Recent Update of Early Intervention in NICU

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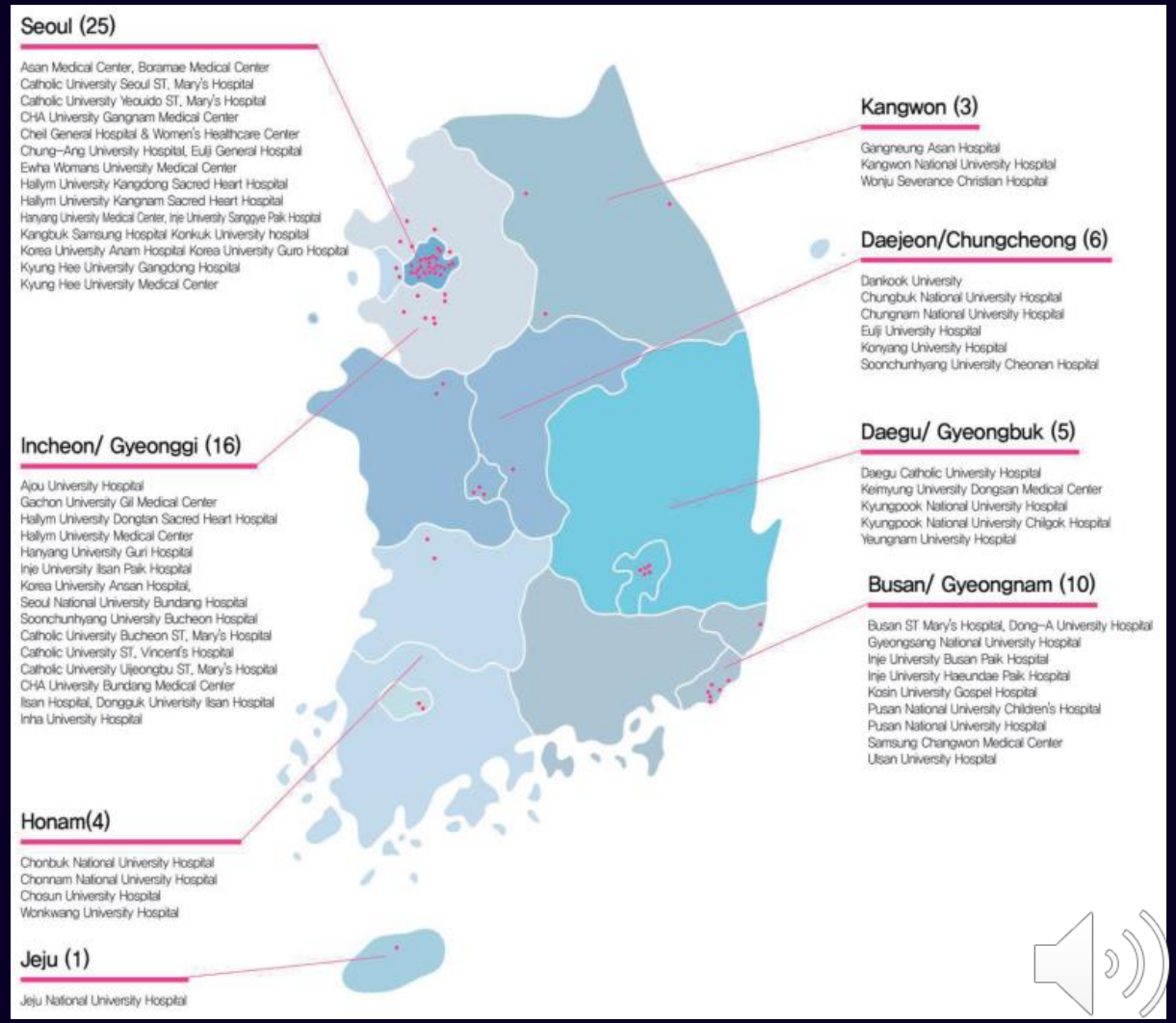
1. Epidemiology in Korea

한국 신생아 네트워크(Korean Neonatal Network)

- Population-based data for VLBW infants (2013-) from 72 hospitals
- 85% of all VLBW infants
- 3-year clinical outcomes



Very Low Birth Weight (VLBW): <1500g

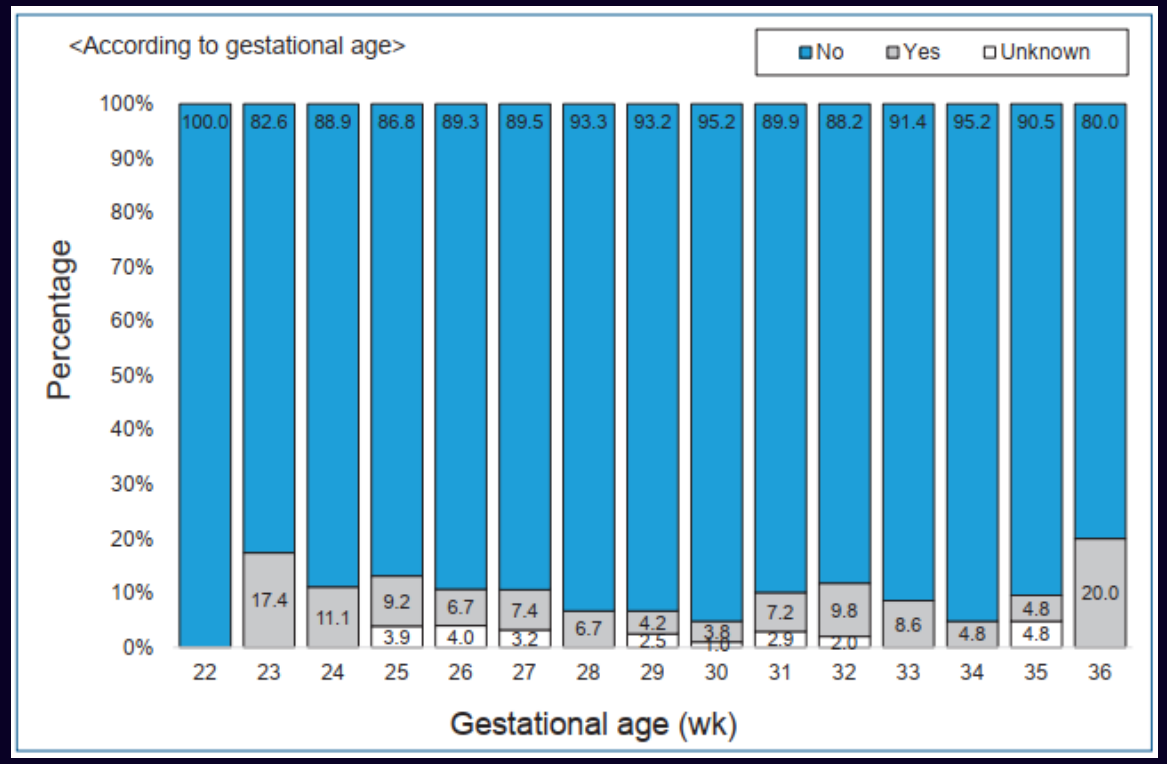
Neonatal complications (2013-2016)

Gestational age (wk)	22-23 (n=372)	24-25 (n=1,156)	26-27 (n=1,644)	28-29 (n=2,191)	30-32 (n=2,078)	>32 (n=828)	Total (n=8,269)
Survival rate	33 (28-38)	65 (62-67)	84 (82-85)	94 (93-95)	97 (96-98)	98 (97-99)	86 (85 87)
Respiratory distress syndrome	98 (95-99)	98 (97-99)	96 (95-97)	89 (88-91)	60 (58-62)	21 (18-23)	78 (77 79)
BPD	88 (80-93)	64 (61-68)	47 (44-49)	26 (24-28)	14 (13-16)	5 (4-7)	30 (29 31)
ROP Tx.	20 (16-25)	25 (23 28)	11 (9-12)	3 (2-4)	1 (0-1)	0 (0-1)	8 (7 8)
NEC≥IIa	20 (16-25)	15 (13-17)	9 (8-11)	4 (3-5)	3 (2-3)	2 (1-4)	7 (6 7)
Sepsis	38 (33-43)	36 (33-39)	31 (29-33)	18 (16-19)	11 (9 -12)	6 (4-8)	21 (20 22)
Drug for PDA	39 (34-45)	52 (49-55)	48 (45-50)	34 (32-36)	21 (19-23)	9 (7-11)	34 (33 35)
Ligation of PDA	18 (14-23)	25 (23-28)	18 (16-20)	7 (6-9)	3 (3-4)	2 (1-3)	11 (10 12)
IVH (≥grade III)	45 (39-51)	27 (25-30)	12 (11-14)	5 (4-6)	2 (1-3)	1 (0-2)	10 (9 10)
PVL	15 (11-20)	12 (10-15)	11 (9-12)	8 (7-9)	5 (4-6)	2 (1-3)	8 (7 9)

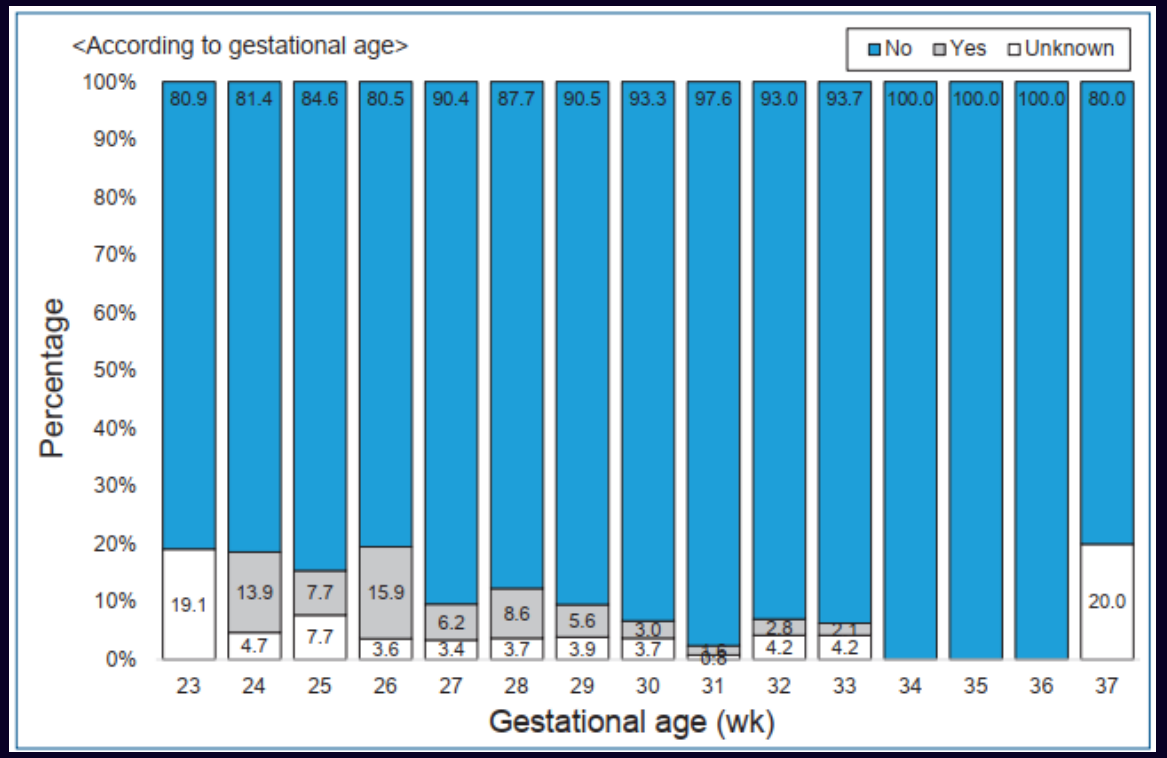
Short- and long-term outcomes of very low birth weight infants in Korea: Korean Neonatal Network update in 2019, CEP (2020)

Cerebral palsy

2014



2015



Overall prevalence: 6.2-6.6%
GA 22-27wks: 8.8-9.6%
GA 36wks: 20.0%

Short- and long-term outcomes of very low birth weight infants in Korea: Korean Neonatal Network update in 2019, CEP (2020)

Variable	2013 (n=1,000)	2014 (n=1,660)
Gestational age (wk)	291/7±26/7	292/7±26/7
Birth weight (g)	1,093±268	1,125±261
Male	504 (50.4)	833 (50.2)
Post-discharge mortality	15 (1.5)	20 (1.2)
Respiratory	5 (45.5)	6 (35.3)
Underlying disease	11 (73.3)	17 (85.0)
Growth at visit		
Weight	n=800	n=1,091
<50th	465 (46.5)	721 (66.1)
50th–90th	243 (30.4)	337 (30.9)
Height	n=753	n=993
<50th	482 (64.0)	622 (62.6)
50th–90th	219 (29.1)	325 (32.7)
Head circumference	n=632	n=811
<50th	404 (64.0)	516 (63.6)
50th–90th	176 (27.8)	267 (32.9)
Rehospitalizations[a)]	n=846	n=1,182
Respiratory	262 (44.9)	349 (47.5)
Surgery	135 (23.2)	168 (22.8)
Infection	106 (18.2)	106 (14.4)
Medical treatment[a)]	n=846	n=1,182
Oxygen	142 (16.8)	166 (14.0)
Ventilator	53 (6.3)	60 (5.1)
Nasogastric tube feeding	76 (9.0)	100 (8.5)
Cerebral palsy	n=846	n=1,182
Diplegia	28 (3.3)	46 (3.9)
Hemiplegia	4 (0.5)	7 (0.6)
Quadriplegia	24 (2.8)	20 (1.7)
Unknown	21 (2.5)	47 (4.0)
Rehabilitative support		
No	512 (60.5)	748 (63.2)
Yes	318 (37.6)	412 (34.9)
Language support		
No	779 (92.1)	1081 (91.5)
Yes	43 (5.1)	68 (5.7)
Eye and hearing	n=846	n=1,182
Blindness	n=846	n=1,134
One-eye	4 (0.5)	3 (0.3)
Both eyes	2 (0.2)	3 (0.3)
Ophthalmologic disorders[a)]	120 (14.2)	179 (15.1)
Retinopathy of prematurity	56 (41.2)	51 (26.6)
Glaucoma	0	3 (1.6)
Cataract	2 (1.5)	1 (0.5)
Strabismus	29 (21.3)	40 (20.8)
Refraction abnormality	15 (11.0)	11 (5.7)
Wearing glasses	23 (2.7)	19 (1.6)
Hearing impairment[a)]	24 (3.2)	22 (1.9)
Unilateral	10 (1.3)	12 (1.0)
Bilateral	14 (1.9)	10 (0.8)
Hearing aid	6 (0.7)	3 (0.3)
Need for cochlear impairment	1 (0.1)	4 (0.3)

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1/3 of VLBW infants in Korea: rehabilitative support

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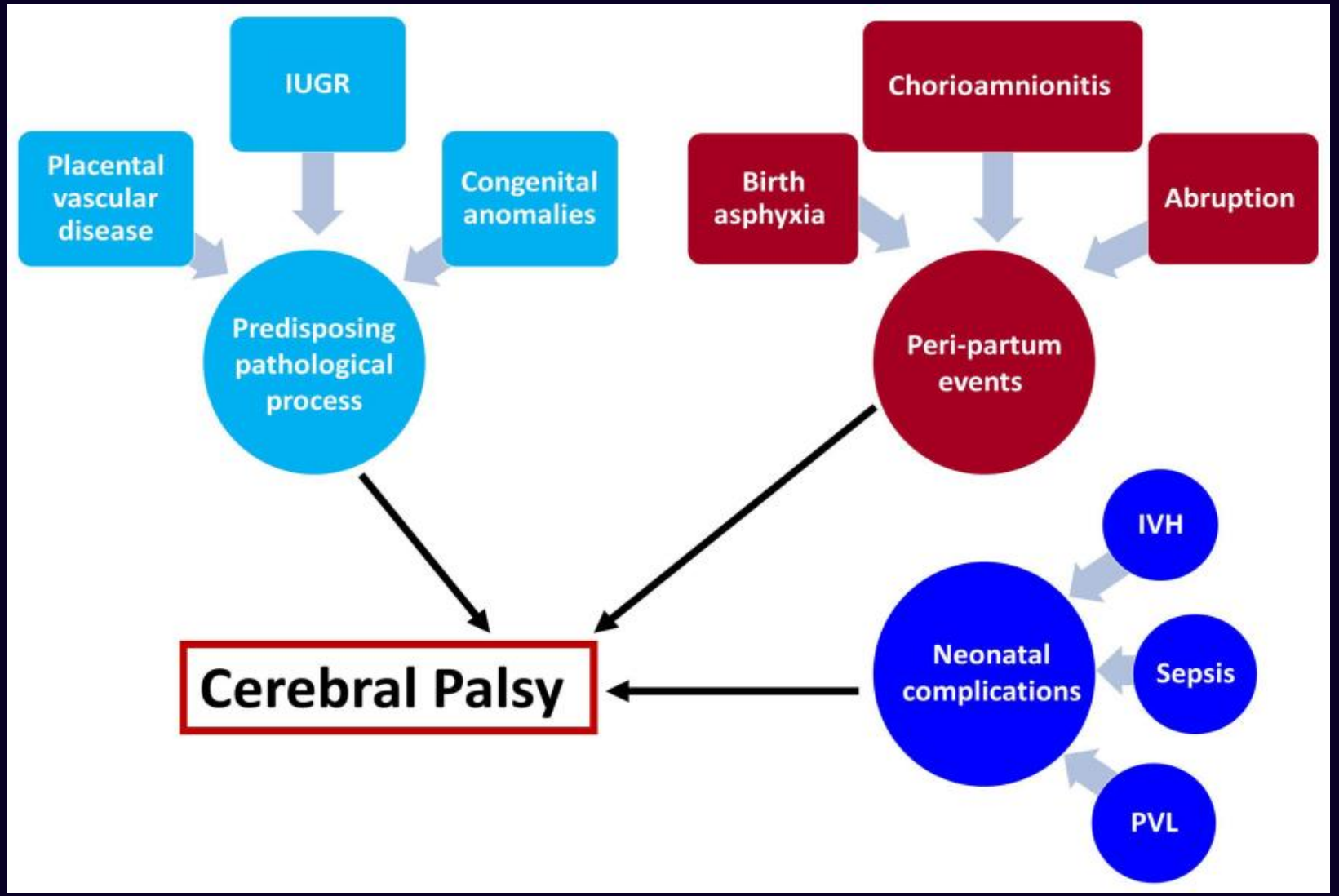
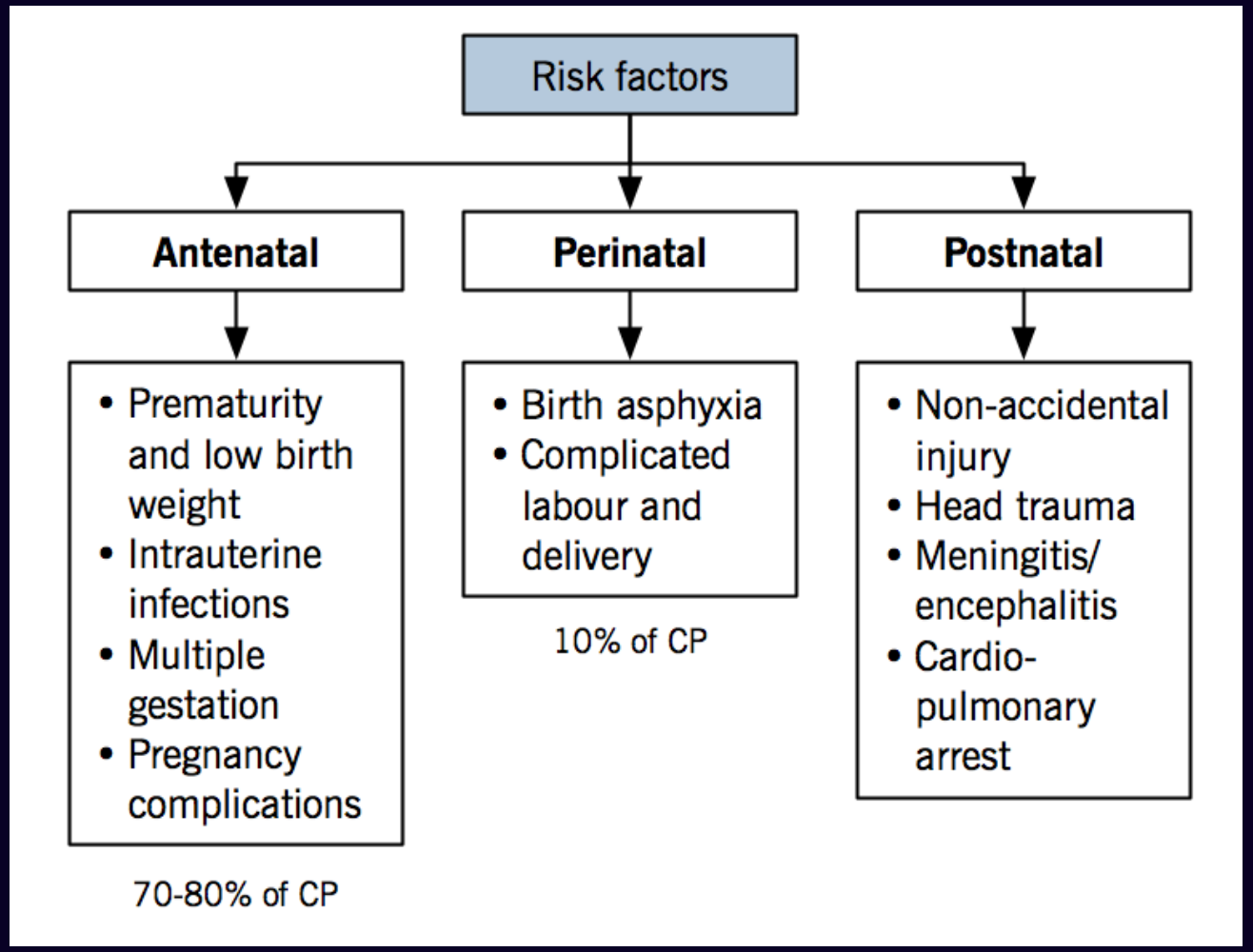
2. Risk factors of infants in NICU



Cerebral Palsy—Trends in epidemiology and Recent Development in Prenatal Mechanisms of Disease, Treatment, and Prevention, Frontiers in Pediatrics (2017)

Risk factors

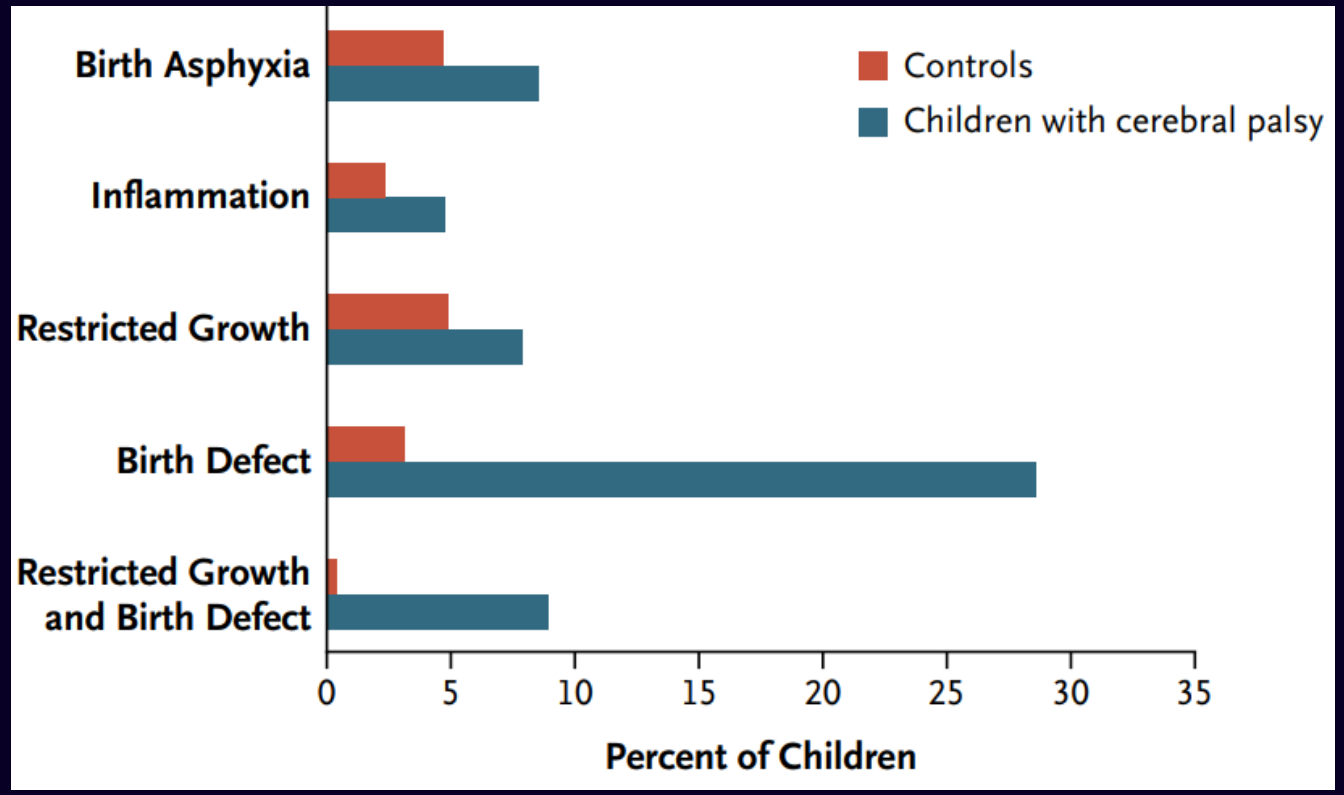


Risk factors at term infant

Preconceptional		Antenatal		Intrapartum		Neonatal	
Previous stillbirths /neonatal death	+ (1.8-5.4)	Poly/oligohydra-mnios	++ (4.2-6.9)	Length of labor		Seizure	++ (5.6-40)
Previous mis-carriage >3	+ (2.0)	Hemorrhage (2-3 trimester)	++ (1.6-3.7)	: <3h precipitous	++ (1.9-3.0)	Respiratory Distress Syndrome	++ (2.3-18)
Maternal age at delivery		Psychiatric illness	+ (9.3)	: 2nd stage>1h	++ (2.1-2.4)	Hypoglycemia	++ (4.3-20.5)
: <20y	+ (1.5-1.9)	Chorioamnionitis	+ (1.5-4.4)	: prolonged labor	++ (3.0)	Jaundice	++ (2.8-3.7)
: >40y	+ (1.3-3.7)	Pre-eclampsia	+ (1.1-8.4)	Membrane rup-ture		Infections including meningitis, sepsis	++ (4.1-7.6)
Prior maternal Dx		Major and minor birth defects	++ (2.6-20.7)	: prolonged & Preterm	++ (3.32)		
: Seizure, intellectual disability, thyroid Ds	+ (2.4-9.0)	Small for GA	++ (1.9-7.5)	Meconium			
: DM, asthma, coagu-lation disorder, surgi-cal Hx, mental illness, poor obstetric Hx	+ (1.2-2.4)	Large for GA	+ (2.6)	: Stained liquor	++ (1.8-3.8)		
				: Aspiration	++ (10.3-15)		
				Abnormal fetal presentation	++ (3-6.5)		
				: Breech	+ (1.1-13.1)		
				Placental abrup-tion	++ (1.7-1.9)		
				Cord around neck	+ (1.7)		
				Hemorrhage/shock	++ (13-20)		
				Birth asphyxia			

A systematic review of risk factors for cerebral palsy in children born at term in developed countries, DMCN (2012)

Risk factors in singletons at near term



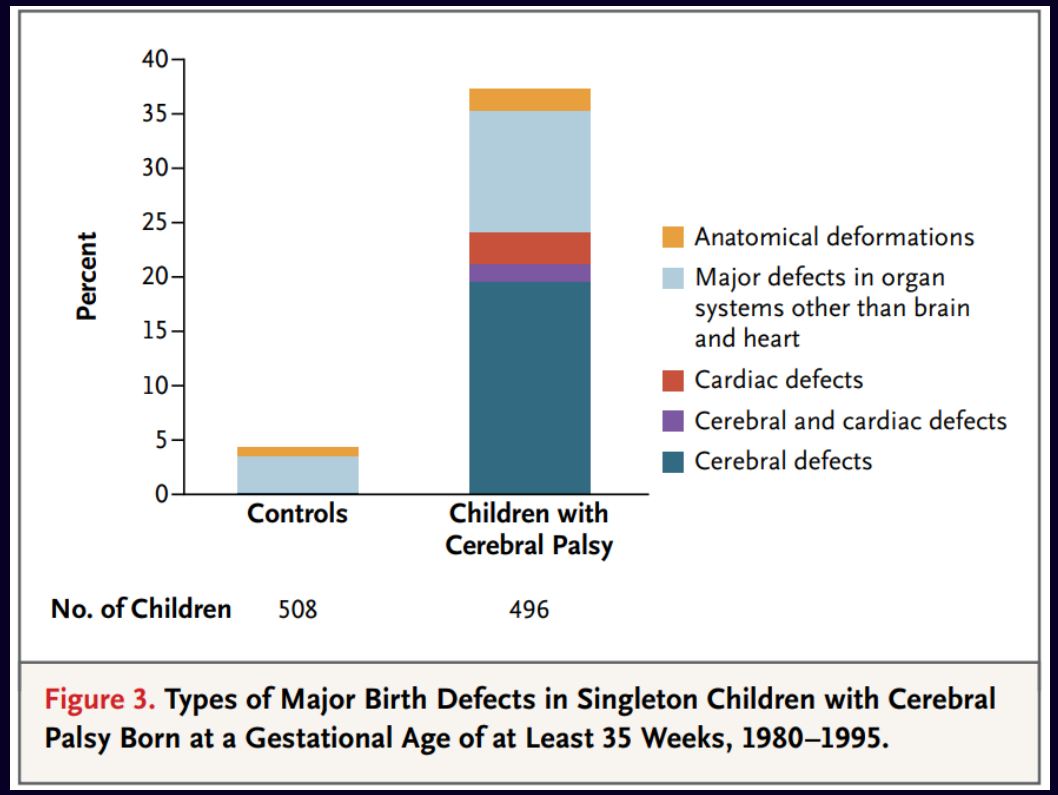
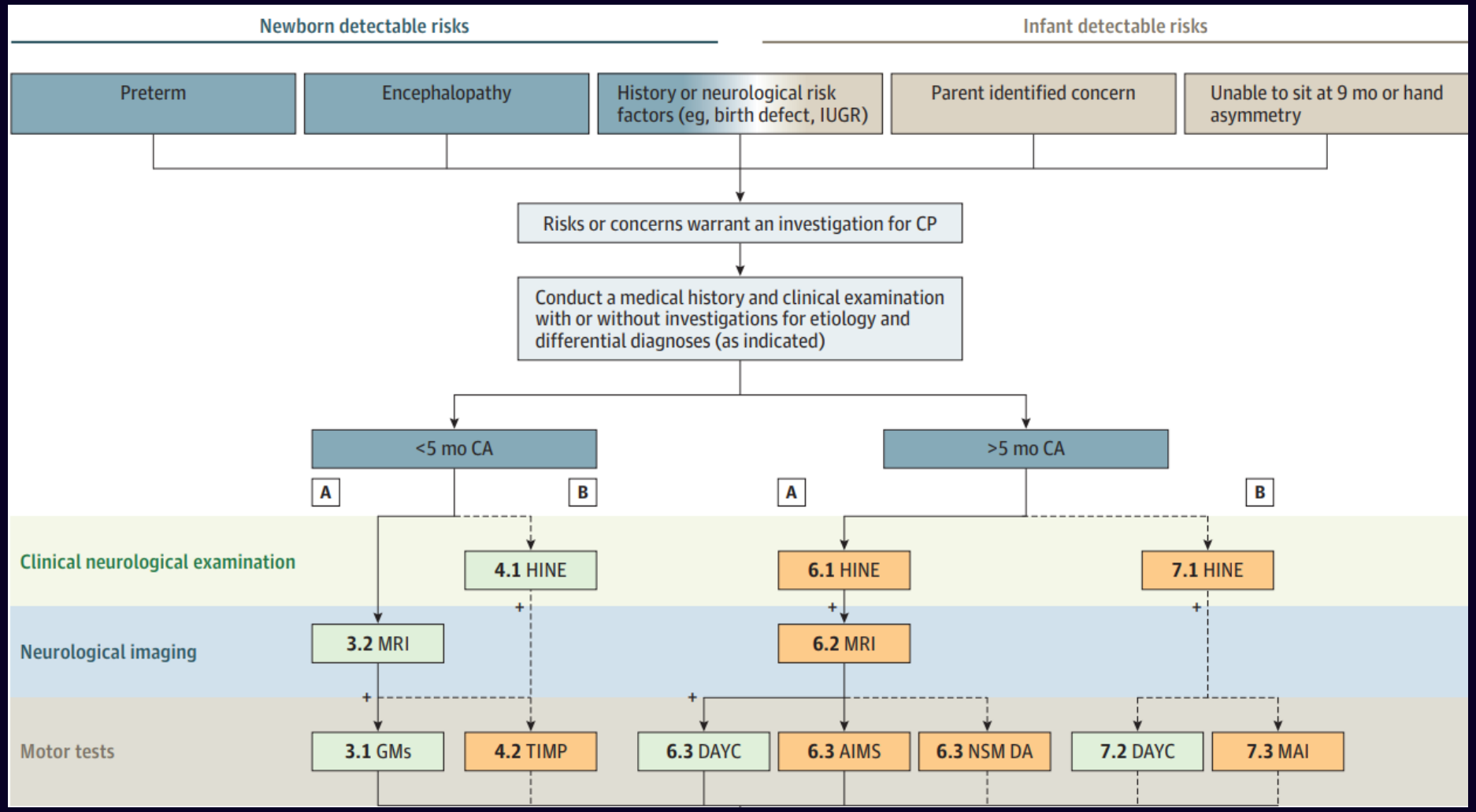


Figure 3. Types of Major Birth Defects in Singleton Children with Cerebral Palsy Born at a Gestational Age of at Least 35 Weeks, 1980–1995.

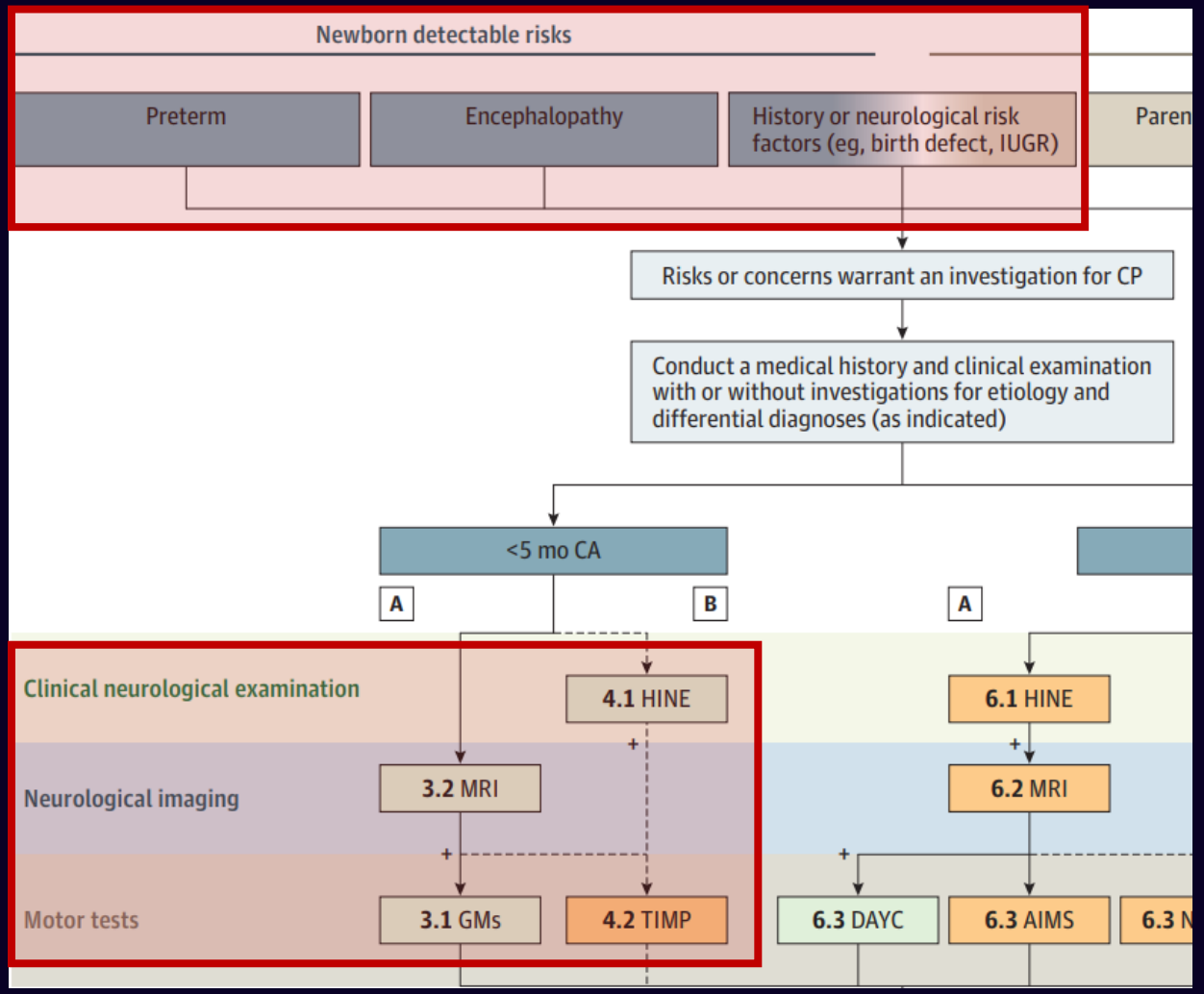
Antecedents of Cerebral Palsy and Perinatal Death in Term and Late Preterm Singletons, NEJM (2013)

Early detection of high risk infants

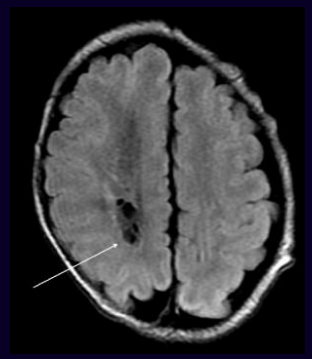


Early, Accurate Diagnosis and Early Intervention in Cerebral Palsy: Advances in Diagnosis and Treatment, JAMA Pediatrics (2017)

Early detection of high risk infants



Term-equivalent Brain MRI



General movements (-5mo)

Early, Accurate Diagnosis and Early Intervention in Cerebral Palsy: Advances in Diagnosis and Treatment, JAMA Pediatrics (2017)

3. Framework for early intervention

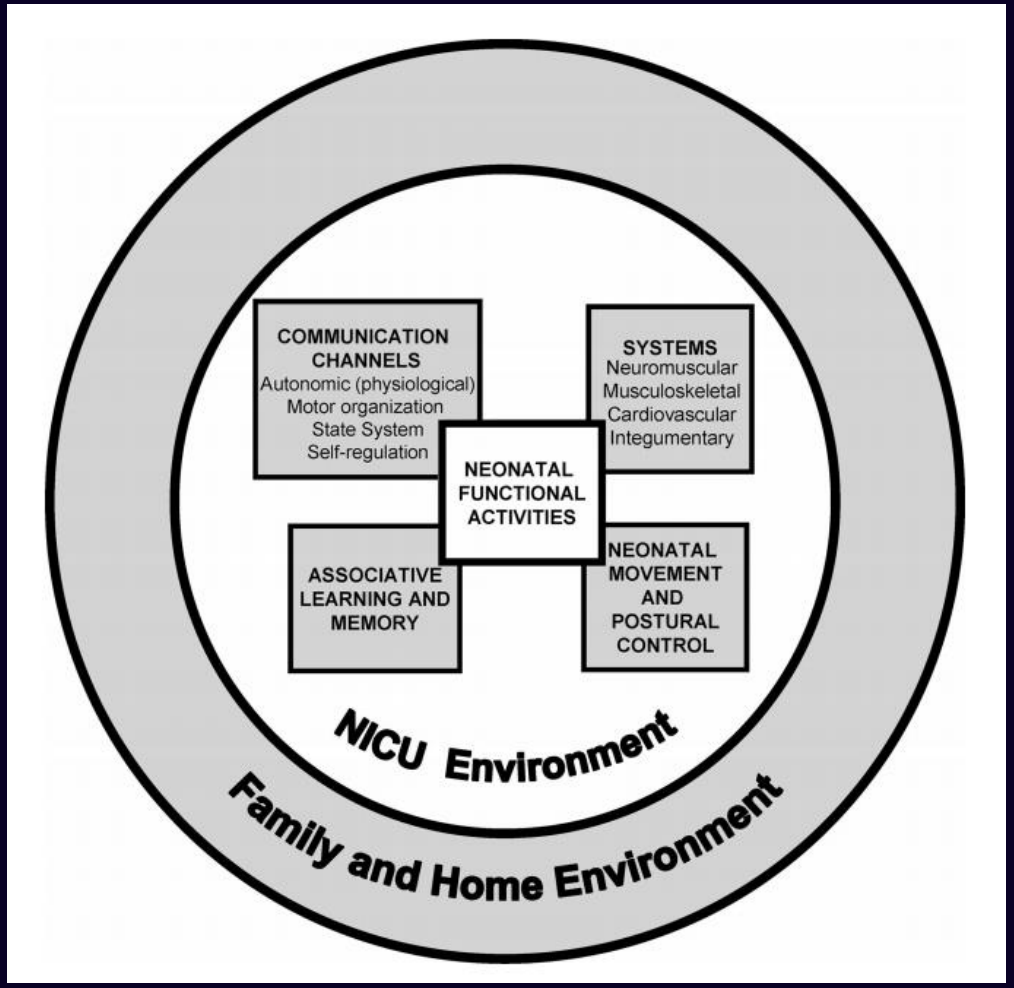
NICU Practice framework

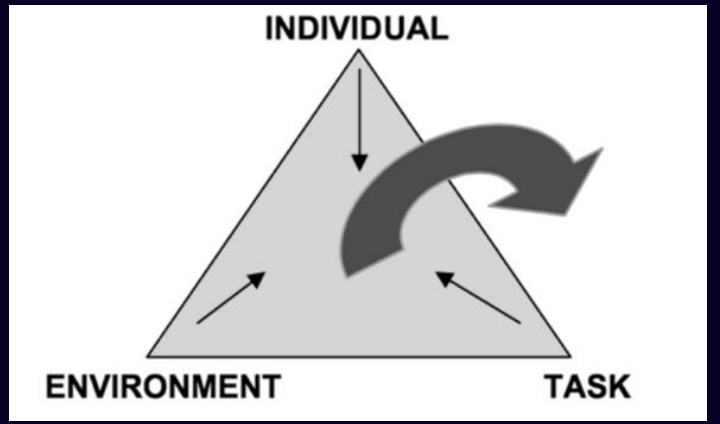
- 3 theoretical concepts

- Dynamics systems theory of development
- International Classification of Functioning, Disability and Health (ICF)
- Family-centered care

Neonatal Physical Therapy. Part II: Practice Frameworks and Evidence-Based Practice Guidelines, Pediatric Physical Therapy (2010)

Dynamic systems

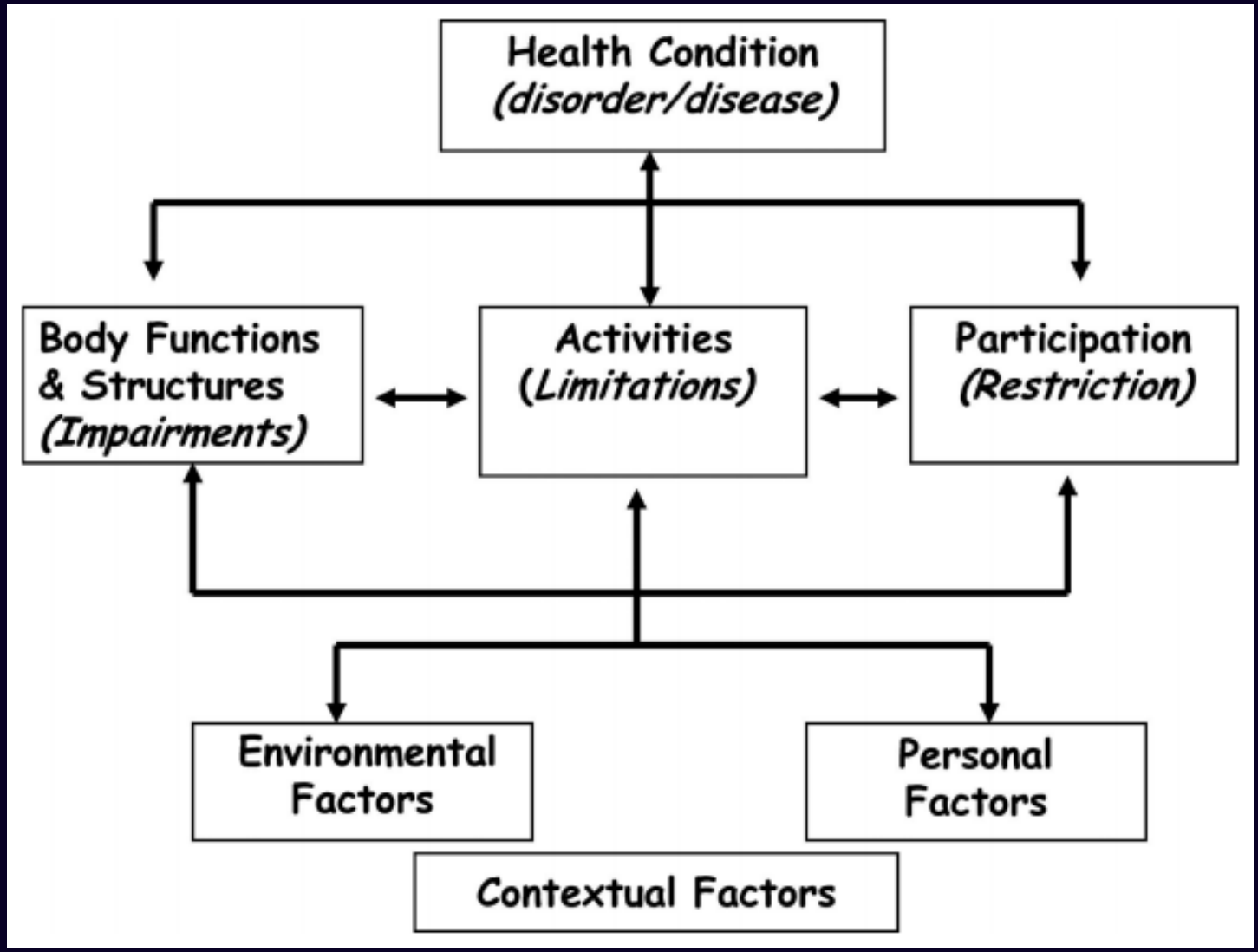




- Biological factor
  - Physiologic, behavioral, physical, social, psychological elements
- Sociocultural and physical environments
  - Neonatal movements and postural control
- Task or goal of the neonate
  - Self-regulation of physiologic processes, behavioral state, posture and movement, attention and interaction with caregivers

Neonatal Physical Therapy. Part II: Practice Frameworks and Evidence-Based Practice Guidelines, Pediatric Physical Therapy (2010)

ICF



Neonatal Physical Therapy. Part II: Practice Frameworks and Evidence-Based Practice Guidelines, Pediatric Physical Therapy (2010)

Family-centered care

- Collaborative partnerships with families and neonatal practitioners
- Family is a primary focus for collaboration and support by the neonatal physical therapists

- Focus on survival and developmental outcome
- Helping parents understand and respond to infant cues
- Enhancement of parent-infant interaction and relationship and cognitive and socioemotional development
- Partnerships, education, emotional stress, culture

Neonatal Physical Therapy. Part II: Practice Frameworks and Evidence-Based Practice Guidelines, Pediatric Physical Therapy (2010)

4. Update of early intervention in NICU

Characteristics of previous RCTs

- Insufficient
- Small-sample sized

- Heterogeneous
  - Infant: GA, BW
  - Intervention: timing, provider, dosage, contents
  - Outcome: short vs long term, domain (motor vs cognitive vs etc)

Neonatal therapy

- Systematic review (Sonia khurana et al. 2020)
  - 15 RCTs or quasi-RCTs, preterm infants (≤37wks GA)

- Type of therapies
  - Parent-delivered motor intervention
  - Therapist-delivered postural control intervention
  - Developmental care
  - Oromotor intervention

Effect of neonatal therapy on the motor, cognitive, and behavioral development of infants born preterm: a systematic review, Dev Med Child Neurol (2020)

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Table 1: Operational definitions

Neonatal therapy	Intervention provided by a physical, occupational, or speech therapist or delivered by parents guided by a therapist
PDMI	PDMI includes teaching a parent or caregiver to provide postural support and opportunities for movement with support during a parent–infant interaction with the goal of increasing infant movement quality and quantity. These interventions are individualized for each infant with the support of a therapist and delivered through a parent–therapist collaboration. It is theoretically based on action perception and dynamic systems theory
TDPCI	TDPCI includes providing postural support and moving the infant in different positions to provide sensory or motor input. These interventions often involve facilitation of movement by incorporating inputs from tactile, vestibular, and somatosensory receptors within the body. Those included in this review are based on NDT/Bobath concept
Developmental care	Developmental care consists of child- and parent-focused interventions that include regulating the environment and activities the infant is exposed to during general caregiving. While developmental care is often considered an NICU-wide framework, in this review developmental care was coordinated or provided by a therapist, meeting the inclusion criteria for this review. Developmental care is based on concepts of synactive theory and family-centered care
Oromotor intervention	Oromotor intervention is used to improve oral feeding in infants born preterm and consists of non-nutritive sucking, oral stimulation, and oral support designed and/or implemented by a therapist

PDMI, parent-delivered motor intervention; TDPCI, therapist-delivered postural control intervention; NICU, neonatal intensive care unit; NDT, neurodevelopmental therapy.

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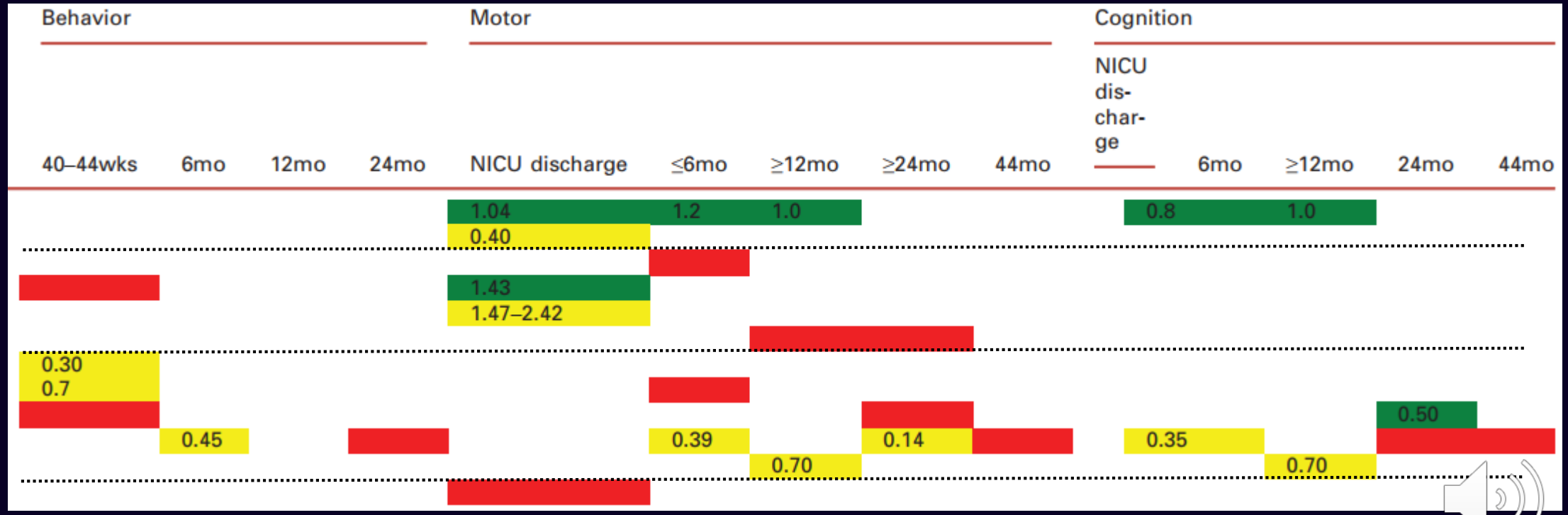


Effect of neonatal therapy on the motor, cognitive, and behavioral development of infants born preterm: a systematic review, Dev Med Child Neurol (2020)

Neonatal therapy

- Systematic review (Sonia khurana et al. 2020)
  - 15 RCTs or quasi-RCTs, preterm infants (≤37wks GA)

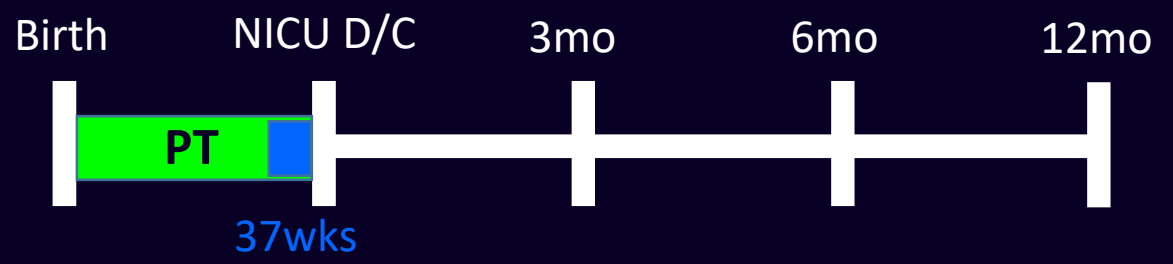
Table 2: GRADE recommendations for different interventions

PDMI PDMI may improve motor and cognitive outcomes. It needs to include: 1. child-initiated active movements; 2. active parental participation and implementation at regular intervals; 3. an engaging environment	Conditional recommendation It is based on limited evidence of moderate quality
TDPCI TDPCI in the NICU may have a short-term effect on motor development; however, the benefits are not seen if the intervention is primarily provided after discharge	Conditional recommendation It is based on limited evidence of moderate quality
Developmental care Developmental care influences short-term behavioral outcomes. There is inconclusive evidence for motor and cognitive development	Conditional recommendation It is based on limited evidence of moderate quality
Oromotor intervention There is only limited evidence to draw any conclusions	There is no adequate evidence to make a recommendation

GRADE, Grading of Recommendations, Assessment, Development and Evaluations; PDMI, parent-delivered motor intervention; TDPCI, therapist-delivered postural control intervention; NICU, neonatal intensive care unit.

Effect of neonatal therapy on the motor, cognitive, and behavioral development of infants born preterm: a systematic review, Dev Med Child Neurol (2020)

Neonatal therapy 1



- Parent-administered PT

- Participant: 153 very preterm infants (≤32wks GA)
- Intervention: Parent-administered PT (n=74) vs Usual care (n=79)
- Primary outcome:
  - Test of Infant Motor performance Screening Items (baseline)
  - Test of Infant Motor Performance (37wks PMA)

Study protocol: an early intervention program to improve motor outcome in preterm infants: a randomized controlled trial and a qualitative study of physiotherapy performance and parental experiences, BMC Pediatrics (2012)
Early Parent-Administered Physical Therapy for Preterm Infants: A Randomized Controlled Trial, Pediatrics (2016)

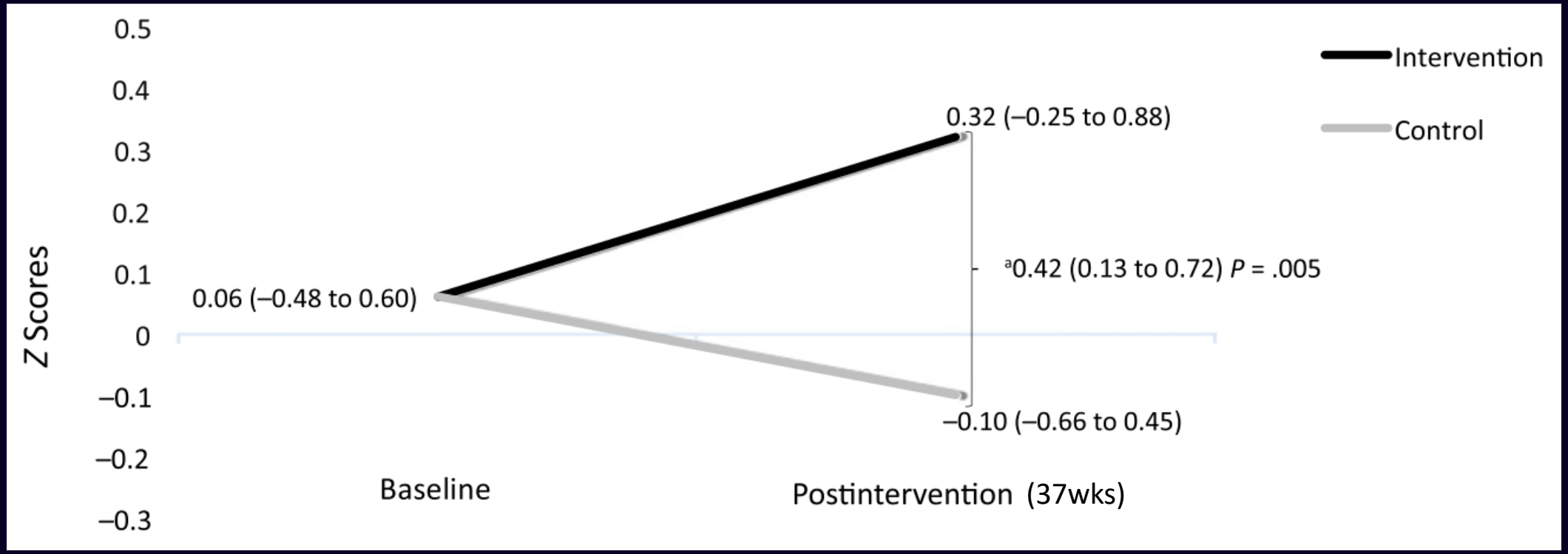
Neonatal therapy 1

Table 1 The protocol for promotion of postural and selective control of movements, supine and sidelying

Objectives	Performer activity	Activity goals for the child
1. Increase strength, balance. Control of the anterior and posterior neck muscles.	1. Activating neck flexors, shoulder and abdominal muscles through intermittent caudal compression.	1. Maintain head in midline and head turning to both sides.
2. Increase strength and control of the anterior shoulder and chest muscles and balance between anterior and posterior shoulder and chest muscles.	2. Horizontal intermittent pressure through the shoulders. Assist the child to bring arms forward to the mouth or on chest.	2. Bringing hands forward, hands to mouth and hands on chest.
3. Increase strength and control of the abdominal muscles.	3. Through lifted pelvis and flexed legs, provide intermittent compression toward shoulder.	3. Antigravity pelvis and lower extremity lifting with hip and knee flexion
4. Affect alignment, righting reactions and antigravity muscle activity in the trunk in the sagital and frontal planes.	4. From the lifted pelvis and control at shoulders, shift the infant's weight in small increments from side to side. When possible allow the infant to control the head and arms without assistance.	4. Rolling from supine to side.
5. Affect alignment, righting reactions and balance and control between the anterior and posterior neck and trunk muscles.	5. Guide the child from supine through sidelying to upright sitting.	5. Maintaining head control in midline during the transition with minimal assist.
6. Increase strength of the anterior neck muscles lateral head righting and neck and cervical extensors when rolling into prone.	6. Guiding upper shoulder slightly backwards with small weight shifting movements while supporting the child with one hand under head.	6. Keep the chin tucked during movements from supine to prone and when in sidelying
7. Increase the strength of the anterior chest and shoulder muscles.	7. Horizontal intermittent compression through the shoulders. Assist the infant in bringing the hands to mouth or toward the midline.	7. Bring hands to mouth or bring hands forward to chest.
8. Elongation of thorax and lumbar muscles; increase strength, balance and control of abdominal and trunk muscle groups.	8. Lifting pelvis laterally upward to lengthen the weight-bearing side of trunk and activate lateral muscles of the trunk and head on the non-weight-bearing side. Facilitate rolling from supine to side. Head, neck, trunk and pelvis are in alignment.	8. Maintain the pelvis in a neutral position while flexing the hip and knee. Improved antigravity strength of the lateral neck and trunk muscles

1-5: The child is in supine. 6-8: The child is sidelying

Neonatal therapy 1



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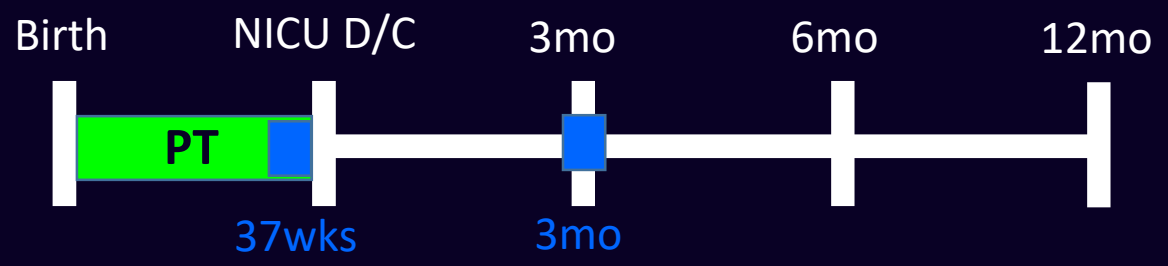
Neonatal therapy 1



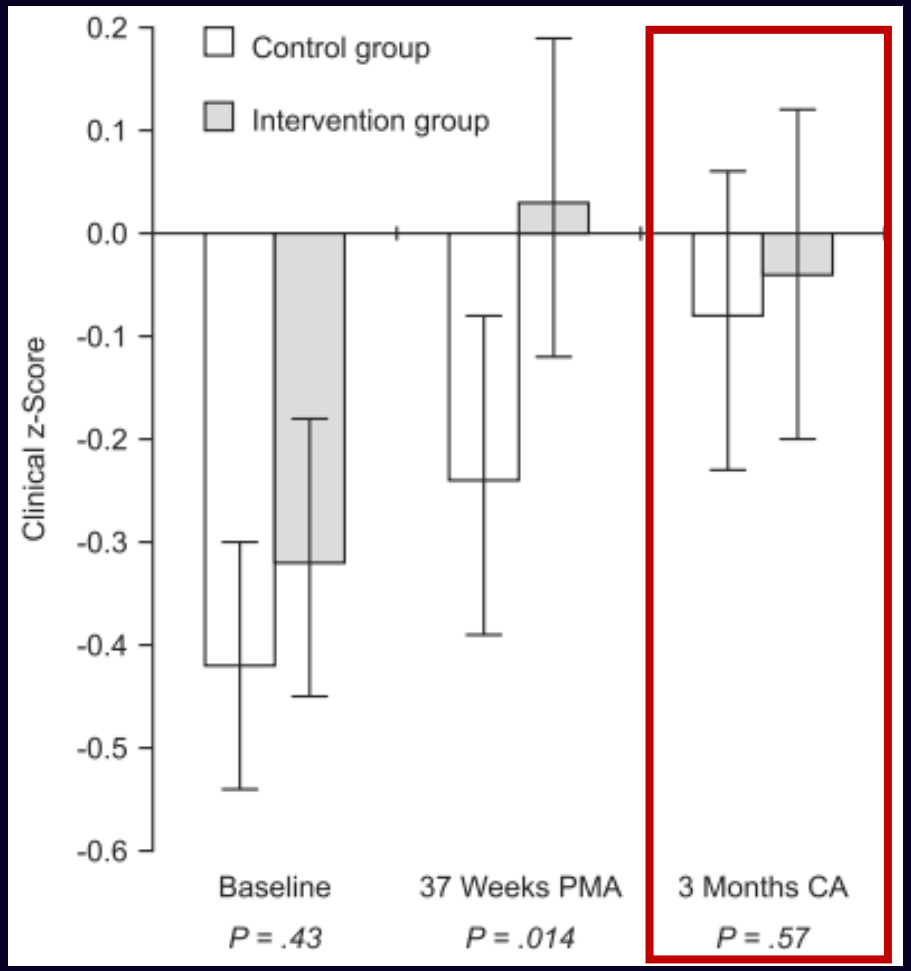
- Parent-administered PT

- Participant: 153 very preterm infants (≤32wks GA)
- Intervention: Parent-administered PT (n=74) vs Usual care (n=79)
- Primary outcome:
  - TIMP Screening Items (baseline)
  - TIMP (37wks PMA)
  - TIMP (3mos CA)

TIMP: Test of Infant Motor Performance

Effects of a Parent-Administered Exercise Program in the Neonatal Intensive Care Unit: Dose Does Matter—A Randomized Controlled Trial, Physical Therapy (2020)

Neonatal therapy 1



Relationship (β-coefficient) Between Total Intervention Time and Motor Performance (TIMP Clinical Z-Score) 37 Weeks PMA and 3 Months CA (n = 59)[a]

Intervention Time	37 Weeks PMA			3 Months CA		
	ß	95% CI	*P*	ß	95% CI	*P*
Total intervention time, h[b]	.03	−.06 to .11	.50	.14	0.06 to 0.22	.001
Total intervention time, h[c]	.04	−.05 to .12	.42	.14	0.05 to 0.22	.003

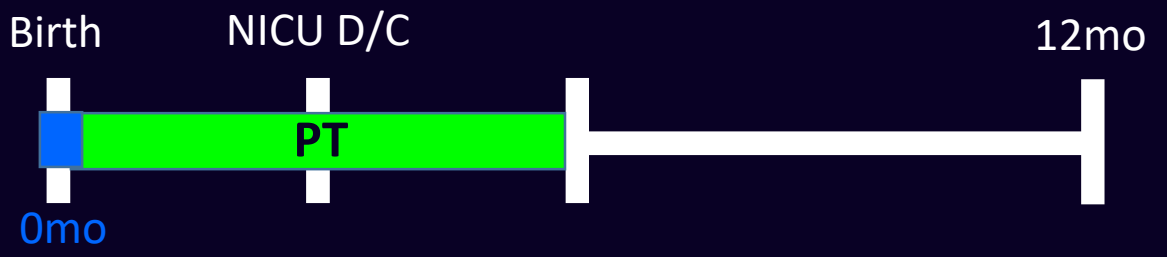
[a]CA = corrected age; CI = confidence interval; PMA = postmenstrual age; TIMP = Test of Infant Motor Performance.
[b]Adjusted for hospital.
[c]Additional adjustments for sex, birth weight, and mother's education.

OR for a Low TIMP Clinical Z-Score by 3 Month CA (Z-Score <0) According to Intervention-Time Categories[a]

Intervention time	Total		OR for a Clinical Z-Score <0			
	z-score < 0 n = 28	z-score ≥ 0 n = 31	OR[b]	95% CI	OR[c]	95% CI
Low (<222 min)	19	8	5.9	1.8 to 18.8	5.7	1.7 to 19.1
High (≥222 min)	9	23	1.0		1.0	

[a]CI = confidence interval; OR = odds ratio; TIMP = Test of Infant Motor Performance.
[b]Adjusted for hospital.
[c]Additional adjustment for sex, birth weight, and mother's education.

Neonatal therapy 2



- Supporting play exploration and early developmental intervention (SPEEDI)
- Participant: 14 extremely preterm infants (<29 wks GA) and/or brain injury
- Intervention: SPEEDI vs Usual care

Domain	Baseline	End Phase 1	End Phase 2	Follow up 1	Follow up 2	12 months Adjusted Age
	Day 0	Day 21	Day 111 (15 weeks)	Day 141 (20 weeks)	Day 201 (29 weeks)	Target Day 382 –clinical visit
Therapy or EI Services	EMR	EMR	Parent survey	Parent survey	Parent survey	Clinical records
Seated Exploration and Reaching			Hands midline and Reaching	Hands midline and Reaching	Hands midline and Reaching	
Problem Solving			EPSI	EPSI	EPSI	
Motor	TIMP	TIMP	TIMP	TIMP	Bayley	Bayley
Cognition					Bayley	Bayley
Language					Bayley	Bayley

Supporting play exploration and early developmental intervention versus usual care to enhance development outcomes during the transition from the neonatal intensive care unit to home: a pilot randomized controlled trial, BMC Pediatrics (2018)

Neonatal therapy 2

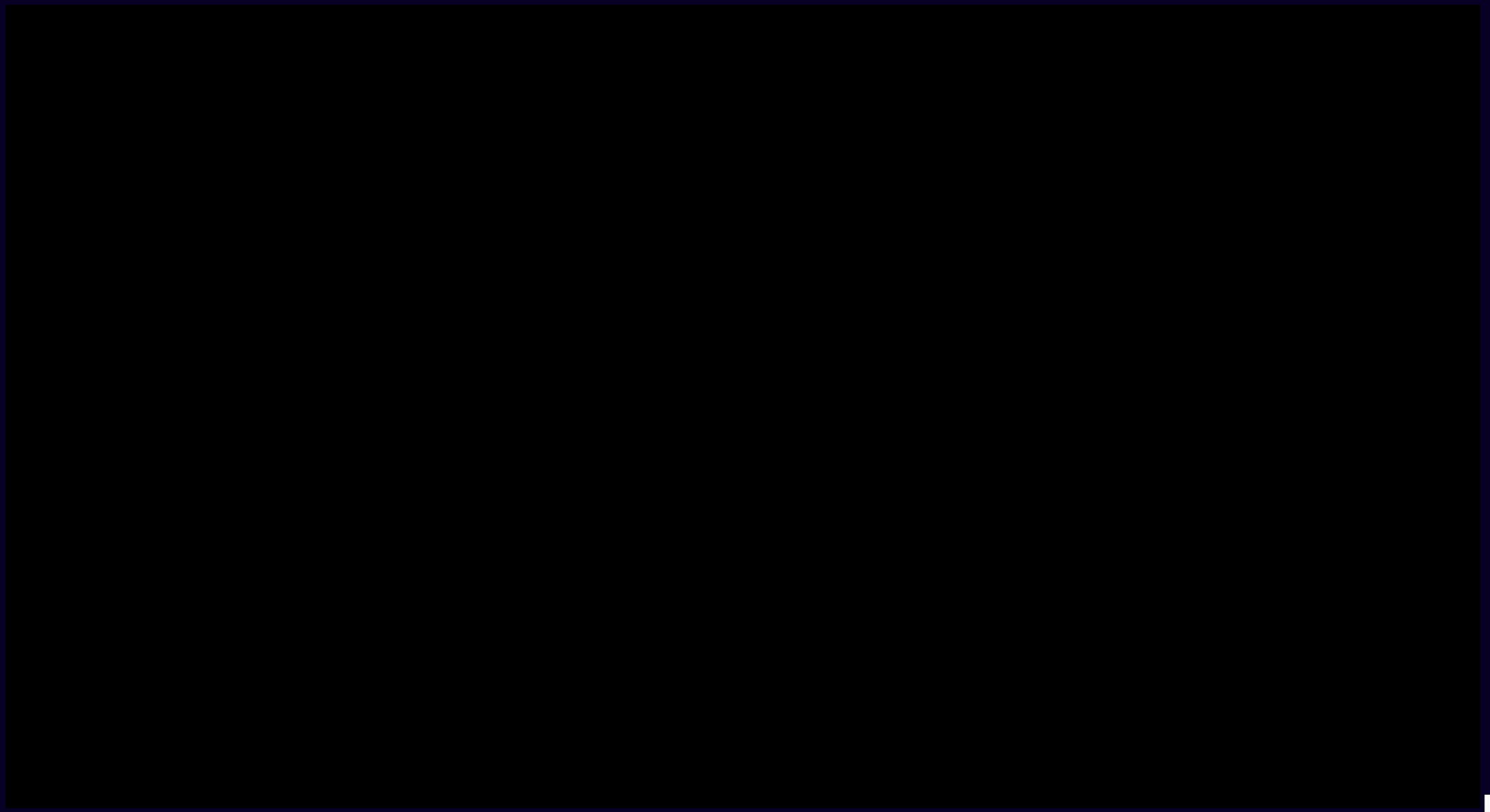
Table 1 SPEEDI Intervention Description

Phase 1 (21 days starting when medically stable)	Phase 2 (12 weeks starting at the end of phase 1)
In NICU	Primarily at home, but started in NICU if not ready for discharge on day 21 post baseline.
5 intervention sessions provided by the parent and therapist jointly and in response to the infant's behavioral cues based on the synactive theory of development [31, 32].	Parents were encouraged to provided activities daily, with a goal of at least 20 min per day of activities 5 days per week, provided by the parent
33 Videos of positive and negative interaction available to parents throughout the phase 1 intervention as examples (Additional file 2)	An activity booklet (Additional file 3), with pictures, simple text, and a log for parent to record daily activities and questions was used to encourage parents to provide motor and cognitive opportunities daily in a variety of play positions, environments, and with objects [13].
Coaching on behavioral states, self-calming, environmental modification, and choosing times for feeding and play based interactions using dolls or video clips if the infant was not alert or fatigued	Parent encourage to provide the "just right challenge" advancing from stage 1 to stage 2 activities as they observed their infant improving or discuss with therapist at each visit
Provide experience with variable and self-directed movements and social interaction without physiological or behavioral stress. Introduced phase 2 activities by end of phase1	Physical Therapist participated in 5 parent-infant activity session over 12 weeks and helped with advancing from stage 1 to stage 2 activities as the infant was ready.
Guided participation used in identifying cues to stop, alter, or delay interactions during caregiving, feeding, play activities	Parent was encouraged to develop a daily routine for encouraging developmental play.

- **Key principles**
  - Encourage self-initiated movement, variability, object interaction, and social interaction
  - Do not impose movement on the infant
  - Observe and respond to the infant's behavioral cues

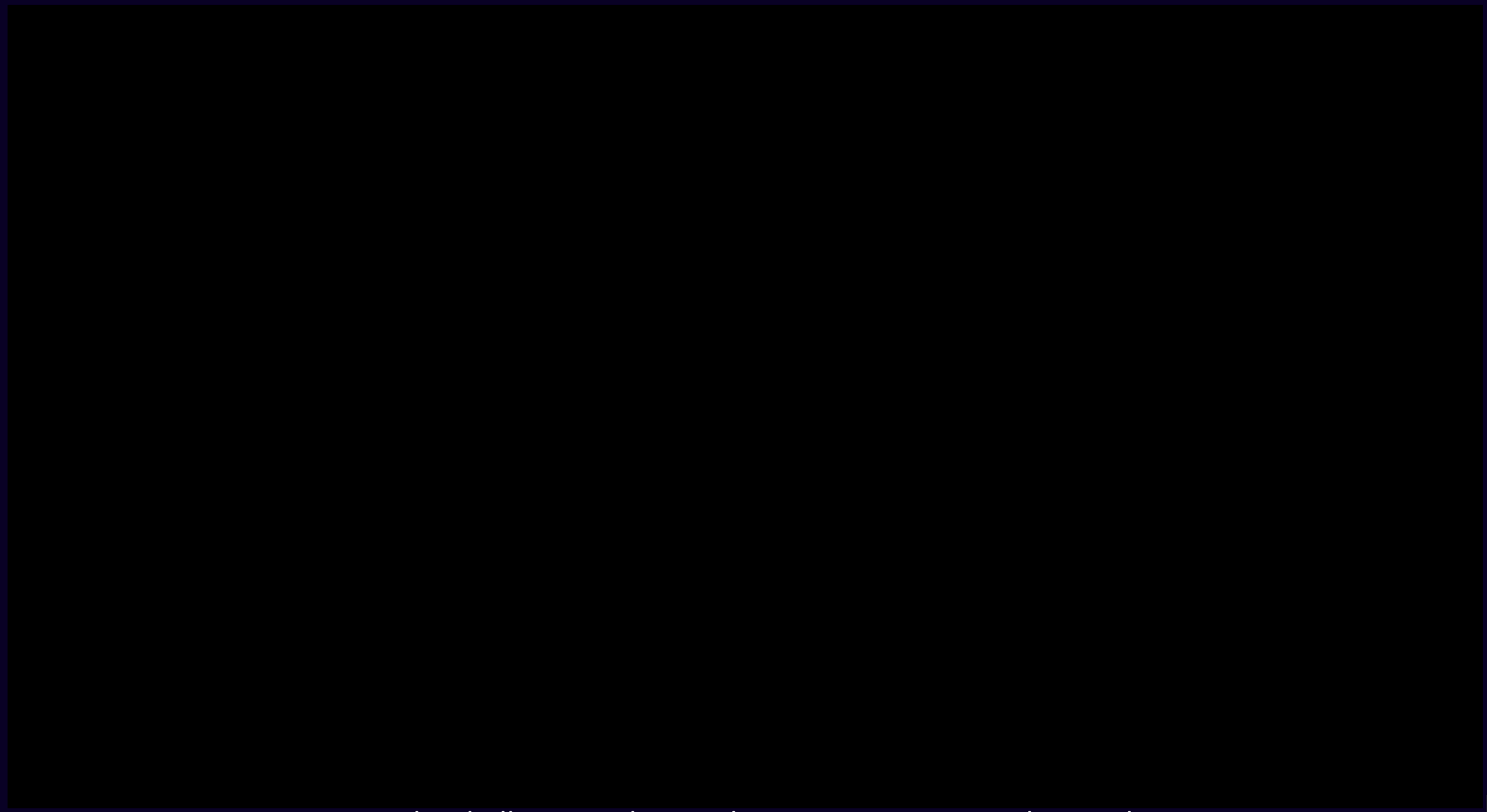
- **Key Strategies** to support motor development during interactions
  - Provide graded postural support
  - Observe spontaneous movement in response to your support
  - Vary postural support to encourage different opportunities and sensory input
  - Vary positioned with the minimal support to encourage variable movements

https://rampages.us/speedi/



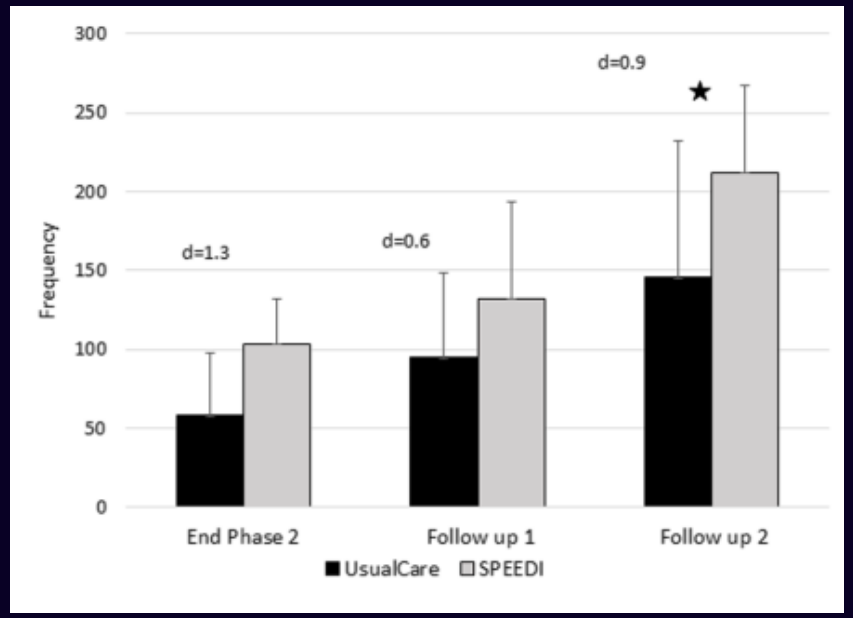
Self-Initiated Exploration in Young Baby

https://rampages.us/speedi/

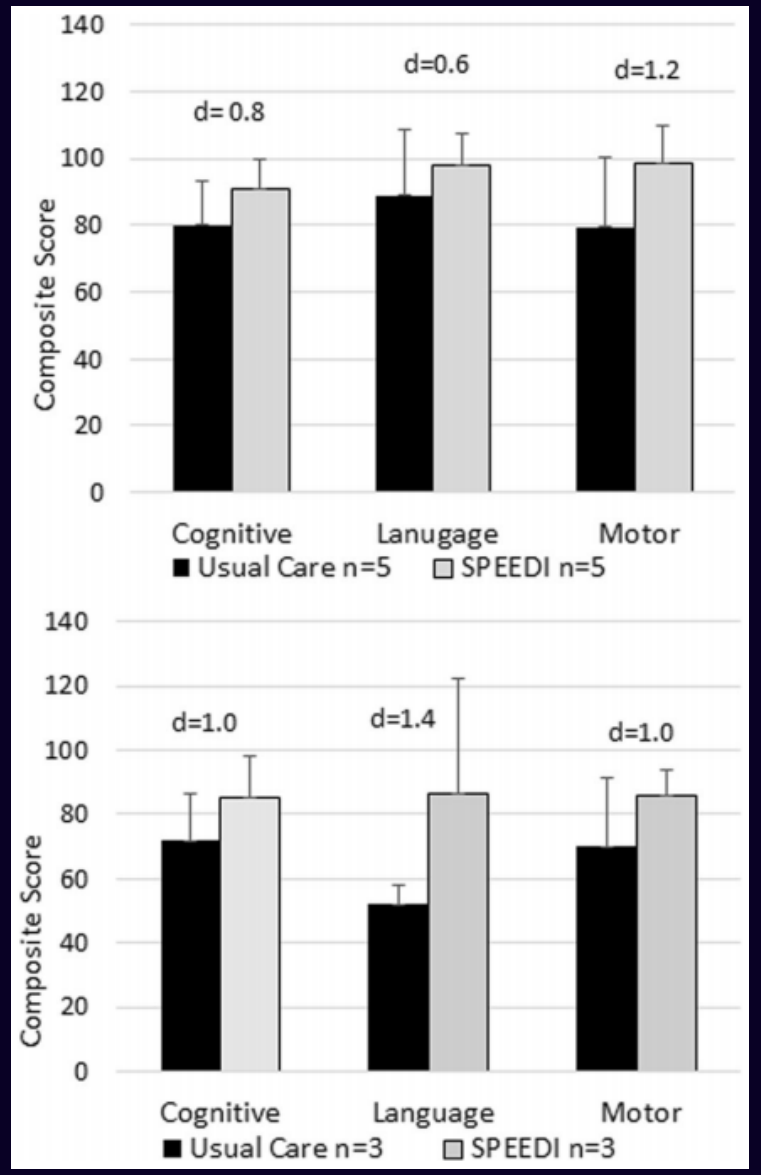


Just Right Challenge – Change the environment or task to make it slightly easier to increase length of practice

Problem solving outcomes
(15wks, 20wks, 29wks)



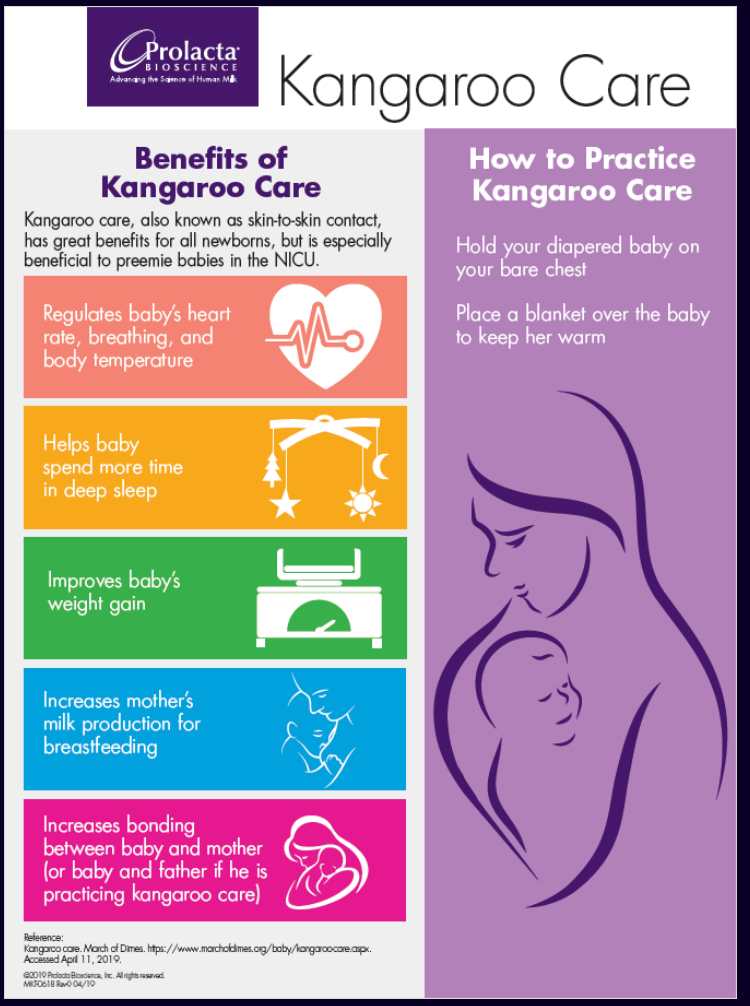
Bayley
(6mo, 12mo)



Developmental care 1

- Kangaroo Mother Care

- Position: skin-to-skin contact
- Nutrition: breast feeding
- Discharge: continuation kangaroo mother care at home after discharge
- Support: by healthcare staff at hospital and home



Meta-analysis (n = 124)

Outcome	All Studies					RCT and Adjusted Observational Studies				
	n	RR (95% CI)[a]	*P*	Test for Heterogeneity (*P*)	I^2, %[b]	*n*	RR (95% CI)[a]	*p*	Test for Heterogeneity (*P*)	I^2, %[b]
Mortality										
Latest follow-up[46–61]	16	0.77 (0.60 to 0.99)	.05	<.01	67	12	0.95 (0.73 to 1.23)	.69	.13	32
≤45 d[46–55,58]	11[c]	0.79 (0.57 to 1.10)	.17	<.01	77	7	1.16 (0.91 to 1.47)	.23	.29	18
3–12 mo[46,47,56,57,59–61]	7[c]	0.59 (0.43 to 0.82)	<.01	.63	0	6	0.67 (0.47 to 0.96)	.03	.88	0
LBW <2000 g[46–54,56–61]	15	0.64 (0.46 to 0.89)	.01	<.01	72	11	0.86 (0.59 to 1.24)	.41	.10	38
All birth weights[50,55]	2	1.04 (0.82 to 1.33)	.73	.83	0	1	1.06 (0.80 to 1.41)	.70	—	—
Exclusive breastfeeding										
Discharge or 40–41 wk PMA[28,50,59,62–71]	13	1.50 (1.26 to 1.78)	<.01	<.01	93	8	1.25 (1.10 to 1.42)	<.01	<.01	59
1–4 mo old[45,62,63,65,69,72–74]	8	1.39 (1.11 to 1.74)	.01	.02	60	6	1.53 (1.08 to 2.18)	.02	<.01	71
Other										
Infection[15,27,28,48,52,53,58,60,65,67,75,76]	12	0.67 (0.43 to 1.05)	.08	<.01	60	10	0.60 (0.36 to 1.01)	0.05	<.01	65
Sepsis[15,27,28,48,52,53,58,65]	8	0.53 (0.34 to 0.83)	.01	.23	25	7	0.44 (0.29 to 0.66)	<.01	.49	0
NEC[49,58,65]	3	0.96 (0.45 to 2.04)	.92	.45	0	3	0.96 (0.45 to 2.04)	.92	.45	0
Hypothermia[15,18,36,48,52,58,65,77,78]	9	0.22 (0.12 to 0.41)	<.01	<.01	71	7	0.28 (0.15 to 0.53)	<.01	.01	65
Hyperthermia[15,48,52]	3	0.77 (0.59 to 1.01)	.06	.88	0	3	0.77 (0.59 to 1.01)	.06	.88	0
Apnea[27,46,48,52,58,65]	6	0.39 (0.13 to 1.14)	.09	.12	42	6	0.39 (0.13 to 1.14)	.09	.12	42
Hypoglycemia[27,48]	2	0.12 (0.05 to 0.32)	<.01	.53	0	2	0.12 (0.05 to 0.32)	<.01	.53	0
Readmission[60,74]	2	0.42 (0.23 to 0.76)	<.01	1.00	0	1	0.42 (0.14 to 1.29)	.13	—	—

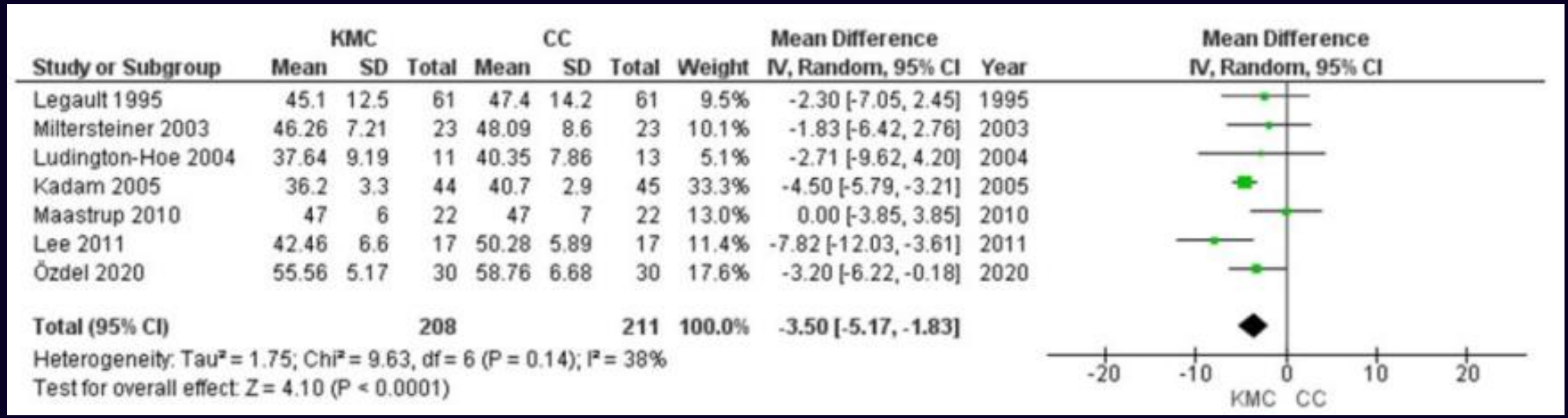
Kangaroo Mother Care and Neonatal Outcomes: A Meta-analysis, Pediatrics (2016)

Table 3. Primary and Secondary Outcomes.*

Outcome	Intervention (N=1609)	Control (N=1602)	Risk Ratio, Hazard Ratio, or Difference (95% CI)†	P Value
Primary				
Death between enrollment and 28 days — no./total no. (%)	191/1596 (12.0)	249/1587 (15.7)	0.75 (0.64–0.89)	0.001
Death between enrollment and 72 hr after birth — no./total no. (%)	74/1606 (4.6)	92/1599 (5.8)	0.77 (0.58–1.04)	0.09
Secondary‡				
Exclusive breast-feeding at end of neonatal period — no./total no. (%)	1208/1401 (86.2)	1140/1336 (85.3)	1.01 (0.98–1.05)	
Fully breast-fed (i.e., by suckling) at hospital discharge — no./total no. (%)	62/1435 (4.3)	55/1376 (4.0)	1.06 (0.73–1.53)	
Hypothermia — no./total no. (%)§	90/1609 (5.6)	133/1602 (8.3)	0.65 (0.51–0.83)	
Median time to clinical stabilization — hr (IQR)¶	73.8 (26.8–138.5)	74.8 (25.3–140.6)	0.98 (0.90–1.07)‖	
Suspected sepsis — no./total no. (%)**	361/1575 (22.9)	434/1561 (27.8)	0.82 (0.73–0.93)	
Hypoglycemia at any time between 0 and 36 hr after birth — no./total no. (%)††	82/799 (10.3)	66/651 (10.1)	1.15 (0.85–1.56)	
Mean duration of hospital stay — days‡‡	14.9±0.2	15.2±0.2	1.07 (0.99–1.16)‖	
Mean score for maternal satisfaction§§	9.2±1.0	9.1±1.2	0.11 (0.03–0.19)¶¶	
Maternal depression — no./total no. (%)‖‖	2/1276 (0.2)	7/1231 (0.6)	0.23 (0.05–1.14)	

- 3211 LBW infants (1000-1800 g at birth)
- Intervention: Kangaroo mother care vs. Usual care
- Primary outcome: death at 28 and 3 days of life

Immediate “Kangaroo Mother Care” and Survival of Infants with Low Birth Weight, NEJM (2021)



Study or Subgroup	KMC Mean	KMC SD	KMC Total	CC Mean	CC SD	CC Total	Weight	Mean Difference IV, Random, 95% CI	Year
Legault 1995	45.1	12.5	61	47.4	14.2	61	9.5%	-2.30 [-7.05, 2.45]	1995
Miltersteiner 2003	46.26	7.21	23	48.09	8.6	23	10.1%	-1.83 [-6.42, 2.76]	2003
Ludington-Hoe 2004	37.64	9.19	11	40.35	7.86	13	5.1%	-2.71 [-9.62, 4.20]	2004
Kadam 2005	36.2	3.3	44	40.7	2.9	45	33.3%	-4.50 [-5.79, -3.21]	2005
Maastrup 2010	47	6	22	47	7	22	13.0%	0.00 [-3.85, 3.85]	2010
Lee 2011	42.46	6.6	17	50.28	5.89	17	11.4%	-7.82 [-12.03, -3.61]	2011
Özdel 2020	55.56	5.17	30	58.76	6.68	30	17.6%	-3.20 [-6.22, -0.18]	2020
Total (95% CI)			**208**			**211**	**100.0%**	**-3.50 [-5.17, -1.83]**	

Heterogeneity: Tau² = 1.75; Chi² = 9.63, df = 6 (P = 0.14); I² = 38%
Test for overall effect: Z = 4.10 (P < 0.0001)

Physiological stress parameters in NICU (Meta-analysis, n=20)

- Significant: low respiratory rate (CI, -5.17 to -1.83, P<0.00001)
- Not significant: heart rate, oxygen saturation, and temperature

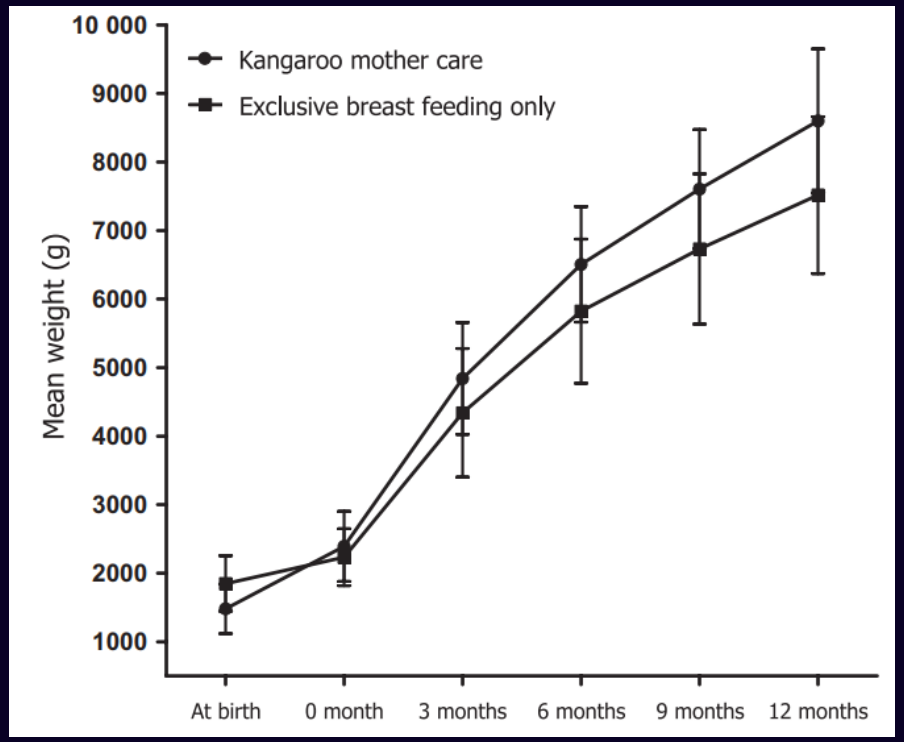
Effects of Kangaroo Mother Care in the NICU on the Physiological Stress Parameters of Premature Infants: A Meta-Analysis of RCTs, Environ Res and Public Health (2021)

Developmental care 1

- Kangaroo Mother Care

- Participant: 449 VLBW preterm infants
- Intervention: Kangaroo Mother Care vs. Usual care
- Primary outcome:
  - Body weight, length, head and chest circumference at 0/3/6/9/12 mos
  - Developmental Assessment Scales for Indian Infants at 12 mos (CA)

Effect of kangaroo mother care on growth and development of low birthweight babies up to 12 months of age: a controlled clinical trial, Acta Pediatrica (2014)



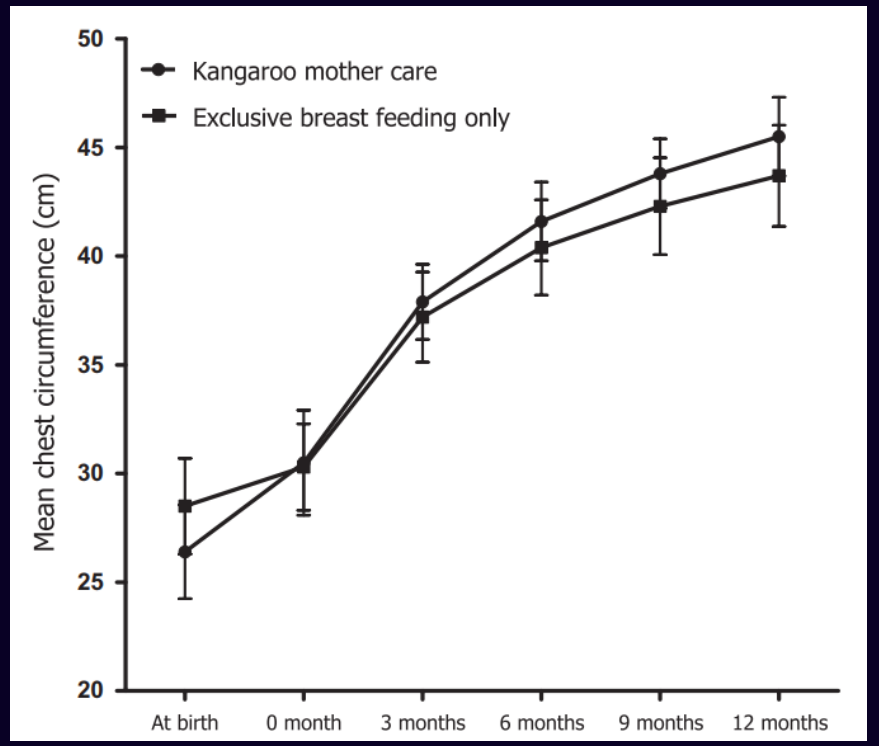
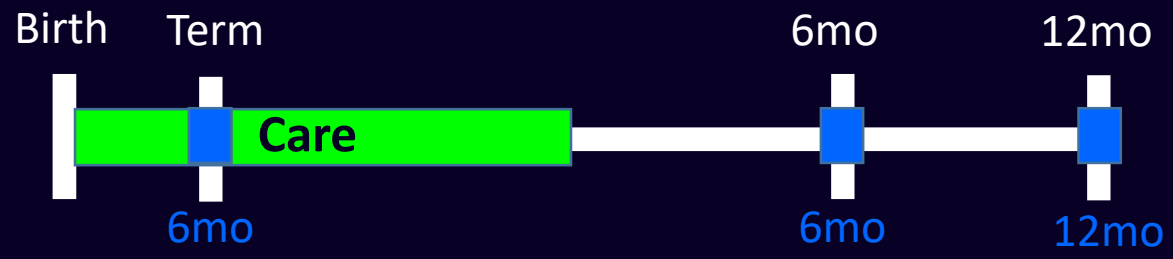


Table 2 Changes in physiological parameters before and after KMC in the study cohort

	KMC babies (n = 282)			Control babies (n = 167)			
Parameter	Range	Mean ± SD	95% CI	Range	Mean ± SD	95% CI	p value
DASII_DmoQ							
At 12 months	54.83–132.00	97.48 ± 10.637	96.13–98.63	40.83–132.41	83.72 ± 12.733	81.77–85.66	<0.001
DASII_DmeQ							
At 12 months	64.51–128.30	102.94 ± 8.377	101.96–103.93	50.00–115.38	86.47 ± 11.576	84.70–88.24	<0.001

CI = Confidence interval; DASII_DmeQ = Developmental Assessment Scales for Indian Infant (DASII) development quotient score – mental scale; DASII_DmoQ = DASII development quotient score – motor scale; SD = Standard deviation.

Developmental care 1



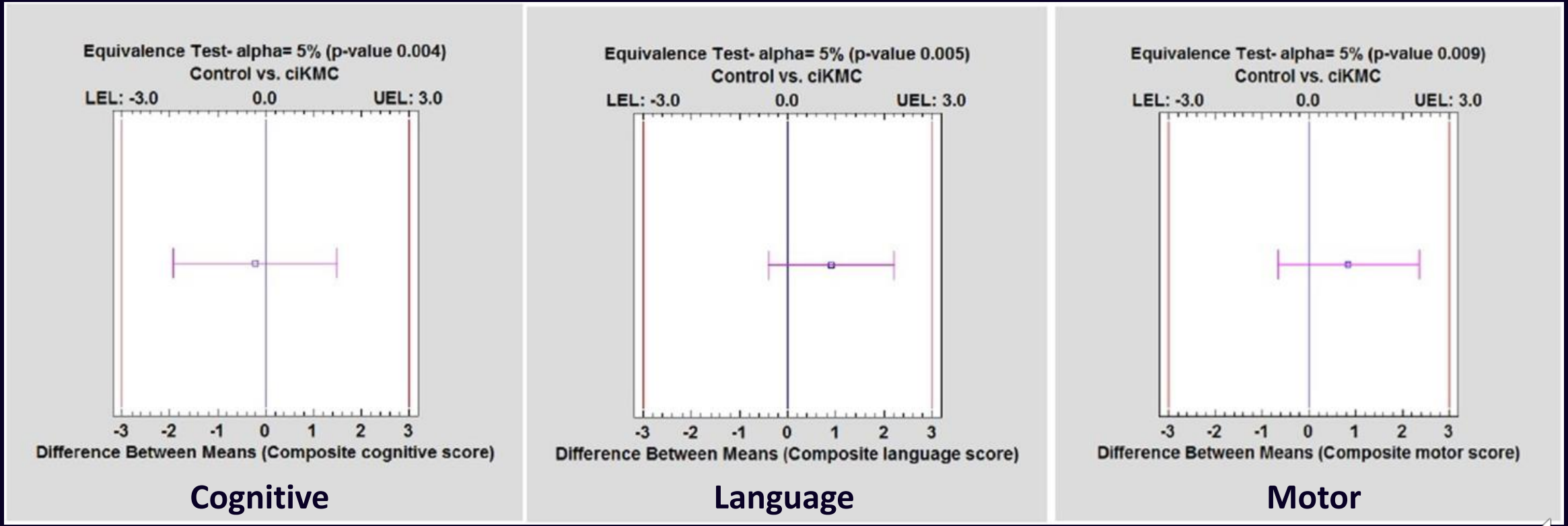
- Kangaroo Mother Care

- Participant: 552 healthy LBW infants (1500-2250 g at birth)
- Intervention: Home Based Post Natal Care vs. Usual care
  - until no longer accepted skin-to-skin contact
- Primary outcome:
  - Neonatal Neurobehavioral Examination at term, 6, 12 mos (CA)

Community initiated kangaroo mother care and early child development in low birth weight infants in India-a randomized controlled trial, BMC Pediatrics (2020)

Developmental care 1

- Kangaroo Mother Care



Community initiated kangaroo mother care and early child development in low birth weight infants in India-a randomized controlled trial, BMC Pediatrics (2020)

Developmental care 1

- Kangaroo Mother Care: safe, but feasible?

- NICU physical environment: space in NICU, chairs, family room
- Healthcare provider's beliefs
- Clinical practice variation
- Parental presence in NICU

What is stopping us? An implementation science study of kangaroo care in British Columbia's neonatal intensive care units, BMC Pregnancy and Childbirth (2021)

Developmental care 2

- Family-centered intervention program (FCIP)

- Participant: 251 VLBW preterm infants (<1500 g)
- Intervention: FCIP vs. Usual care
- Primary outcome: at term only
  - Neurobehavioral performance
  - Full oral feeding
  - Hospital discharge
  - Weight gain

Family-centered Care Improved Neonatal Medical and Neurobehavioral Outcomes in Preterm Infants: Randomized Controlled Trial, Physical Therapy (2017)

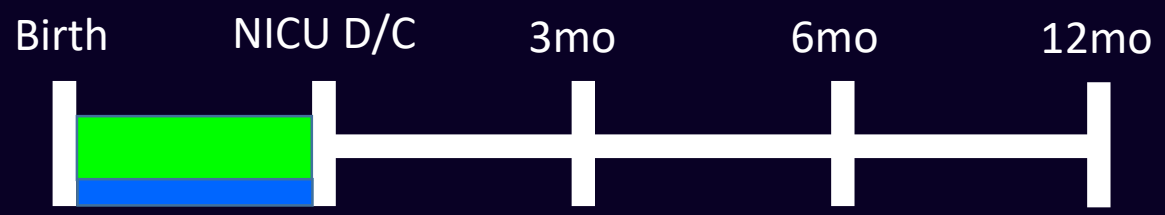
Characteristic	In-NICU Interventions		After-Discharge Interventions		Neonatal Follow-Up (All Infants)
	FCIP	UCP	FCIP	UCP	
Framework	Family-centered care, synactive theory	Synactive theory	Family-centered care, biosocial developmental theory		
Mode	Ward visits	Ward visits	Clinic and home visits	Telephone calls	Clinic visits
Target	Child, parent, and dyad focused	Child, parent, and dyad focused	Child, parent, and dyad focused	Child focused	Child focused
Topics of service	(1) NICU environmental modulation (session I) (2) Feeding support (session II) (3) Massage (session III) (4) Dyadic interaction activities (session III) (5) Child developmental skills (session IV) (6) Parent support and education (sessions I–V) (7) Transition home preparation (session V)		(1) Home environmental modulation (covered only in home visits) (2) Child developmental skills (3) Feeding support (4) Parent support and education (5) Dyadic interaction activities (topics 2–5 were covered in all sessions)	General care issues asked by parent	(1) Health surveillance (2) Immunization (3) Growth assessment (4) Nutrition consultation (5) Clinical referral if needed
Approach	Interventions containing all items listed above	Interventions containing all items listed above	Interventions containing all items listed above	Consultation on general care	Consultation on items listed above
Provider	Nurse, parent, and physical therapist	Nurse and physical therapist	Family members and physical therapist	Physical therapist	Neonatologist
Frequency	5 sessions (parental involvement in all sessions)	5 sessions (parental involvement in at least 1 session)	Clinic: 4 sessions (1, 2, 4, and 9 mo) Home: 3 sessions (term and 6 and 12 mo)	7 phone calls (term and 1, 2, 4, 6, 9, and 12 mo)	7 visits (term and 1, 2, 4, 6, 9, and 12 mo)

[a]FCIP = family-centered intervention program, NICU = neonatal intensive care unit, UCP = usual care program.

Family-centered Care Improved Neonatal Medical and Neurobehavioral Outcomes in Preterm Infants: Randomized Controlled Trial, Physical Therapy (2017)

Variable	FCIP Group (n = 122)[b]	UCP Group (n = 129)[b]	β Coefficient or Odds Ratio (95% CI)[c]	Effect Size
Morbidity				
Duration of oxygen use, d	42.0 ± 35.6	49.5 ± 39.9	–7.6 (–17.0 to 1.9)	0.20
Sepsis	16 (13.1)	26 (20.2)	0.6 (0.3 to 1.2)	
Mild to severe BPD	76 (62.3)	84 (65.1)	0.7 (0.4 to 1.1)	
Stage II or III retinopathy of prematurity	12 (9.8)	23 (17.8)	0.5 (0.2 to 1.1)	
Postmenstrual age at discharge, wk	37.7 ± 2.1	38.3 ± 2.2	–0.6 (–1.1 to –0.1)[d]	0.28
Length of hospital stay, d	56.6 ± 23.9	62.1 ± 24.3	–5.5 (–11.5 to 0.5)	0.23
Feeding				
Postmenstrual age when achieving full enteral feeding, wk	35.5 ± 2.1	36.6 ± 4.3	–1.1 (–1.9 to –0.2)[d]	0.33
Feeding desaturation	11 (9.0)	15 (11.6)	0.8 (0.3 to 1.7)	
Growth				
Weight gain, g/d	40.0 ± 13.1	36.7 ± 13.1	3.3 (0.1 to 6.6)[d]	0.25
Weight at term, g	3,005.2 ± 566.2	2,912.5 ± 633.3	92.7 (–57.0 to 242.3)	0.15
Normalized weight at term, *z*	–0.8 ± 1.5	–1.1 ± 1.7	0.3 (–0.1 to 0.7)	0.19
Neurobehavioral score, points	**n = 120[e]**	**n = 124**		
Tone and motor patterns	**23.8 ± 2.0**	**23.1 ± 2.0**	**0.6 (0.1 to 1.1)[d]**	**0.35**
Primitive reflexes	**24.2 ± 1.8**	**23.9 ± 1.7**	**0.3 (–0.1 to 0.7)**	**0.17**
Behavioral responses	**23.5 ± 2.5**	**23.2 ± 2.6**	**0.3 (–0.4 to 0.9)**	**0.12**
Total	**71.5 ± 4.6**	**70.2 ± 4.0**	**1.2 (0.2 to 2.3)[d]**	**0.30**

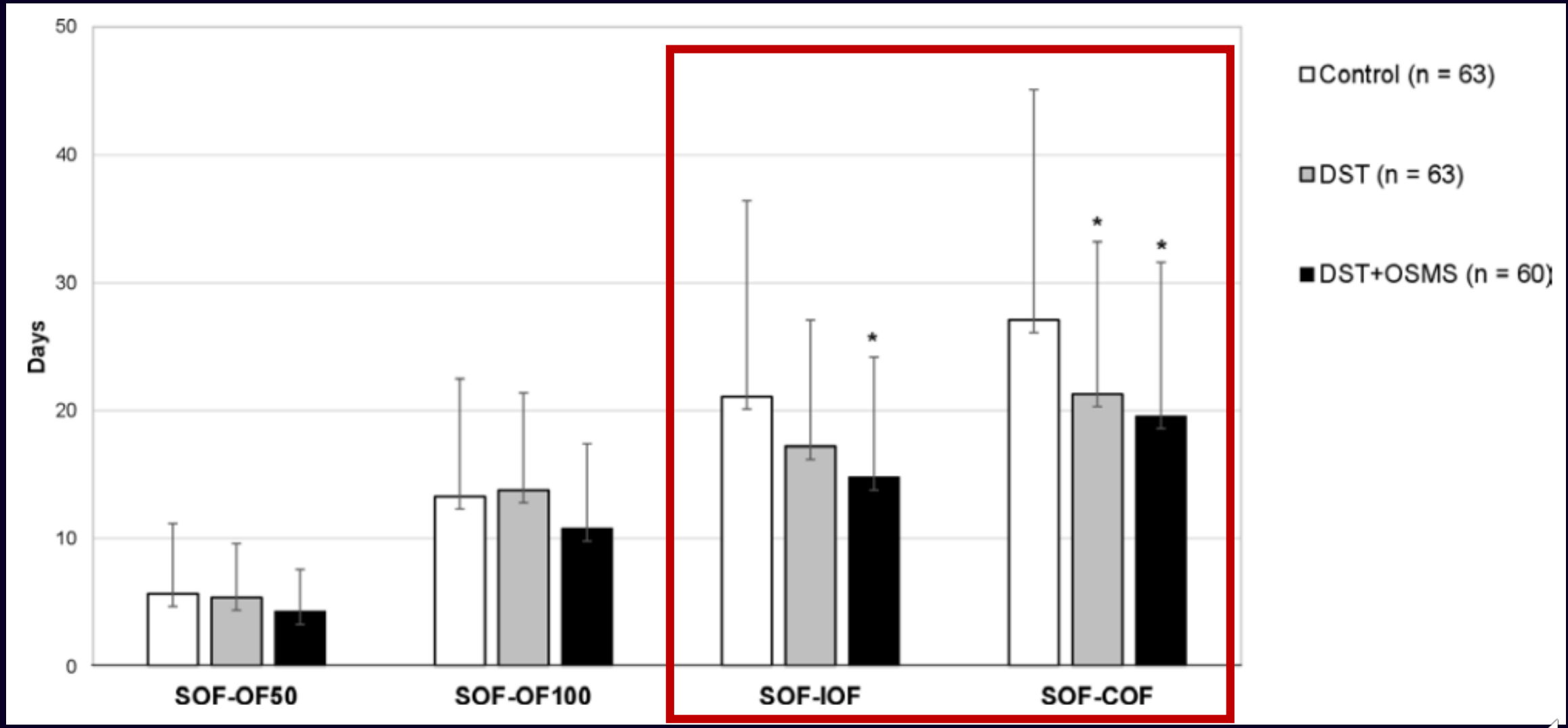
Oromotor therapy 1

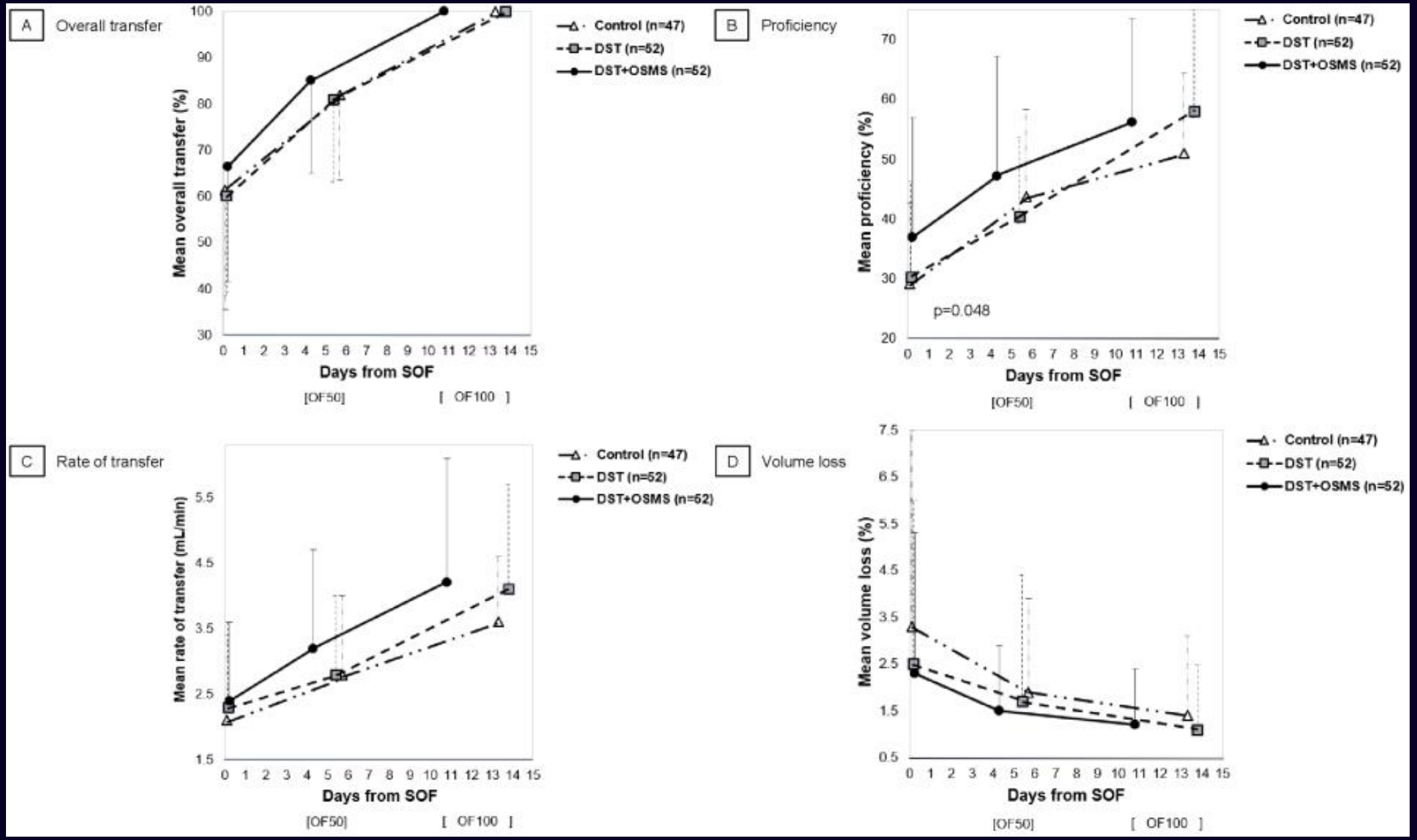


- Direct swallowing training (DST) + oral sensorimotor stimulation (OSMS)

- Participant: 186 preterm infants (<32 wks GA)
- Intervention: DST + OSMS vs. DST vs. Usual care
  - 1/day, 5 days/week, until achievement 100% oral feeds of daily intake
- Primary outcome:
  - Time from start to independent oral feeding

Direct swallowing training and oral sensorimotor stimulation in preterm infants: a randomised controlled trial, Arch Dis Child fetal Neonatal Ed (2021)


50
40
30
20
10
0
Days
SOF-OF50
SOF-OF100
SOF-IOF
SOF-COF
Control (n = 63)
DST (n = 63)
DST+OSMS (n = 60)
*
*
*


A
Overall transfer
Mean overall transfer (%)
Days from SOF
[OF50]
[OF100]
Control (n=47)
DST (n=52)
DST+OSMS (n=52)
B
Proficiency
Mean proficiency (%)
p=0.048
C
Rate of transfer
Mean rate of transfer (mL/min)
D
Volume loss
Mean volume loss (%)

SEOUL NATIONAL UNIVERSITY CHILDREN'S HOSPITAL

SNUH

소아재활의학과

우리 아기 어떤 운동을 하면 좋을까요?

신생아중환자실 입 · 퇴원 아기들을 위한
조기 운동 교육 자료

SNUH
서울대학교어린이병원

1 바로 누운 자세에서의 운동

1-1 고개 가누기 운동

목적 머리 조절 능력 향상, 목 굽힘근 강화, 복근 자극 운동

● 고개를 가눌 수 있는 경우

① 아기를 바로 누운 자세로 편안하게 해줍니다.

② 보호자는 아기의 손 또는 손목을 잡아 보호자 가슴방향으로 당겨 줍니다. (아기가 아래팔에 힘이 약한 경우에는 위팔을 잡아 줍니다.)

③ 아기의 턱이 배꼽을 향할 수 있도록 손 또는 팔을 당겨서 유도해 줍니다.

잘못된 반응 아기가 머리를 조절할 힘이 약해서 과도하게 목이 뒤로 젖혀질 수 있습니다. (기관 절개를 한 아기의 경우 주의해야 합니다.)

● 고개를 가누는 힘이 약한 경우

① 아기가 목을 가누는 힘이 약하다면, 보호자의 한 손은 아기의 목을 받쳐주어 목이 과하게 젖혀 지지 않도록 해줍니다.

② 목이 지지가 된 상태로 아기의 턱이 배꼽을 향할 수 있도록 손 또는 팔을 당겨 유도해 줍니다.

③ 보호자는 다른 한 손으로 장난감을 이용하여 아기의 고개가 숙여질 수 있도록 유도할 수 있습니다.

1 감각 자극 놀이 – 청각 / 촉각

목적 청각 및 촉각 자극으로 영아의 감각을 촉진시켜 이를 지각하고 놀이에 참여하게 합니다. 감각 놀이를 통해서 이와 관련된 감각 기억력을 촉진시킵니다.

●머리 쓰다듬으며 아기 이름 부르기

아기가 정서적으로 안정감을 느낄 수 있도록 자세를 편안하게 해줍니다. 아기의 이름을 부르며 신체를 쓰다듬는 행위를 자주 제공해줍니다. 이러한 활동은 아기의 청각적, 촉각적 발달을 촉진시키는데 도움이 됩니다.

●종소리, 딸랑이, 음악 소리 들려주기

아기를 편안하게 눕히고 다양한 소리를 일정하게 들려줍니다. 아기를 목욕시킬 때, 우유를 먹일 때 등 일상에서 노래를 반복적으로 불러주는 활동도 청각 자극을 활성화시키고 기억력을 자극하는데 도움이 됩니다.

2 감각 자극 놀이 – 시각

목적 시선의 초점을 맞추고 시각적 추적능력을 증진시킵니다. 사물 식별을 촉진시킵니다.

●사물을 줄에 매달아 보여주기 (물건을 바로보기)

침대나 유모차에 줄을 매어 물건(색깔 대비가 명확한 인형, 딸랑이, 양말 등)을 걸어주면 아기는 사물에 초점을 맞추고 시선을 고정할 수 있는 능력을 기르는 기회가 됩니다. 나아가 사물을 식별하는 능력도 키울 수 있게 됩니다. 초기에는 하나로 시작하여 점차 개수를 늘려가는 것이 좋습니다. 소리가 나는 물건을 걸어준다면 청각과 시각 반응을 함께 유도할 수도 있습니다.

●모빌 보여주기 (움직이는 물건을 따라보기)

누운 자세에서 아기의 시선에 맞춰 모빌을 달아줍니다. 움직이는 사물을 보도록 하는 것은 아기에게 시각적 추적능력 발달의 기회가 됩니다. 색이 선명하고 명확하게 대비되거나 소리가 나는 모빌은 감각 촉진에 더욱 도움이 됩니다.

〈초점놀이 그림의 예〉

1 수유 자세

- 머리와 팔, 다리는 신체 중앙으로 모으고 어깨는 좌우 대칭이 되게 합니다.
- 양팔은 자연스럽게 안쪽으로 모으고 엉덩관절은 45~90도로 굽힙니다.
- 보호자와 아기가 서로 바라보며, 신체적으로 가까이 밀착되게 안아줍니다.

2 영양적 빨기

- 정상적 빨기 속도는 초당 1회 정도이며, 20~30회 폭발적으로 빨다가 숨쉬기 위해 잠시 멈추게 됩니다. 충분한 수유 시간은 15~20분 정도이며, 30분을 넘기지는 않도록 합니다. 건강한 아기는 수유 동안 빨기-삼킴-호흡의 통합적 조절이 가능합니다.

3 비영양적 빨기

- 새끼손가락이나 고무젖꼭지를 입 안에 넣었을 때 빠는 것을 볼 수 있습니다. 아기가 깊이 잠들어 있지 않고 깨어있는 시간에 제공하는 것이 좋으며, 초당 약 2회 정도로 빠는 것이 정상 속도입니다. 일반적으로 10~15분 정도 제공합니다.
- 비영양적 빨기를 수행하면, 관으로 영양 공급을 받고 있는 아기의 소화 기능에 관여하는 호르몬 분비가 촉진되어 식사 시간을 현저하게 감소시켜 줄 수 있습니다. 관 영양 공급에서 구강 섭취로 전환하는데 도움을 제공합니다.

뇌성마비 장애인과 가족들을 위한 건강보건 길라잡이

서울대학교어린이병원
보건복지부

에듀팩토리 EDU FACTORY

(3) 대운동 발달을 돕는 운동

뇌성마비 아동의 대운동 발달을 돕는 가정에서 시행할 수 있는 운동을 알아보도록 하겠습니다(그림 2-13~23).

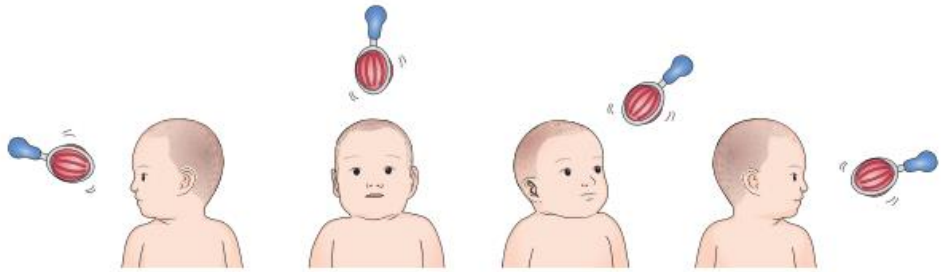


그림 2-13 목 가누기

젖꼭지나 딸랑이와 같은 소리나는 장난감을 움직여 아동이 쳐다보도록 유도하며 목 가누기 연습을 할 수 있습니다. 제대로 고개를 들고 돌릴 때마다 웃어주거나 만져주어 칭찬을 해주면 좋습니다.

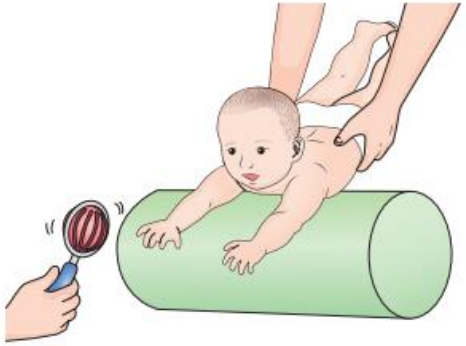


그림 2-14 엎드린 자세

부모가 양다리를 쭉 펴고 앉은 자세에서 그 위로 아동이 가로질러 엎드리게 하거나 짐볼이나 롤 위에 엎드리게 하여 골반을 잡아줍니다. 가급적 머리와 허리를 펴도록 앞에서 장난감을 흔들어 주고 아동이 고개를 들면 칭찬해 주는 것도 좋습니다. 아동이 목과 몸통을 잘 가누면 이 자세에서 팔꿈치나 팔로 체중을 지지하는 연습을 하고 나아가 양손으로 물건을 잡고 놀도록 유도합니다.

그림 2-18 네발로 기기

A) 아동을 앉은 자세로 두고 부모의 한 손은 아동의 엉덩이에 다른 손은 아동의 가슴에 대고
B) 네발기기 자세가 되도록 아동의 몸통을 서서히 기울입니다.
C) 네발기기 자세가 만들어지면 롤 위에서 네발기기 연습을 할 수 있습니다.

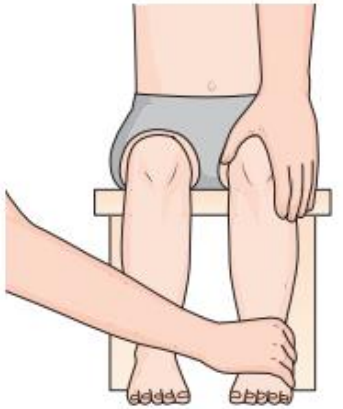
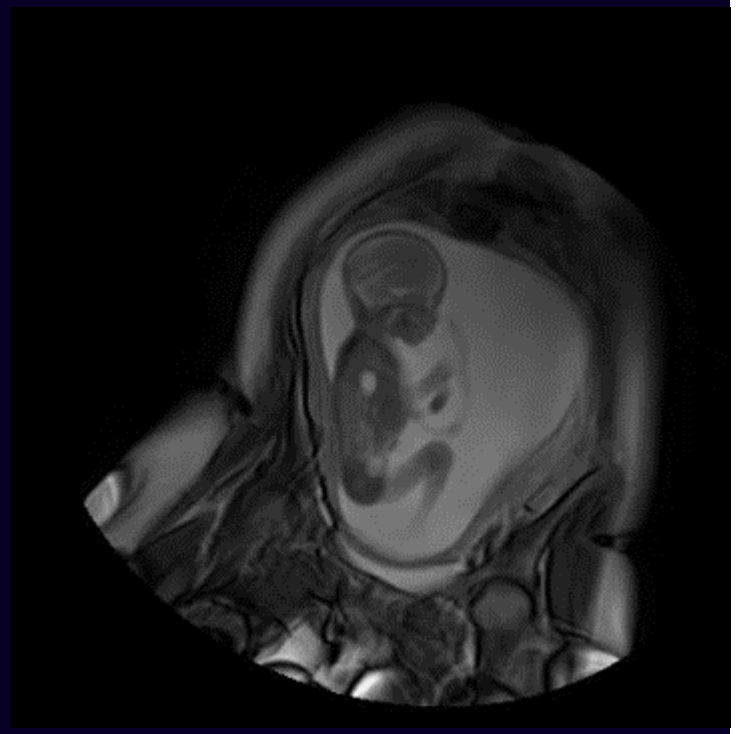


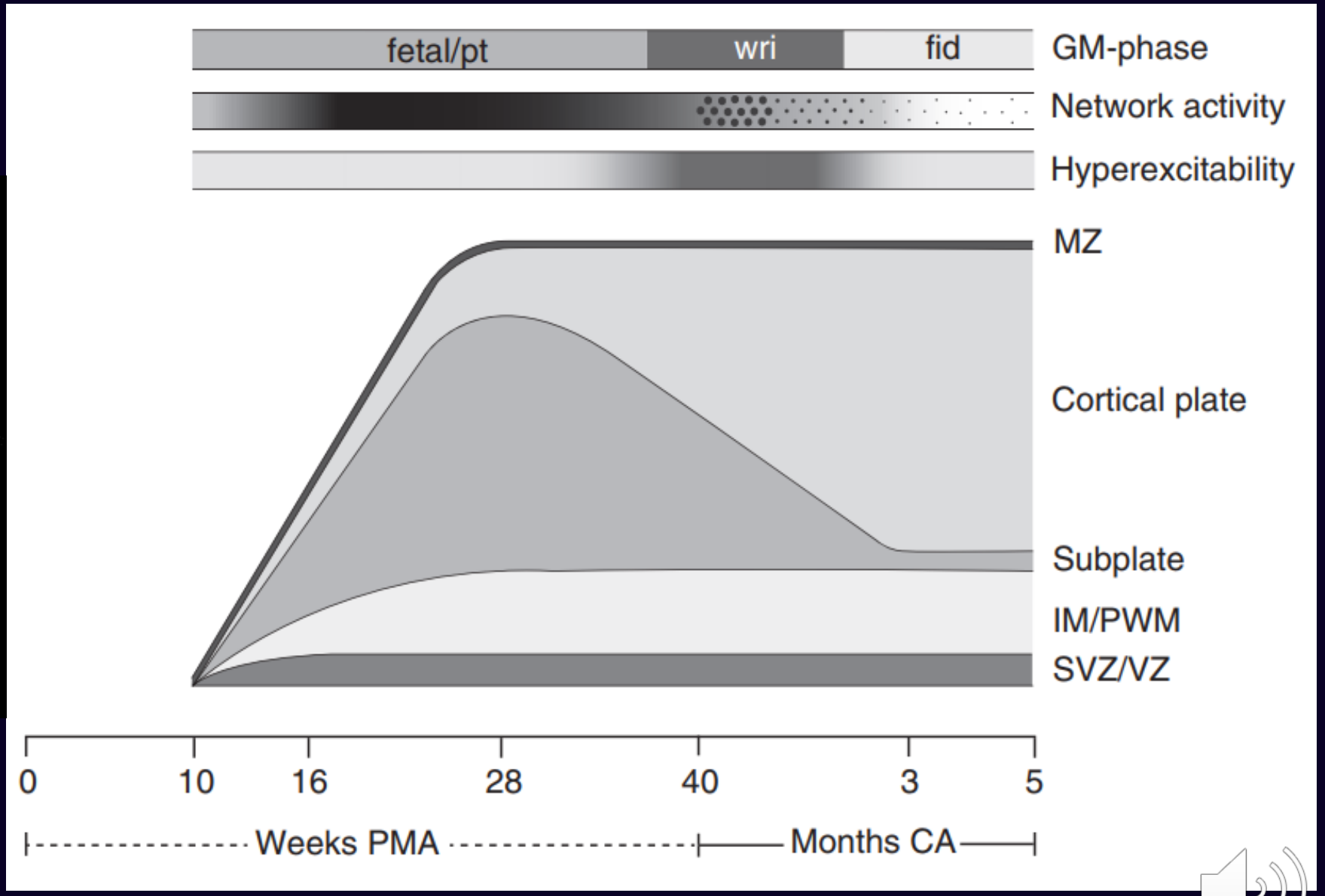
그림 2-19 다리에 체중을 지지하기

아동을 의자 위에 앉혀서 발의 바깥쪽(새끼발가락 방향)에 체중을 지지하게 하면서 발을 평평하게 펴서 놓습니다. 한 손으로 무릎을 지긋이 눌러주고, 다른 손으로는 [illegible]을 고정하여 압력을 줍니다. 점차적으로 일어서는 자세를 연습하며, 체중을 의자에서 다리로 옮겨가는 연습을 합니다.

Issues in early intervention

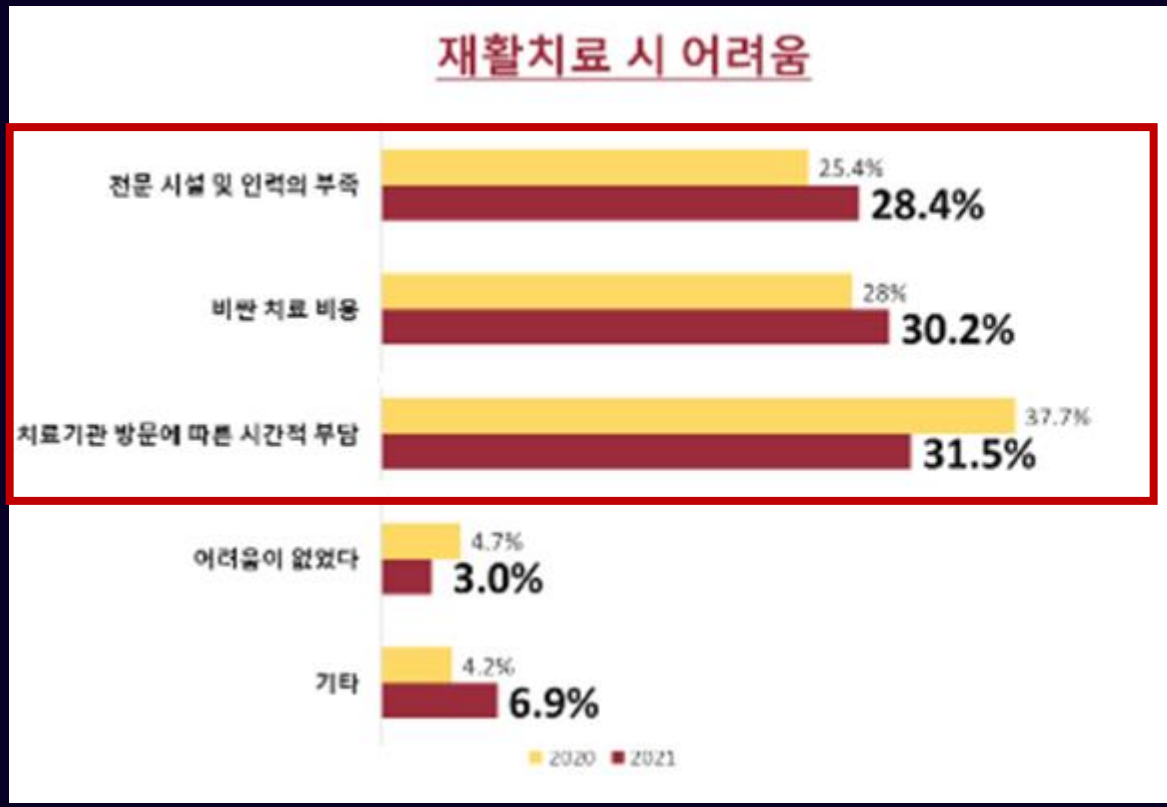
- Theory
- Contents of intervention: age (developmental stage), initiation, duration, dosage
- Provider: therapist, parent
- Supervision
- Goal and progression: “just right challenge”
- Environment

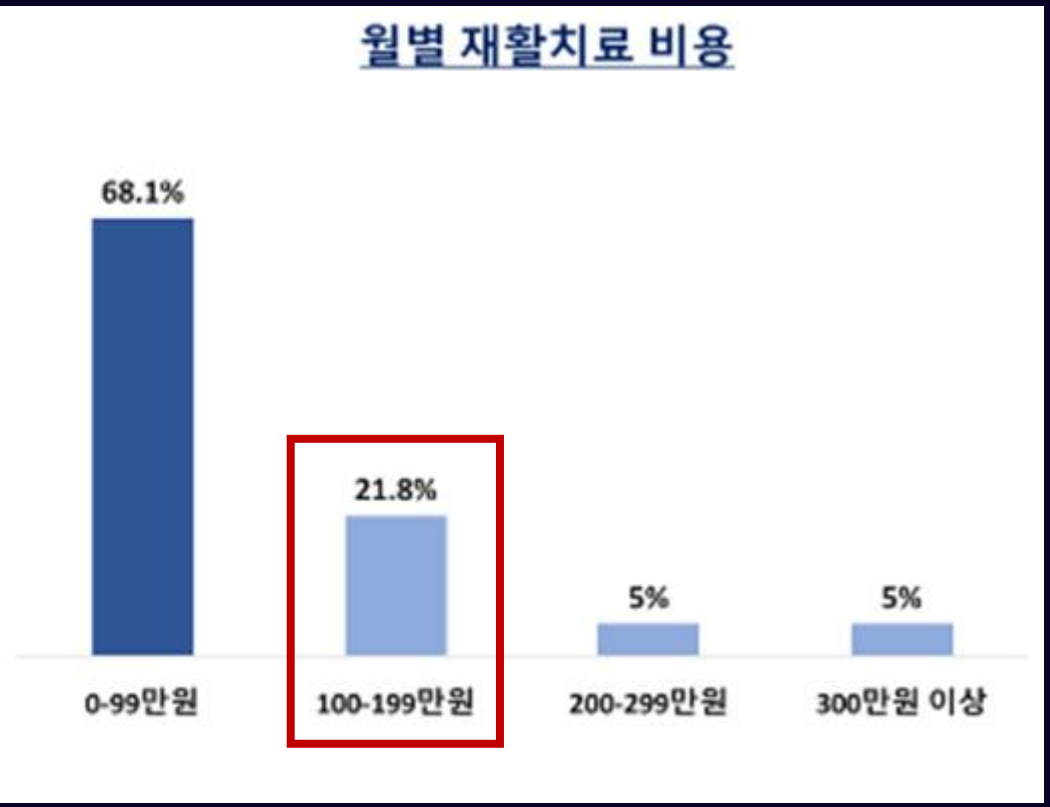




Neural substrate and clinical significance of general movements an update, DMCN (2017)

Current status in Korea





- 총 320명의 미숙아 부모 대상 설문
- 평균 재활치료 기간: 16.7개월
- 재활치료 장소: 종합/대학병원(56%), 사립기관(32%)

- 재활치료를 받지 못하는 이유:
  - 치료비가 비싸서(39.6%) > 전문시설은 있으나 대기가 길어서(22.9%) > 시간적 여유가 없어서 (20.8%)

이른둥이 양육 및 치료 실태조사, 대한신생아학회 (2021)

Summary

- 1/3 of VLBW infants in Korea: rehabilitative support
- Risk factors: preterm + term (antenatal, perinatal, postnatal)
- Early detection of high risk infants
- Framework: dynamics systems theory, ICF, family-centered care
- Early intervention: insufficient, small-sample sized, heterogeneous
  - Parent-delivered: conditional (short- and long-term motor/cognitive outcome)
  - Therapist-delivered: conditional (short-term motor outcome)
  - Developmental care: conditional
  - Oromotor: inconclusive
- Issues: provider, contents, supervision, environment (+mechanism)

Thank you