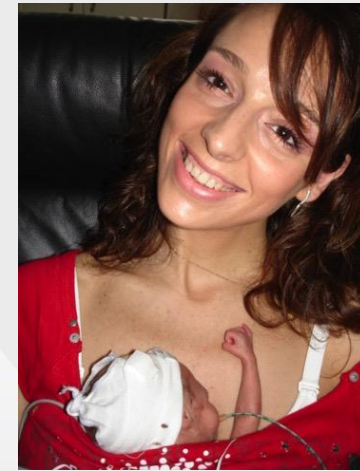
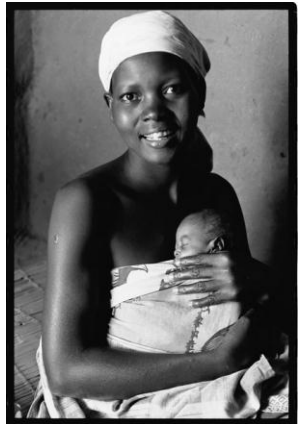


XII INTERNATIONAL CONFERENCE ON KANGAROO MOTHER CARE November, 14th to 17th 2018, Bogota - COLOMBIA

Potential impact of Kangaroo Mother Care on the neurobehavioral development of the ex-premature infant at middle and long term.

Dr Nathalie Charpak Pr Rejean Tessier
Laval, Quebec
Fundación Canguro, Bogota

U



THE PROBLEM



- 15 million children are born premature or LBW each year (10% of all deliveries in the world)
- Prematurity and LBW are a direct, or associated cause, of 50% of the 3.200.000 children's deaths occurring annually in the world 'during the first month of life
- 90% of LBW infants are born in low and middle income countries
- Diffusion of KMC is too slow and coverage is not sufficient
- Mid-term and long term effects for survivors:
 - Cognitive deficits, poorer academic performance, attention problems,
 - less social competence and less secure attachment and relationship.

What is the KMC method?

Kangaroo Mother Care Method has three fundamental components:

- 1) **Kangaroo position (KP)** - Skin to skin contact on the mother's chest, in upright position 24 hours a day
- 2) **Kangaroo nutrition** Exclusive breastfeeding or almost exclusively
- 3) **Kangaroo discharge policy:** Timely (early) discharge in kangaroo position with close and strict outpatient follow-up up to 40 weeks of gestational age. In a second step high risk follow up during at least the first year of corrected age in a KMC program



KMC is a concept, a method of care targeted mainly at the baby/mother dyad

There is a logical progression in the implementation of KMC in a hospital facility



1-Skin to skin contact o kangaroo position

Intermittent

Continuous

2-Breastfeeding the premature infant or kangaroo nutrition

Empowerment of the mother and the family

Kangaroo rooms/ward

3-Home discharge in kangaroo position and Kangaroo discharge policies with strict follow up

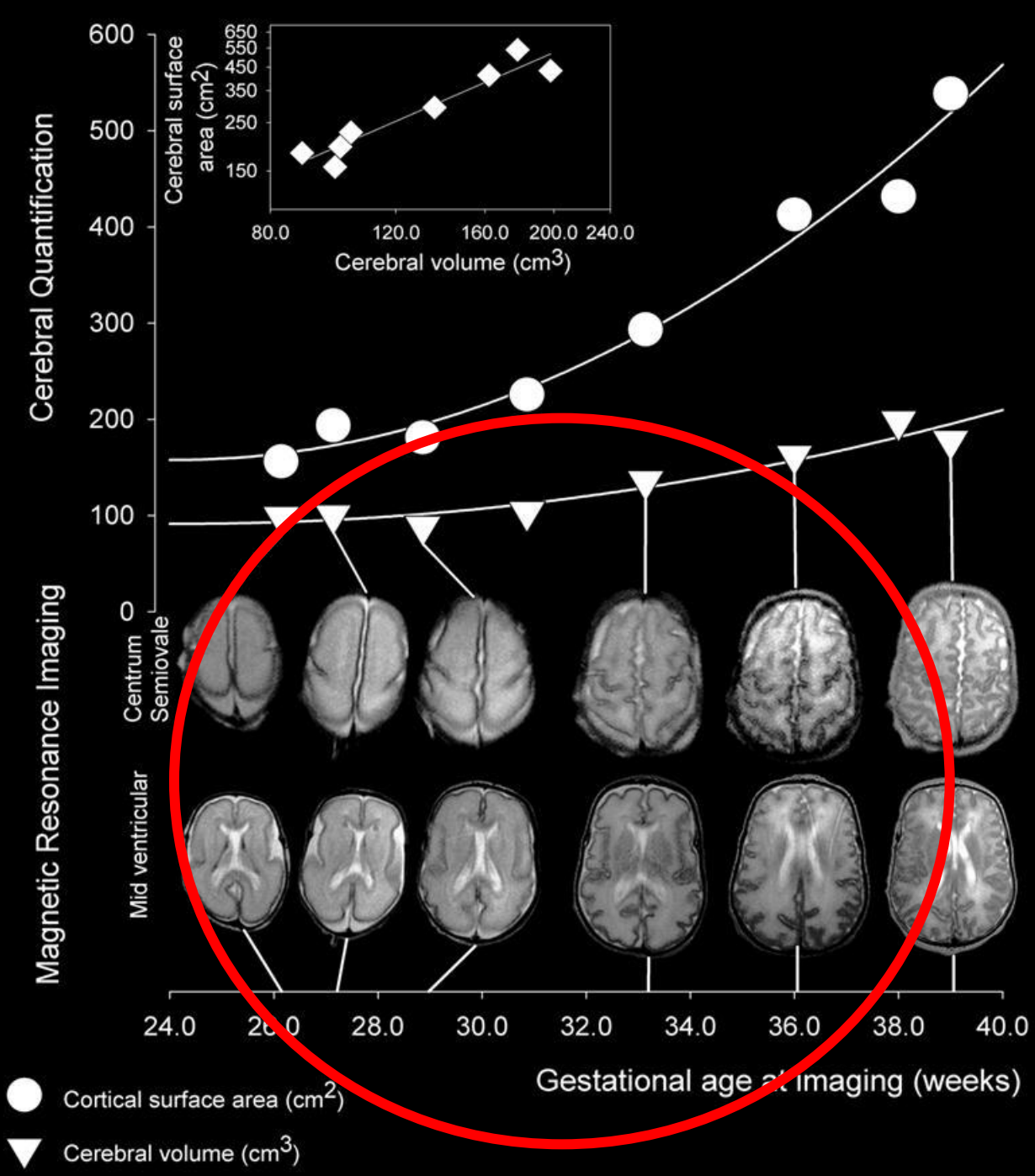
Macroscopic evolution of the brain between 24 and 40 weeks

Maturation of the brain

Brain cerebral volume increase x 1,5

Brain Cortex surface increase x 4

Cortesy Frédérique BERNE AUDEOUD



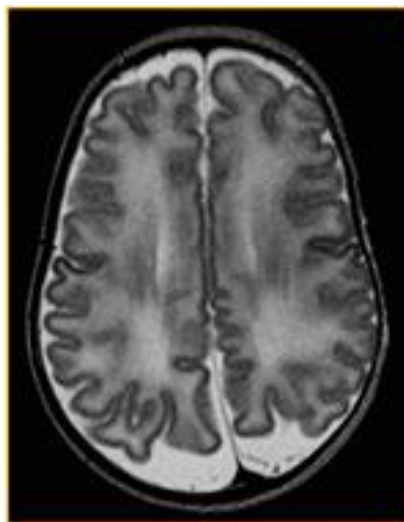
The main problem of prematurity?

Brain of a preterm infant at 40 weeks compared to a brain of a term infant (Rueckert 2003)



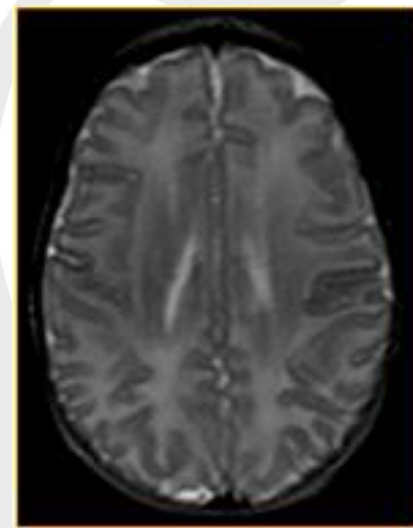
Preterm

Born at 25 weeks AG
Image at 25 weeks AG



Preterm

Born at 25 weeks AG
Image at 40 weeks AG



Term infant

Born at 40 weeks AG
Image at 40 weeks AG



Erika Pineros

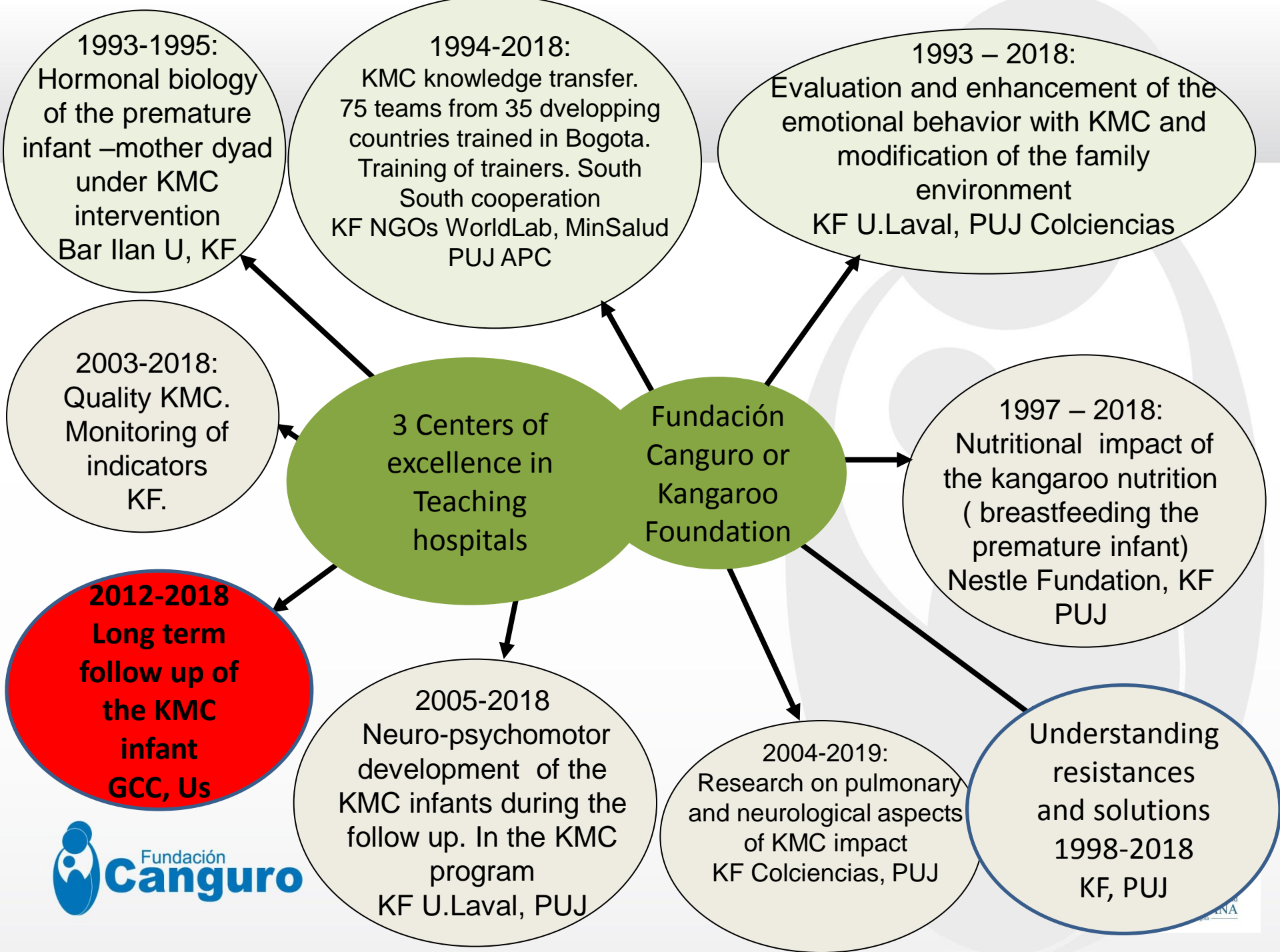




Early discharge
with Ambulatory
follow up



The life of the
kangaroo mother
and her baby at
home



1993-1997

Cognitive development in a sub cohort in a RCT KMC versus traditional care

1996 – 1998

Longitudinal descriptive study between 2 cohorts of preterm infants who received or not KMC during the neonatal period and a term infant cohort from the same socio economic level

1999 – 2018:

Short and long term Impact of KMC in the family environment of the premature infant

1993 – 2018:

Evaluation and enhancement of the social and emotional behavior in a cohort of preterm and low birth weight infant with or without KMC and modification of the family environment

2005

Ambulatory KMC and Brazelton scale

2013-2018

Comparison Griffiths/Bailey

2012-2018

Long term follow up of the KMC infant GCC, Us (5)

2010-2011 KMC and

cerebral connectivity in a adolescent cohort U Laval

1. Kangaroo mother care and the bonding hypothesis. *Pediatrics* 1998;102(2):e17
2. “Kangaroo Mother Care: a method for protecting high risk LBW and premature infants against developmental delay” *Infant behavior and development (IBAD)*26 (2003) 384-397. Elsevier Edition30.
3. Kangaroo Mother Care, home environment and father involvement in the first year of life: a randomized controlled study. *Acta Paediatr.* 2009 Sep;98(9):1444-50.
4. La prématurité : y survivre et s'en guérir. 2011 Rouen University, France
5. Brain motor excitability in adolescents born very preterm and influence of the Kangaroo Mother Care : a pilot study using transcranial magnetic stimulation *Acta Pædiatrica* 2012 101, pp. 1045–1053
6. [A Multi-faceted Visual Analytics Tool for Exploratory Analysis of Human Brain and Function Datasets.](#) *Front Neuroinform.* 2016 Aug 23; 10:36.
7. [Twenty-year Follow-up of Kangaroo Mother Care Versus Traditional Care.](#) *Pediatrics.* 2017 Jan;139(1) 2016-2063.
8. Long-term attention deficits combined with subcortical and cortical structural central nervous system alterations in young adults born small for gestational age. *Early Human Development*, 110, 44-49 (2017).
9. The long-term effects of the Kangaroo Mother Care intervention on cognitive functioning: Results from a longitudinal study. Stéfanie Ropars, Réjean Tessier, Natalie Charpak, Luis Felipe Uriza, *Developmental Neuropsychology.* Volume 43, 2018 - [Issue 1](#), Pages 82-91 | Published online: 29 Jan 2018

Photos 1993-1996



Objective of the first RCT in 1993

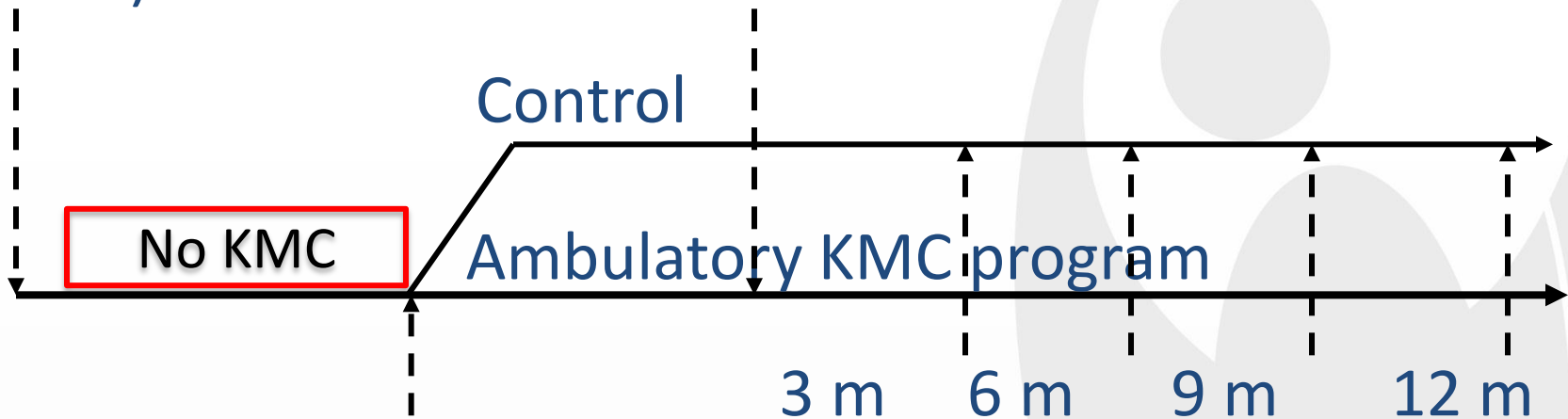
- Given that effects of socioeconomic factors and perinatal conditions (including gestational age and birth weight) were controlled for, morbimortality at one year in infants with birth weights equal to or less than 2000 assigned to the kangaroo method, are **at least as good** as those observed in infants under "traditional" care.
- Eligibility for the intervention: thermal stability while in incubator, appropriate nutritional intake, absence of bradycardia and/or apnea episodes, no ambulatory oxygen no treatment evaluated by experienced nurse while the infant is still in the hospital.

KMC after eligibility, after
NCU, after NICU, after
aggression, before
minimal care unit

RCT on the KMC method 1993-1996

Recruitment
(delivery room,
NCIU)

“Term or 40 weeks”



Eligible

(Randomization after stabilization)

Psychological and medical results

Pediatrics 1994; 94:804-810, .Pediatrics 1997;100:682-8, Pediatrics 1998;102(2):e17, . Pediatrics 2001;108:1072-9 . Infant behaviour and development 26(2003) 384-397

Mother feels more competent. she is more sensitive to her baby, especially if he stayed in NCIU, baby will respond better to her mother

Breast-feeding proportion was higher in KMC infants at 3 months

KMC infants spent less time in hospital

Less nosocomial infections in the KMC.

Protective effect with regard to mortality and infectious morbidity for more fragile infants, protective effect when father's level of education is very low, better Griffith quotients in infants with transient abnormalities in the INFANIB test and a mid-term impact (15 months) on mother-infant interactions where KMC mothers of infants with "transient" INFANIB were more sensitive and had more contingent responses.

Our results suggest a 50% RR reduction in mortality

Adequate Growth (HC)

KMC families had higher environmental scores, (appearing as greater stimulation for their KMC infants).

The MMK does not only have a component of education and modification of the family and social environment that acts on the stimulation that the child receives, but could have a direct "physiological and anatomical" action on the premature brain.



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Infant Behavior & Development 26 (2003) 384–397

Infant
Behavior &
Development

Kangaroo Mother Care: A method for protecting high-risk low-birth-weight and premature infants against developmental delay

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Received 25 November 2002; received in revised form 27 January 2003; accepted 12 February 2003

Abstract

Aim: The purpose of this study was to examine the relationship between intervention with Kangaroo Mother Care (KMC) and the subsequent mental development of the infants. In this prospective study, 431 low-birth-weight and premature infants (≤ 1801 g) were assigned randomly to KMC or Traditional Care. Of these, 336 (78%) received the Griffiths test at 12 months of corrected age. **Results:** After control for the infant's health at birth, family socioeconomic status and mother labor and delivery characteristics, the KMC infants had a higher IQ than those given traditional care (TC). The difference was most highly significant for infants who were more premature (30–32 weeks of gestational age), had required intensive care, and had a diagnosis of doubtful or abnormal neurological development at 6 months. The main impact of KMC was on the development of personal relations and on planning functions related to brain developmental stage at birth. **Discussion:** The KMC intervention can be viewed as a developmentally supportive care, in which parents are guided in managing their biological parenting abilities and which provides "brain care" during a highly sensitive period of a preterm infant's neurological development. © 2003 Elsevier Inc. All rights reserved.

Keywords: Kangaroo Mother Care; Low-birth-weight; Prematurity; Mental development; Developmental care

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E-mail address: rtessier@psy.ulaval.ca (R. Tessier).



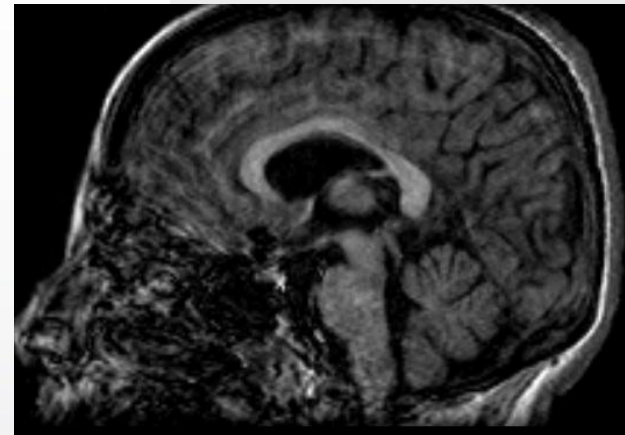
0163-6383/\$ - see front matter © 2003 Elsevier Inc. All rights reserved.
doi:10.1016/S0163-6383(03)00037-7

2003: The KMC intervention can be viewed as developmentally supportive care, in which parents are guided in managing their biological parenting abilities and which provides "brain care" during a highly sensitive period of a preterm infant's neurological development.



15 years later... What's about brain development

- ▶ “ Sensorimotor impairment, poorer cognitive outcomes and behavioral disabilities observed in school-aged preterm children, have been related to a reduction in the volume of rapidly conducting myelinated nerve fibers, with a 13–35% thinning of the corpus callosum (interhemispheric connection)”
- ▶ (Schneider et al, 2011)



Sensorial stimulations



Structure and functioning of the CNS

20 w

25w

36w

Connexion of 40.000 synapses per second

Neuronal migration

astrocitogénesis

oligodendrogénesis

axonal and dendritic development

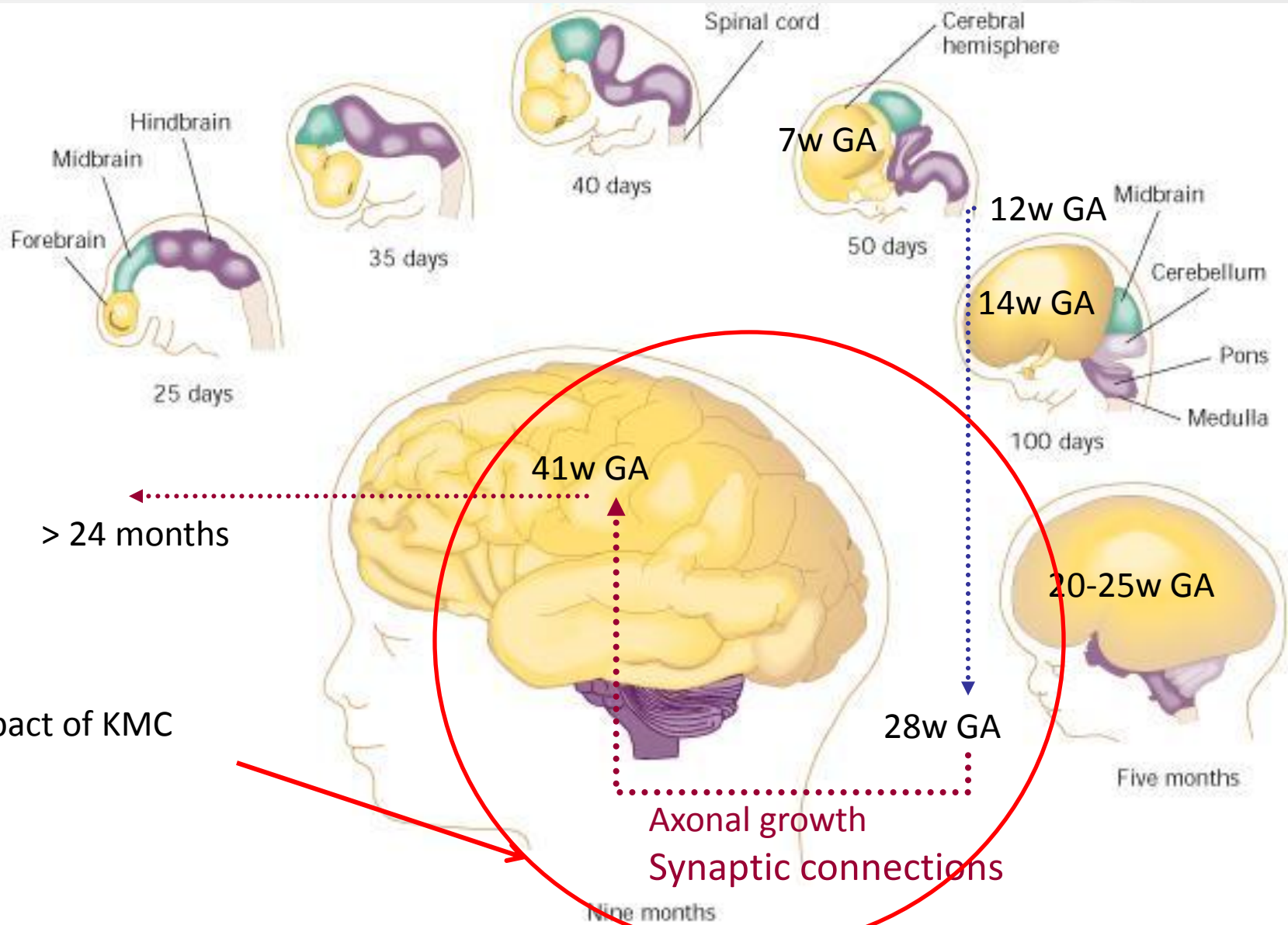
sinaptogénesis

- KMC intervention could nurture the infant brain, with multiple sensory informations from the parents:
 - tactile
 - cutaneous
 - olfaction
 - audition
 - balance
 - proprioception
 - and visual
- KMC: optimal condition for cerebral integration of the body sensorimotor scheme

Time window: between 26 and 43 weeks of gestational age= last trimester of pregnancy= synaptogenesis and establishment of the intra and interhemispheric networks



KMC time window



Neurogenesis

What happened 20 years after?

1. The documented 1-year benefits persist up to 20 years?
2. Does the KMC intervention has a long-term protective effect against cognitive, social, and academic difficulties as reported in long term follow up?
3. ¿Hay modifications in the functioning of the brain or in volumes of anatomical brain structures related with psychological test and KMC intervention?



¿Puede ayudar mejorar la imagen visual? Todos los días de su vida, cientos de niños y niñas se enfrentan al desafío de entender el mundo que los rodea. Conocerlo es el primer paso para el éxito y el bienestar personal.



Setenta años del Nacimiento de un Reto: el HUSI
www.husi.org.co



Centre de Recherche du CHU Sainte-Justine
Le centre hospitalier universitaire mère-enfant



UNIVERSIDAD DEL ROSARIO

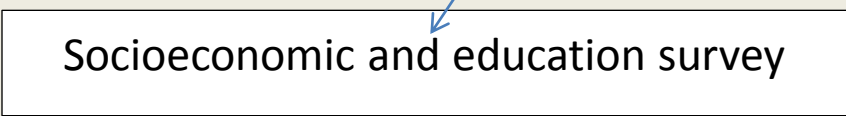
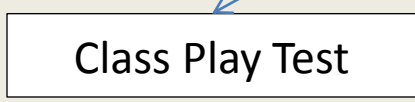
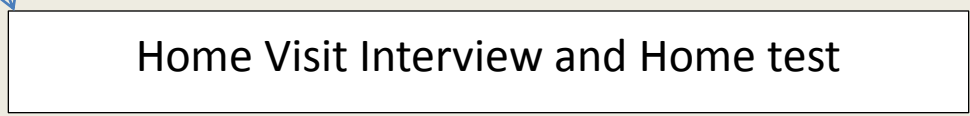
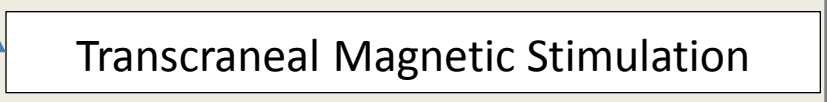
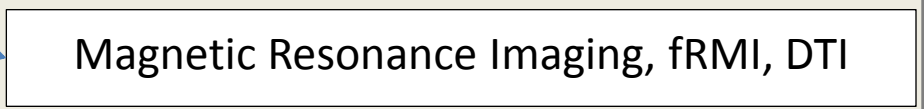
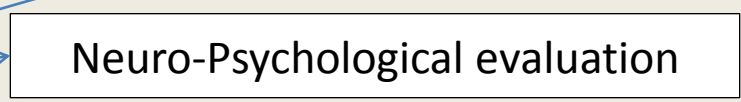
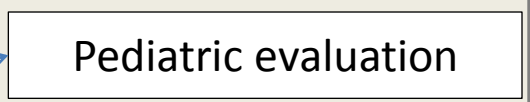
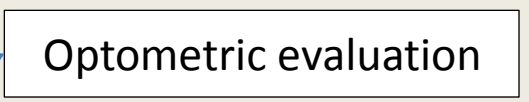
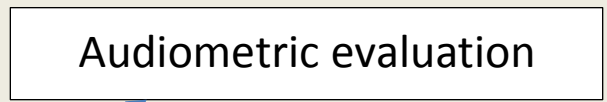
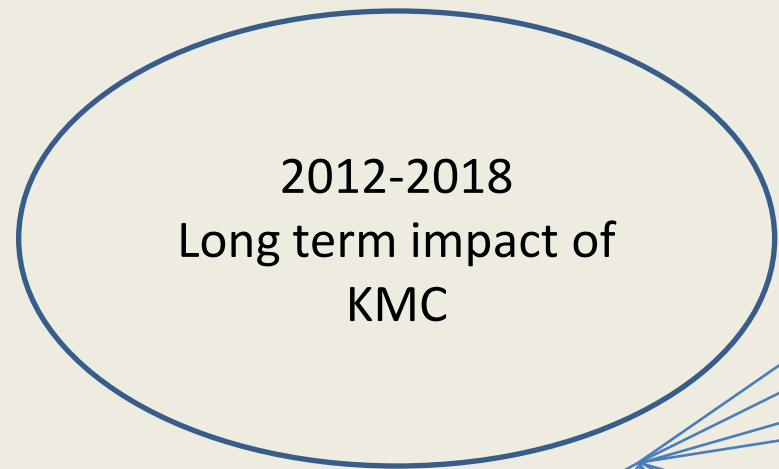


UNIVERSITÉ LAVAL
Faculté des sciences sociales
École de psychologie

Randomized open controlled trial on Kangaroo Mother Care versus traditional Care for low birth weight infants. Patient-centered outcomes at the age of 20 years. 2014 2017



Grand Challenges Canada™
Grands Défis Canada™



Population and Sample



433 Original RCT
Participants \leq 1800 g

412 survivors
at 1 year CA

293 participants
were located (71%)

119 participants
could not be located

3 died

6 living outside
Bogotá

20 refused to
participate

264
participants
(64%)



Outcome Variables

- Mortality and morbidity at 20 years
- General health at 20 years
 - Relevant medical history (diagnosed illnesses)
 - Clinical exam
 - Physical growth: height-for-age, weight-for-age, weight-for-height, head circumference; body mass index, lean body mass.
 - Metabolic profile

Outcome Variables

- Productivity and academic data
 - Preschool and school history
 - School achievement and performance (National Colombian Examination)
 - Labour force participation status and wages
- Sensory motor status
 - Fine motor skills, including visual motor integration.

Outcome Variables

- Cognition
 - General intelligence (Wechsler abbreviated scale of intelligence)
 - Memory (California Verbal Learning Test)
 - Attention (Test of attentional performance)
- Social and emotional behaviour
 - Behavioral and emotional problems (Conners Scal, ABCL)
 - Index of parent and peers attachment
 - Self-esteem and depressive mood
 - Stress and mental state (life habits)

Outcome Variables

- Family environment
 - HOME inventory during the domiciliary visit
- Sensorial acuity
 - Visual acuity: full optometric exam
 - Auditory acuity: tonal audiometry

Outcome Variables

- Neurophysiology and Imaging
 - Transcranial Magnetic Stimulation
 - Magnetic resonance imaging (MRI)
 - Functional MRI with five paradigms
 - Diffusion Tensor Imaging (DTI)

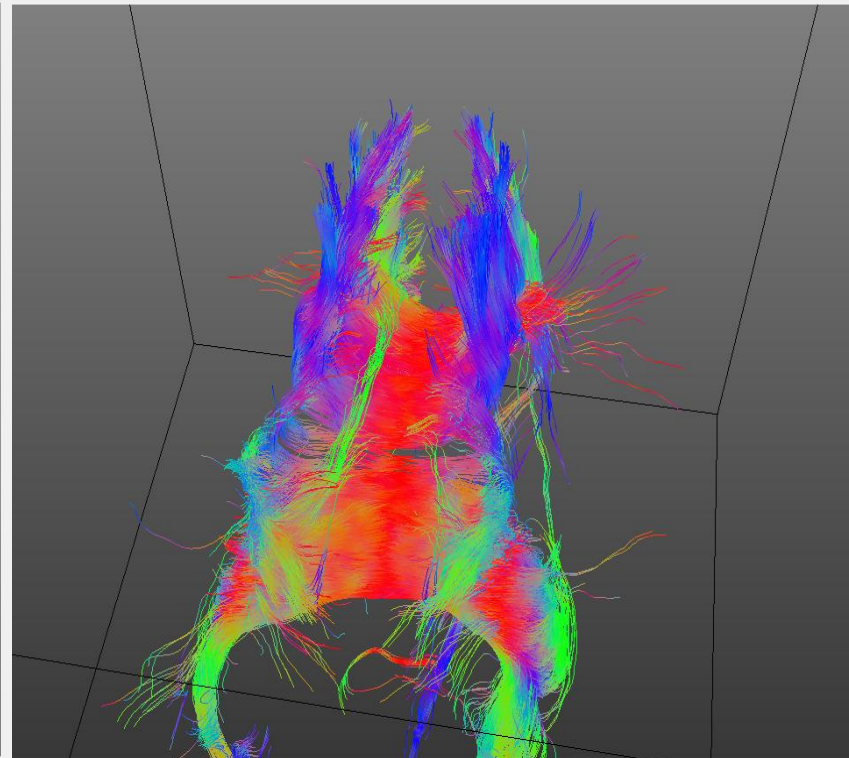
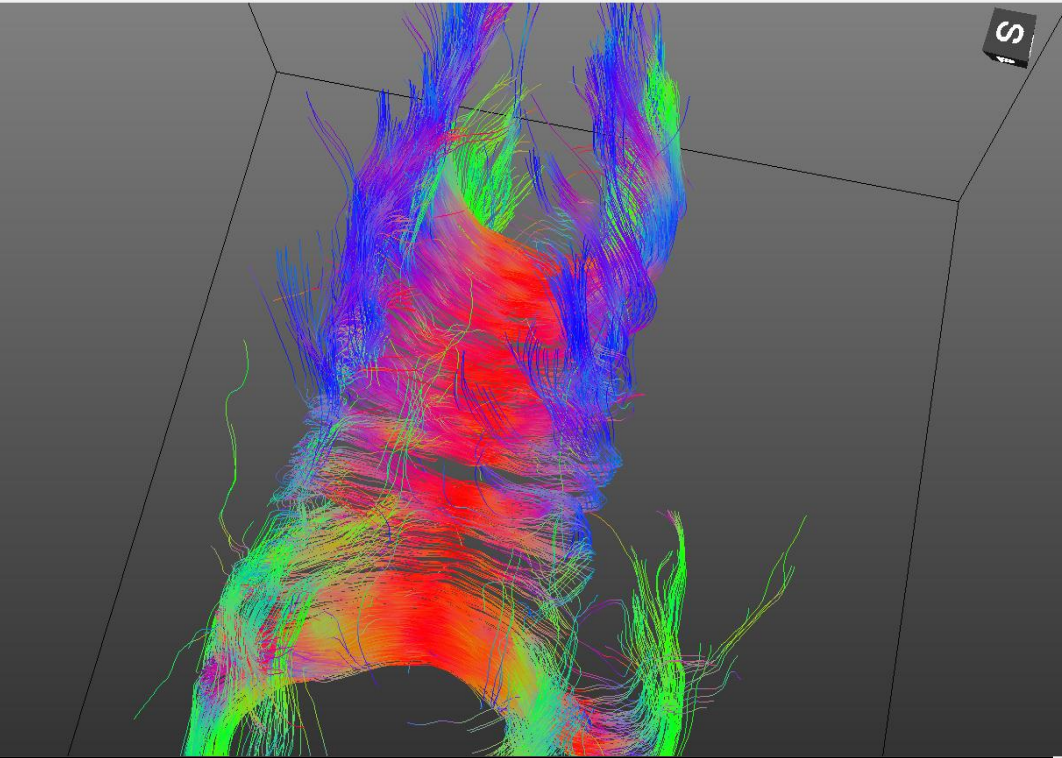
Innovative research for new tools to analyze neuroimages

Braviz (Grupo Imagine. U de los Andes)

Braviz: Subject Overview



Braviz: Subject Overview



Premature infant (Control=not KMC) of 900 gr at birth with 31 weeks of gestational age), IQ 78 (WISCR4) at 15 years

At term infant, male, 41 weeks of gestational age with a birth weight of 2855 gr. IQ 105 at 15 years

Angulo, D. A., Schneider, C., Oliver, J. H., Charpak, N., & Hernandez, J. T. (2016). A Multi-faceted Visual Analytics Tool for Exploratory Analysis of Human Brain and Function Datasets. *Frontiers in neuroinformatics*, 10.

Kangaroo mother care helps premature babies thrive 20 years later



Los bebés prematuros que se crían con el método canguro tienen mejor desarrollo físico y mental.

Los bebés prematuros que se crían con el método canguro tienen mejor desarrollo físico y mental. Los investigadores de la Universidad de Chile, en un estudio publicado en la revista *PLoS One*, descubrieron que los bebés que se crían con el método canguro tienen un mayor peso corporal y una mayor longitud al nacer, así como un mayor peso corporal y una mayor longitud al cumplir los 20 años de edad. Los investigadores también descubrieron que los bebés que se crían con el método canguro tienen un mayor peso corporal y una mayor longitud al cumplir los 20 años de edad. Los investigadores también descubrieron que los bebés que se crían con el método canguro tienen un mayor peso corporal y una mayor longitud al cumplir los 20 años de edad.

PEDIATRICS

Twenty-year Follow-up of Kangaroo Mother Care versus Traditional Care

Journal:	<i>Pediatrics</i>
Manuscript ID:	2016-2063.R1
Article Type:	Regular Article
Date Submitted by the Author:	n/a
Complete List of Authors:	Charpak, Nathalie; Fundacion Canguro, Research group; Tessier, Rejean; Universite Laval, Psychology Ruiz-Peláez, Juan; Pontificia Universidad Javeriana, Pediatrics Hernandez, Jose; Universidad de los Andes, Faculty of Engineering Uriza, Luis; Pontificia Universidad Javeriana, Radiology Villegas, Julieta; Fundacion Canguro, Research Nadeau, Line; Université Laval, Rehabilitation Mercier, Catherine; Université Laval, Reahabilitation Maheu, Francoise; CHU Ste-Justine, Centre de recherche Marin, Jorge; Hospital Universitario Infantil San Jose, Radiology Cortes, Darwin; Universidad Del Rosario, Economy Maldonado, Dario; Universidad de los Andes, Escuela de Gobierno Gallego, Juan ; Universidad Del Rosario, Economy
Keyword/Topic:	Public Health, Neonatology < Fetus/Newborn Infant

Prensa Libre, Guatemala
Page: 41

Los beneficios del método canguro

Cada año nacen en el mundo unos 15 millones de bebés antes de la semana 38 del embarazo.



Los bebés prematuros se benefician de haber mantenido un intenso contacto físico con sus padres, una década después del nacimiento, según revela un estudio sobre el llamado método canguro, desarrollado en Bogotá, Colombia, con ayuda de investigadores canadienses y publicado en la revista *Pediatrics*.

Los bebés prematuros que se crían con el método canguro tienen mejor desarrollo físico y mental. Los investigadores de la Universidad de Chile, en un estudio publicado en la revista *PLoS One*, descubrieron que los bebés que se crían con el método canguro tienen un mayor peso corporal y una mayor longitud al nacer, así como un mayor peso corporal y una mayor longitud al cumplir los 20 años de edad. Los investigadores también descubrieron que los bebés que se crían con el método canguro tienen un mayor peso corporal y una mayor longitud al cumplir los 20 años de edad.

Känguru-Methode mit viel Mehrwert

Langzeitstudie bestätigt von nachdrücklich den Nutzen für Frühgeborene.



Die Känguru-Methode ist ein Verfahren zur Betreuung von Frühgeborenen. Dabei werden die Kinder in einem Känguru-Karrier gehalten, was zu einer besseren Entwicklung führt.

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“袋鼠育儿法”有助于提升早产儿的健康和智力
"Kangaroo Parenting Act" to help improve the health and intelligence of premature children

El artículo fue reportado en más de 500 noticieros on-line, 18 idiomas, 50 países, más TV y prensa escrita!!!!

- Reuters, UK
Spanish: *Método "mamá canguro" favorece la salud de los niños a largo plazo*
<https://es-us.noticias.yahoo.com/m%C3%A9todo-mam%C3%A1-canguro-favorece-la-salud-los-ni%C3%B1os-140001673.html>
- Can Tho Online, Viet Nam
Phương pháp "da kê da" có lợi cho trẻ đến khi trưởng thành
<http://www.baocantho.com.vn/?mod=detnews&catid=74&id=187620>
- Neuf Mois, France
En quoi le peau à peau avec un bébé né prématuré lui est favorable 20 ans plus tard ?
<http://www.neufmois.fr/au-fil-de-lactu/quoi-peau-a-peau-bebe-ne-premature-lui-favorable-20-ans-plus-tard>
- The Post Internazionale, Italy
La Canguro Terapia Migliora La Salute e L'intelligenza Dei Bambini Prematuri
<http://www.tpi.it/mondo/colombiana/canguro-terapia-migliora-salute-intelligenza-bambini-prematuri>



Primary Finding

Cumulative Mortality at 20 years

KMC (N/Total)	Control (N/Total)	OR (95% CI)
8/229 (3.5%)	16/204 (7.7%)	0.42 (0.18 -1.02)

- After adjusting for weight and gestational age at birth:

Protective effect of KMC OR 0.42 (0.16-0.94) $P=0.04$

Repeated measures of developmental and environmental outcomes at 6 months, 1 and 20 years according to neurological status at 6 months in the re-enrolled sample (≤ 1800 g)

Measure	KMC		Controls		<i>P</i>		
	Normal	Transient or abnormal	Normal	Transient or abnormal	KMC vs controls	Neurological status	Interaction between neurological status and groups
IQ at 6 months, Mean (SD)	98.1 (10.0)	90.0 (13.4)	99.5 (9.2)	84.5 (12.6)	0.23	0.00	0.03
IQ at 12 months, Mean (SD)	103.4 (6.6)	99.4 (8.8)	103.0 (6.7)	94.6 (10.2)			
IQ at 20 years, Mean (SD)	87.2 (13.1)	90.2 (14.9)	89.9 (14.9)	87.0 (12.7)			
HOME at 12 months, Mean (SD)	39.3 (6.8)	39.9 (5.5)	39.7 (7.5)	35.5 (8.0)	0.11	0.12	0.02
HOME at 20 years, Mean (SD)	39.5 (7.3)	40.5 (6.0)	40.7 (6.6)	36.6 (5.4)			

Outcomes of the intervention observed at 12 months of corrected age on IQ at 20 years

Outcome at 1 year	IQ at 20 years		P
	IQ < 90	IQ ≥ 90	
Factorial score* of weight during first year of corrected age (mean (SD))	- 0.16 (0.96)	0.01 (0.89)	0.01
Factorial score* of height increase during first year of corrected age (mean (SD))	- 0.24 (0.95)	0.07 (0.97)	0.01
Factorial score* of head circumference during first year of corrected age (mean (SD))	- 0.12 (0.95)	0.15 (0.98)	0.03
Head circumference at 1 year of corrected age per 50th percentile of expected head circumference for age and gender x 100 (mean (SD))	97 (3.13)	98 (2.72)	0.01
Factorial score* of maternal feeling of stress (mean (SD))			
At 41 weeks	0.12 (0.93)	-0.14 (1.15)	0.04
At 1 year of corrected age	-0.13 (0.90)	0.28 (0.99)	0.00
HOME test at 1 year of corrected age (mean (SD))			
All five subscales	37.5 (6.24)	40.4 (5.32)	0.00
Family cognitive stimulation subscale	4.4 (2.34)	5.6 (2.46)	0.00
Structured environment subscale	5.5 (1.49)	5.8 (1.26)	0.02

* Factorial score of weight, height and head circumference at 40 weeks, 3, 6, 9 and 12 months of CA.

KMC and attachment at 20 years: is there a specific gender effect?

Frédérique Bégin-Auclair, Joanie Lamirande, & Réjean Tessier

École de psychologie, Université Laval, Canada

Contact

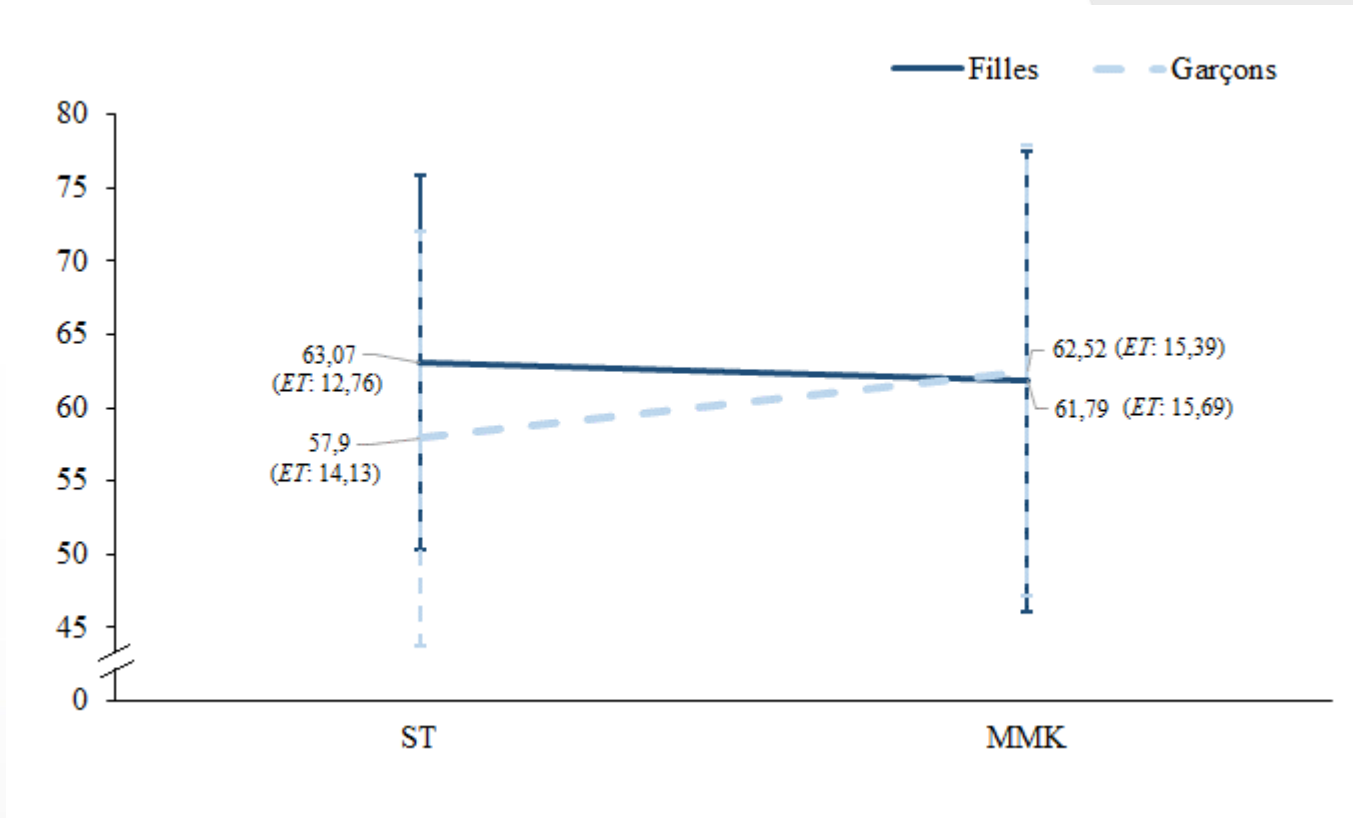
Objective: to study the attachment differences at 20 years according to gender and exposure to KMC during the neonatal period



Attachment's gender difference and KMC

- Even when they are born at term, girls are 1.8 times more likely to have a secure attachment than boys (Gloger-Tippelt & Kappler, 2016). In a premature birth, boys are the more vulnerable, since their right brain (responsible for attachment functions) has a slower growth and is therefore more sensitive to social and environmental stressors (Schoore, 2017).
- The structures involved are the right prefrontal cortex which regulates the limbic system and the right orbitofrontal system, with its cortical and subcortical connections (Schoore, 2000, 2017).

There is a girl / boy difference (better in girls) in the control group ($p < ,02$) and none in the KMC group



KMC and Working Memory in a large sample of premature young adults

BROCHU-HAMEL, Camille; CARON, Laurence; CAYOUILLE, Audrey; TESSIER, Réjean
Université Laval, Québec, Québec, Canada

- Prematurity (<37 weeks' gestation) affects brain development in regions such as the hippocampus and executive functions such as the Working Memory
- KMC is a early intervention that could decrease the impact of prematurity through a reduction of stressful environmental factors
- KMC at birth favored Working Memory for both gender $F(1,238) = 3,73, p = 0,05$
- However, girls make significantly fewer errors of omission than boys ($F(1,238) = 6,33, p = ,01$, which is inversely proportional to the Working Memory score

Paternal Support

- Paternal support had a positive impact on the home environment at 1 year of corrected age (CA).
- Paternal support at one year of CA depends on whether the father had carried the infant in the Kangaroo Position during the neonatal period.
- Clear relation between paternal support at 1 year and the stability of the family 20 years later (score for paternal support in families without separated parents, 15.3 versus 14.6 for separated families, $P = 0.01$).

Social Behaviour

Mother's level of education	KMC		Controls		P		
	Low level	Higher level, mean (SD)	Low level, mean (SD)	Higher level, mean (SD)	KMC vs controls	Mother's level of education	Interaction mother's level of education and intervention
Conners hyperactivity, mean (SD)	62 (10)	65 (15)	74 (14)	60 (14)	0.15	0.01	0.00
Conners aggressivity, mean (SD)	54 (12)	54 (11)	64 (15)	53 (11)	0.03	0.00	0.00
ABCL DSM antisocial, mean (SD)	69 (16)	71 (14)	78 (14)	68 (16)	0.29	0.09	0.02
ABCL DSM internalization, mean (SD)	72 (26)	74 (24)	82 (16)	74 (22)	0.23	0.42	0.18
ABCL DSM externalization, mean (SD)	63 (24)	64 (22)	79 (16)	62 (23)	0.09	0.03	0.00

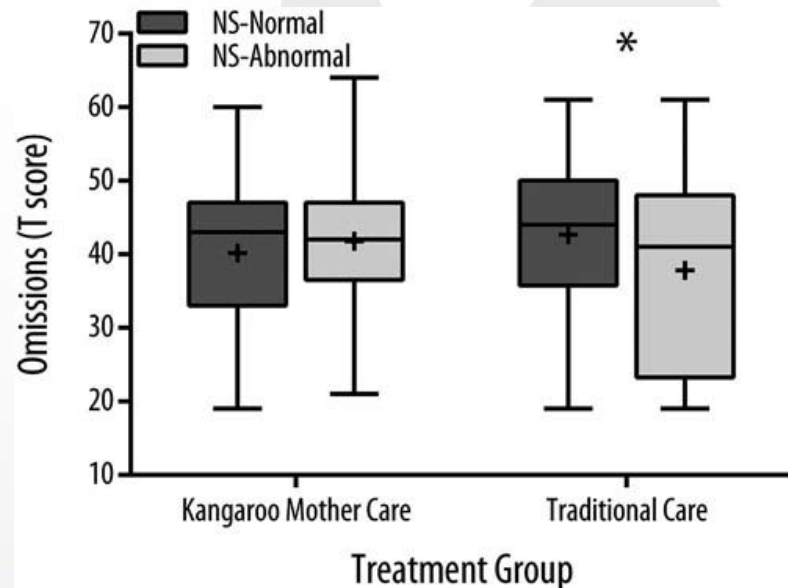
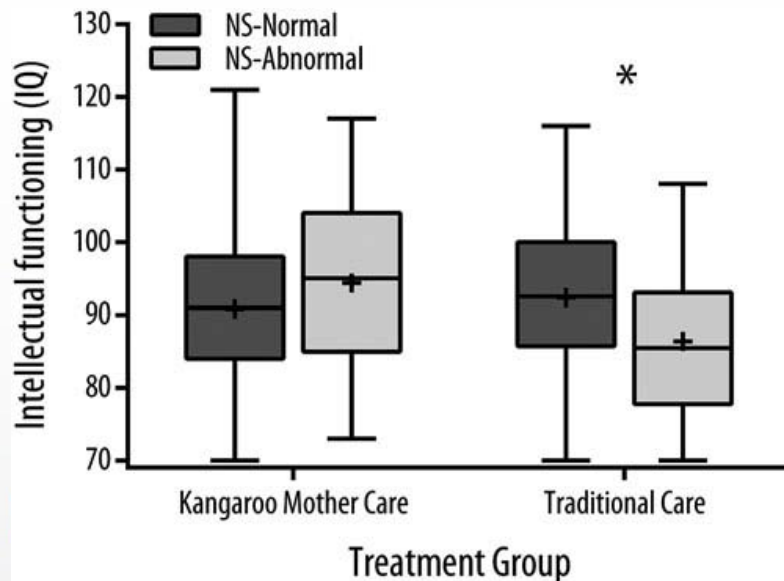
The long-term effects of the Kangaroo Mother Care intervention on cognitive functioning: Results from a longitudinal study

Stephanie Ropars, R Tessier, N Charpak, L Uriza
Universite Laval, Quebec

ABSTRACT

Three hundred infants were randomly assigned at birth in one of two interventions, KMC or traditional care (TC), and completed cognitive tests at adulthood (19–21 years after recruitment).

The main results show that participants with a neurological vulnerability at 6 months had higher IQ and sustained attention scores at adulthood if they had received KMC than if they had received TC.



RELATIONSHIP BETWEEN ATTACHMENT WITH MOTHER, SELF-ESTEEM, HOME ACCEPTANCE AND SUICIDAL BEHAVIOR IN A COHORT OF EX-PREMATURE YOUNG ADULTS EXPOSED OR NOT TO KANGAROO MOTHER CARE METHOD DURING THE NEONATAL PERIOD

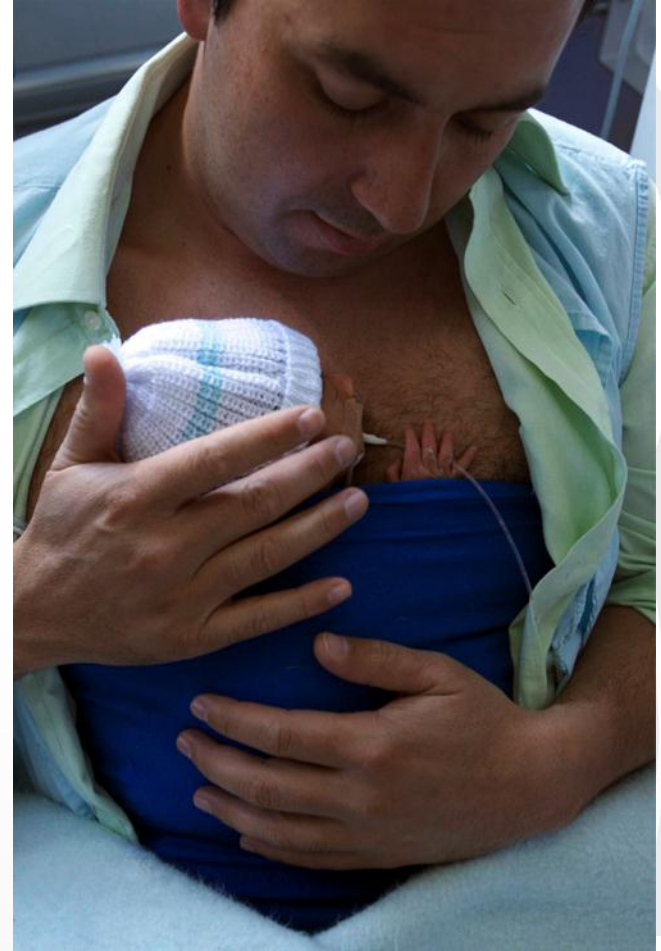
A.Montealegre N. Charpak
Kangaroo Foundation, HUSI, PUJ

There is evidence of lower attachment quality and less control of emotions in patients who have been preterm.



Objective

- To evaluate aspects such as the quality of attachment, self-esteem, the environment and the antecedent of suicidal behavior in young adults with a history of prematurity and Kangaroo Mother Care(KMC) during the neonatal period compared with young adults born at term.



Results

The participant has considered commmitting suicide	Odds Ratio	Std. Err.	p	95% CI	
Attachment Total Score	0.95	0.01	0.00	0.93	0.97
Self Esteem total Score	0.88	0.04	0.00	0.81	0.96
Preterm	2.50	1.28	0.08	0.91	6.87
Days of KP	0.89	0.06	0.09	0.79	1.02
HOME20y Accept	0.82	0.08	0.03	0.68	0.98
HOME20yAccept*Days of KP	1.01	0.01	0.08	0.99	1.03
_Cons	177.4	255.5	0.00	10.55	2983.4

Logistic Regression
Number of Observations= 452
LR Chi2(6)= 51.3
p>Chi2= 0.0000
Pseudo R2= 0.18

Schooling, productivity, academic record, and work history

Variable	KMC (n=139)	Controls (n=125)	Difference	P-value
Years of preschool, mean (SD)	2.52 (1.07)	2.05 (1.04)	0.47 (0.14)	0.00
School absenteeism, mean (SD)	0.07 (0.26)	0.17 (0.37)	-0.09 (0.04)	0.01
Years of school, mean (SD)	11.31 (1.34)	11.50 (1.61)	-0.19 (0.18)	0.15
School quality, mathematics score, mean (SD)	48.22 (4.72)	48.38 (4.26)	-0.16 (0.65)	0.40
Standardized mathematics score, mean (SD)	-0.17 (0.99)	0.17 (1.02)	-0.35 (0.14)	0.01
Standardized language score, mean (SD)	-0.12 (0.89)	0.13 (0.85)	-0.26 (0.13)	0.02
Wage per hour, mean (SD)	4.77 (6.65)	3.13 (2.29)	1.65 (0.78)	0.02

School quality is the school average in the nationally standardized test score in mathematics
Wage per hour is given in thousand Colombian pesos; 1000 pesos is equivalent to US\$ 0.40

Neurophysiology and neuroimages

- Transcranial Magnetic Stimulation (TMS)
- Nuclear Magnetic Resonance (NMR)
- Functional RMI with 5 paradigms: coordination, motor prehension, attention, memory, emotion
- Tractography (DTI)

Oct 2012

REGULAR ARTICLE

Cerebral motor function in very premature-at-birth adolescents: a brain stimulation exploration of kangaroo mother care effects

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2.Department Rehabilitation, Faculty of Medicine, Université Laval, Québec, QC, Canada

3.Kangaroo Foundation, Bogotá, DC, Colombia

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ABSTRACT

Aim: Given that prematurity has deleterious effects on brain networking development beyond childhood, the study explored whether an early intervention such as Kangaroo Mother Care (KMC) in very preterm preemies could have influenced brain motor function up to adolescence.

Methods: Transcranial magnetic stimulation (TMS) was applied over the primary motor cortex (M1) of 39 adolescents born very prematurely (<33 weeks' gestational age, 21 having received KMC after birth, 18 Controls with no KMC) and nine adolescents born at term (>37 weeks' gestational age, >2500 g) to assess the functional integrity of motor circuits in each hemisphere (motor planning) and between hemispheres (callosal function).

Results: All TMS outcomes were similar between KMC and term adolescents, with typical values as in healthy adults, and better than in Controls. KMC adolescents presented faster conduction times revealing more efficient M1 cell synchronization ($p < 0.05$) and interhemispheric transfer time ($p < 0.0001$), more frequent inhibitory processes with a better control between hemispheres ($p < 0.0001$).

Conclusion: The enhanced synchronization, conduction times and connectivity of cerebral motor pathways in the KMC group suggests that the Kangaroo Mother Care positively influenced the premature brain networks and synaptic efficacy up to adolescence.

Neuroimages

- We have 214/264 (78%) sujetos de $\leq 1,800$ gr (target population) with a RMN, 195 were available for the classification of white matter lesions, there was no difference between the 2 groups (66% (N=78) versus 58% (N=54) $p = 0,16$).
- The main obstacle for the RMI has been the presence of “brackets”.

Caudate nucleus volume according to duration of the kangaroo position

Variables associated with left caudate nucleus volume at 20 years

Time	Variable	Slope	P
Before intervention	Fragility index	- 0.29	0.00
During intervention	Duration of kangaroo position	+ 0.25	0.00
At 20 years	Nine-hole peg test	- 0.18	0.01

Results of linear regression ($r^2 = 0.16$ F (3.17) =12.21 P=0.00 calculated with Braviz software (25)

Brain amygdales and prematurity

- Brain amygdales play an important role in social development and neural control of emotions, especially fear.
- These structures are particularly vulnerable to injuries suffered by preterm labor.

RMN

(no brackets, without movements)

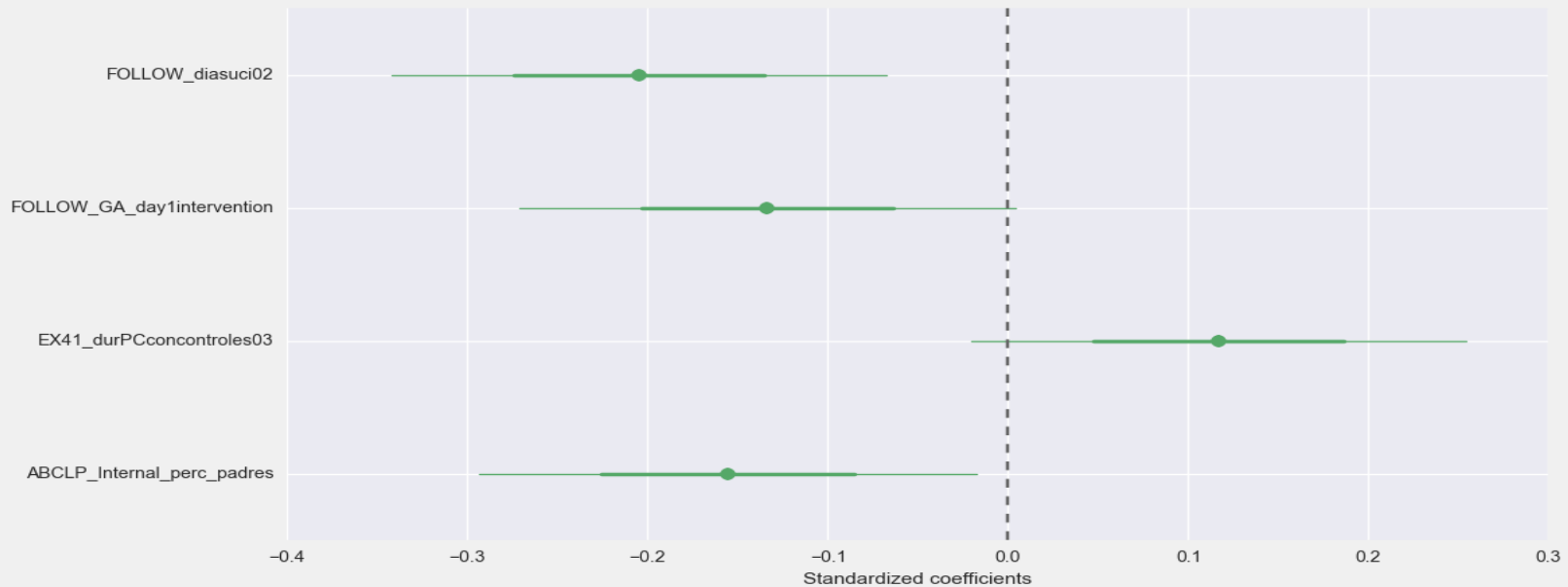
Group	Frequency	Percentage
KMC less than 2001g	104	44,8
Control less than 2001g	91	39,2
Reference population (more than 2500g)	37	15,9
Total	232	100,0

Brain amygdale volumes according to preterm/term group

		N	Media	Typical Deviation	Typical Error	CI 95%		p
						Min	Max	
ASEG_Left- Amygdala volume(mm)	At Term	37	1702.8	253.2	41.6	1618.4	1787.2	0.02
	Preterm	195	1600.0	247.7	17.7	1565.0	1635.0	
ASEG_Right- Amygdala volume(mm)	At Term	37	1782.9	237.7	39.1	1703.6	1862.2	0.07
	Preterm	195	1682.3	313.6	22.5	1637.9	1726.5	

*Comparing preterm and at term patients, a smaller volume of both, left amygdale, with a difference of 102 mm³ (p = 0.02) and right amygdale, with a difference of 100 mm³ (p = 0.07) was evidenced.

Volume of the left amygdale



Coefficients:

Coefficient	Slope	T Value	P Value
(Intercept)	-0.000000	-0.000000	1.000000
ABCLP_Internal_perc_padres	-0.155220	-2.218780	0.027692
EX41_durPCconcontroles03	0.117297	1.689011	0.092866
FOLLOW_GA_day1intervention	-0.133195	-1.908700	0.057816
FOLLOW_diasuci02	-0.204223	-2.932970	0.003773

$R^2 = 0.07$

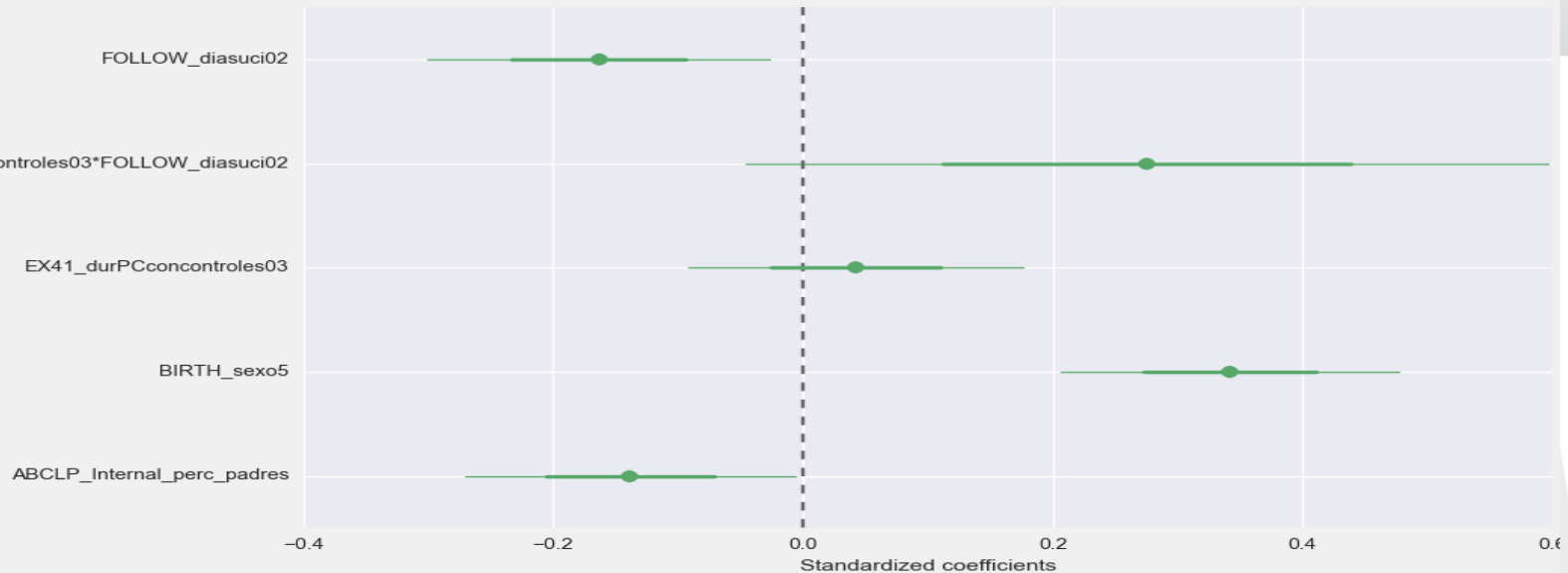
$F(4,189) = 4.84$

$P = 0.000970$

Left Amygdale Volume

- more days in NICU, less volume
- more KP, more volume
- more internationalization, less volume

Volume of the right amygdale



Coefficients:

Coefficient	Slope	T Value	P Value
ABCLP_Internal_perc_padres	-0.138528	-2.067573	0.040050
BIRTH_sexo5	0.341792	4.985425	0.000001
EX41_durPCconcontroles03	0.042438	0.624030	0.533365
EX41_durPCconcontroles03*FOL...	0.275208	1.693195	0.092075
FOLLOW_diasuci02	-0.163500	-2.345262	0.020057
R ² = 0.14			F(5,188) = 7.23
			P = 0.000003

Right Amygdale Volume

- more WASI score, more volume
- male, more volume
- KP and hospitalized in NICU, more volume

Fear paradigm

- 113 fear paradigms in fMRI at 19-20 years
- Not yet analyzed
- Hypothesis: ex-Premature cared in KMC during the neonatal period are able to control better their emotions than ex premature infants who received traditional care.

Hippocampus volume and memory

- Especially sensible to hypoxia
- Less volumes in preterm infants compared with at term infants.
- Right hippocampus (or non dominant) is specially involved in visuospatial memory evaluated with VMI test while left hippocampus (or dominant) works in verbal memory processes evaluated with CVLT test.
- Left hippocampus
 - More days in NICU, less volume left hippocampus
 - Although being in NICU, more Kangaroo Position, more volume
 - Male, more volume
 - Less weight and NICU hospitalization , less volume
 - In spite of having less weight, more volume if Kangaroo Position
 - Less volume left hippocampus in fragile infants
 - Less intrusions in CVLT test, more volume
- Right hippocampus
 - More days in NICU, less volume
 - Although being in NICU, more Kangaroo Position, more volume
 - Male=more volume
 - In spite of having less weight and NICU hospitalization, more volume if Kangaroo Position
 - More volume, higher VMI visual standard score,controlling for fragility, NICU hospitalization, sex and Kangaroo Position

Food for thought

- At 20 years, KMC participants, especially in the poorest and least educated families:
 - Less aggressive drive
 - Less impulsive and hyperactive
 - Less antisocial behaviour
- KMC may change the behaviour of less well-educated mothers by increasing their sensitivity to the needs of their children
- We cannot separate the effects of stimulation by the family from a functional or anatomical impact of the intervention on the brain.

Food for thought

- Family changes are an obvious effect of KMC.
- Reduction of contextual disparities.
- KMC mothers take their children to preschool earlier
 - Lower rate of school dropout.
- KMC promotes paternal involvement in neonatal care, which affects the family structure.
 - In this long-term study, fathers' involvement changed the young adults' cognitive capacity.

Food for thought

- They had significantly larger cerebral volumes of total grey matter, and cerebral cortex and it seems that the duration of Kangaroo position has an impact on these volumes
- The KMC (Kangaroo Mother Care) method is an intervention that allows shortening the separation from mother, and could stamp the stress and its consequences caused by the NICU on preterm infant. In 1994 the mother was not allowed to visit her infant in the NICU, the light, the noise and the pain were intense and a routine for these fragile infants. This situation is better now in developed countries but remains similar in a lot of neonatal units especially in the developing world where the challenge is the survival without considering the quality of the survival.

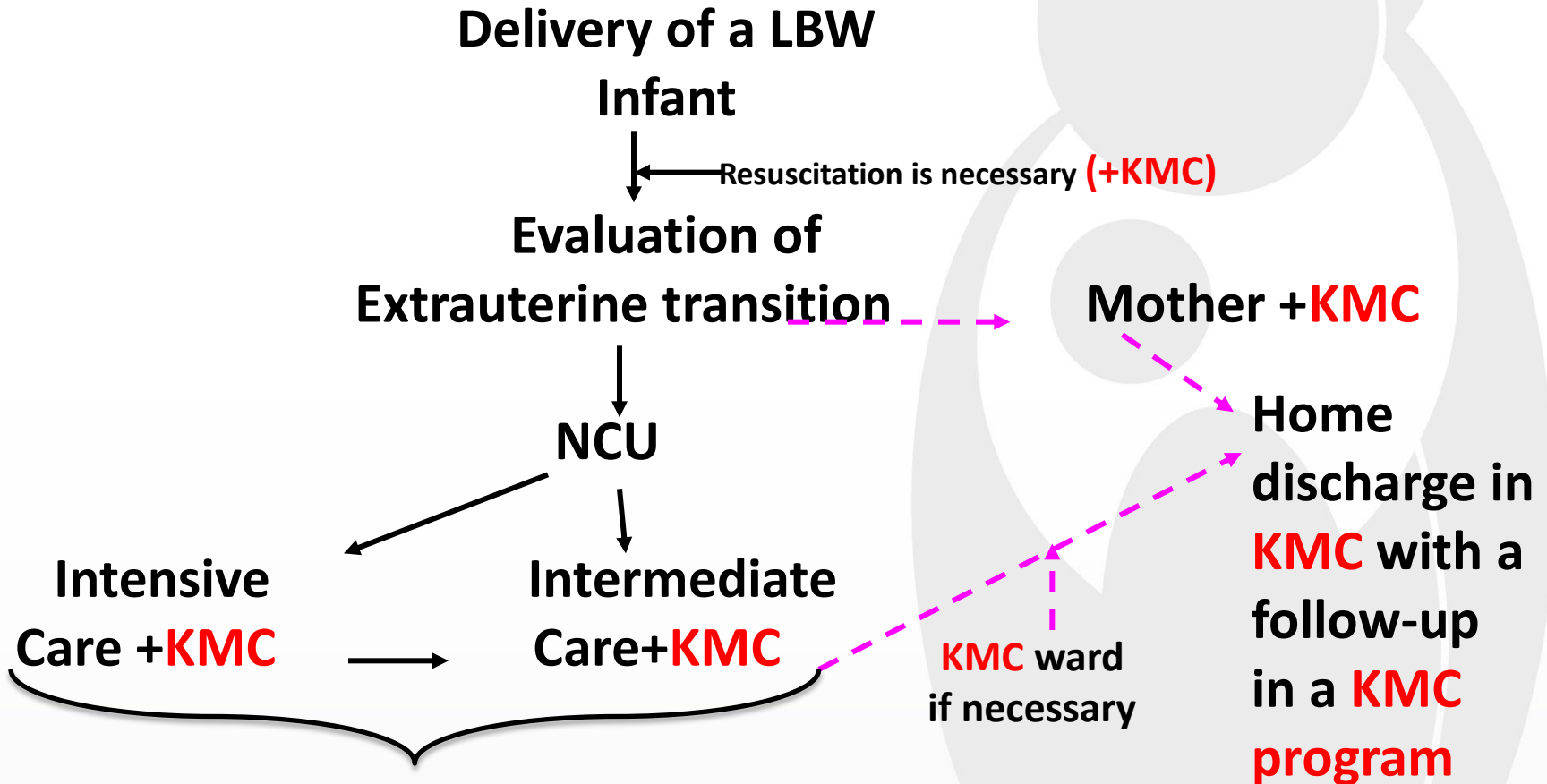
Food for thought

- The moment at which KMC is administered is considered decisive since it is during the third trimester, a critical period for the development of the central nervous system, where interventions are most likely to have a significant and durable effect on cognitive functioning (Als et al, 2012; Kaffashi, Ludington-hoe et al, 2013).
- Moreover, perinatal care depriving infants from physical proximity with their mothers could also cause other types of biophysiological alterations contributing to the emergence of cognitive difficulties:
 1. First, maternal separation could increase apoptosis (e.g. programmed cell death), a phenomenon to which neurons are particularly vulnerable during the post-natal period (Bhutta et al. 2002).
 2. Second, the experience of painful events (e.g. medical interventions, high exposure to lights and noises) could cause an excessive release of excitatory amino acids in premature infants leading to neuronal damage (Anand & Scalzo, 2000)
 3. Finally, at the behavioral level, these events can lead to a disruption of the physiological activation cycle, to altered functioning of the hypothalamic-pituitary axis (HPA) and to difficulties in self-regulation.

Conclusion

- The detection of “minor” sequelae becomes important as neonatal technology becomes more accessible.
- Such “minor” effects can affect the lives of families but often go undetected, especially in developing countries.
- We hypothesize that the results obtained in our study at 18-20 years would be even more significant if KMC was introduced as soon as the infant could tolerate it, in the intensive care unit.

How is the intervention in 2018?

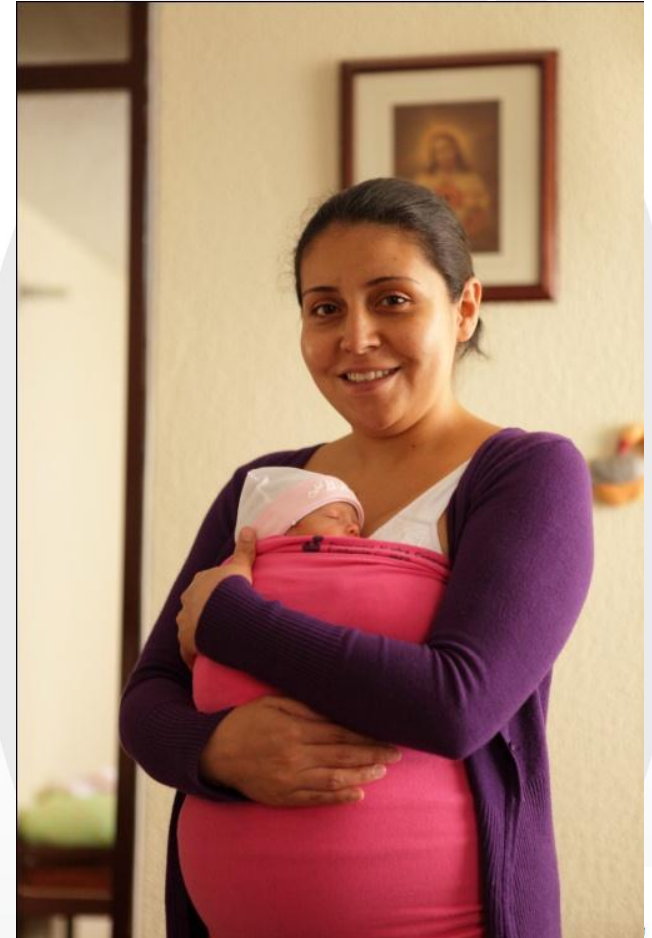


Hospital stay decrease around 10 days even without early discharge
(Sweden, Spain, France)

KMC as soon as possible with the premature infant and its family



...at home during the ambulatory KMC program



2018: <https://www.gatesnotes.com/Health/What-kangaroos-can-teach-us-about-saving-lives>



Lifescovers

What kangaroos can teach us about saving lives

By Bill Gates | July 21, 2018

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- 4 22 COMMENTS
- 5 241

I write a lot about new inventions that are improving people's health and saving lives around the world. But some breakthrough ideas don't involve any new technology at all. Let me tell you about one of my favorite examples—a solution that is readily available, requires no special equipment, and is so cheap any government can support it.

It's called **kangaroo mother care**—continuous skin-to-skin contact between mothers and low-birth-weight or premature babies. Combined with exclusive breastfeeding, this practice prevents neonatal deaths by regulating the baby's temperature, accelerating weight gain, and reducing the risk of infections. What's more, it encourages mother-infant bonding at a critical time of the child's development.



It takes a long time to transform new idea into reality