-335).

- KMC clearly reduces neonatal stress according to results from Randomized Controlled Trials (Badiee et al., 2014; Gitau et al. 2002; Weller et al., 2002; Morelius et al., 2005; Neu et al., 2014)

Toxic Stress Reduction Strategies

- Practice Neuroprotective Care (Continous KMC so no separation more than 2 hours a day)

- Practice Trauma Informed Care – developed by Dr Couglin and has three sources of stress: NICU environment, pain, separation from mother. (Coughlin ME. 2016. Transformative Nursing in the NICU – Trauma-Informed Age-Appropriate Care. 2nd Edition. NY: Springer Publishing Co.)

- Correct Infant Medical Trauma (model proposed by Dr. D'Agata which says that trauma is due to NICU environment itself, pain, and separation from mother.(D'Agata et al., 2016, The Infant Medial Trauma Model in the NICU. *Advances in Neonatal Care, 16(4*), 289-297)

Pain

- Mother is better than sucrose because:
  - sucrose **blunts behavioral or physiologic responses to pain without providing brain-based analgesia, and in turn**
  - Sucrose does not reduce the long term developmental damage caused by repeated noxious stimuli (Slater R, Cornelissen L, Fabrizi, L. et al., Oral sucrose as an analgesic drug for procedural pain in newborn infants: a randomized controlled trial. Lancet, 2010, 376: 1225-1232).

- Maternal touch is discriminated from anyone else's touch and maternal touch eradicates the memory and neural pathways leading to long term adverse effects of repeated pain (Fabrizi, L, et al., (2011). A shift in sensory processing that enables the developing human brain to discriminate touch from pain. Currents in Biology, 21: 1552-1558; Meek, J., & Huertas, A. (2012). Cochrane review: non-nutritive sucking, kangaroo care and swaddling/facilitated tucking are observed to reduce procedural pain in infants and young children. *Evidence Based Nursing,* 15(3): 84-85).

Stress when and when not with mother

- KMC clearly reduces infant stress:
  - FT, 2 day old infants studied by HRV when sleeping with Mom in KC vs in cot. HRV High to Low Frequency ratio was much lower (parasympathetic) during contact with mother than when separated in a co (Morgan, B.E., Horn, A.R. & Bergman, N.J. (2011). Should neonates sleep alone? *Biological Psychiatry* 70, 817-825.)

  - Many studies show KMC reduces infant and maternal stress. So reducing TOXIC STRESS is best accomplished by having mother be the sustaining human presence caring for her NICU baby (a new movement called INTEGRATED FAMILY CARE). Nils Bergman and I call it **NON SEPARATION**

So, don’t get stressed out about NICU stress….

- JUST DO MORE KMC WITH ALL YOUR INFANTS, 24/7 KMC IS BEST

- THANK YOU. Susan M. Ludington, Susan.Ludington@case.edu