



# Executive Function in Infants and Toddlers born Low Birth Weight and Preterm

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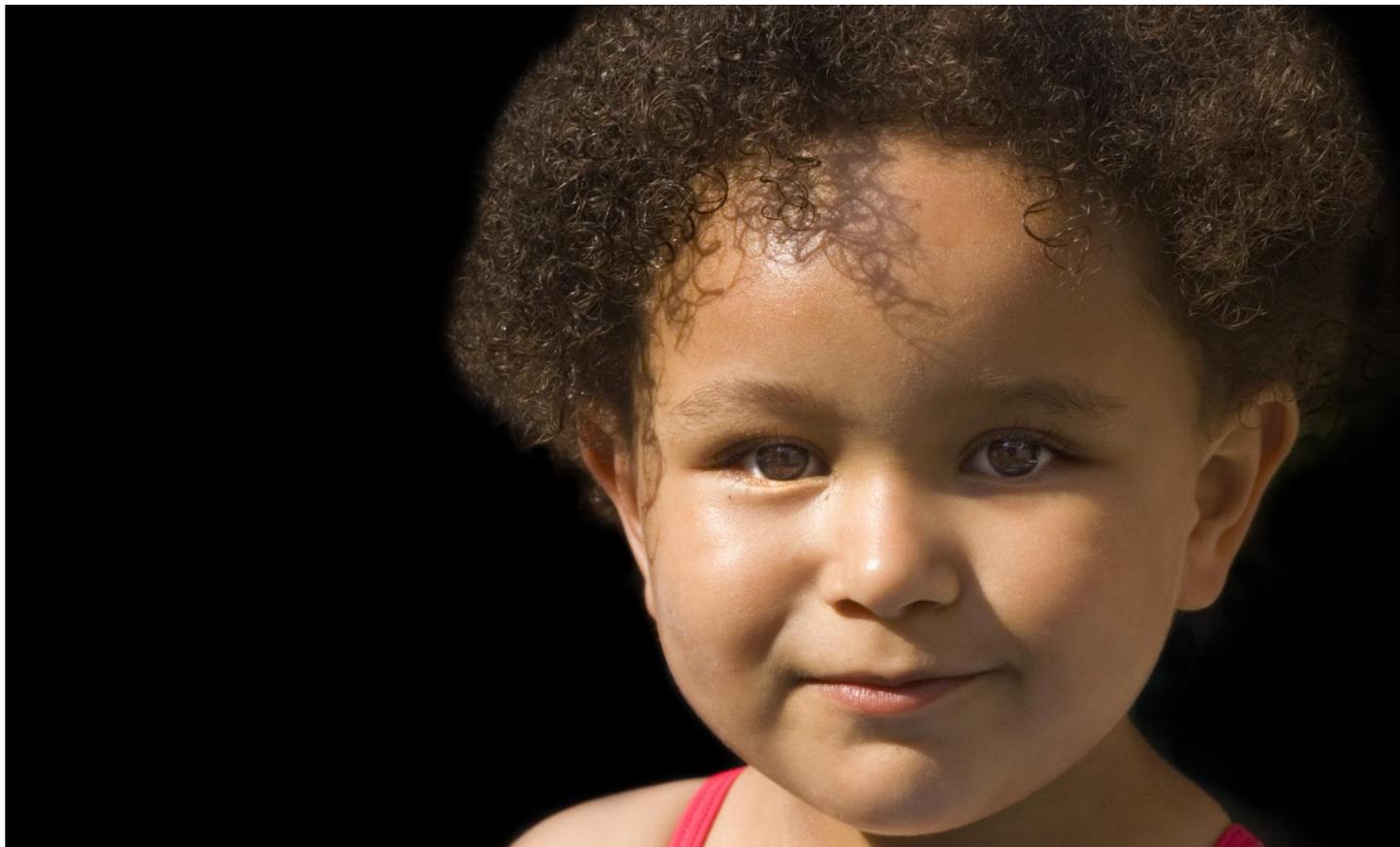
# Objectives

- Participants will understand retrospective research on young children born LBW and later school outcomes.
- Participants will learn preliminary findings from this and other studies by the researchers.
- Participants will engage in active planning for state activities to insure children born LBW are followed at birth and monitored for development.

# Executive Function

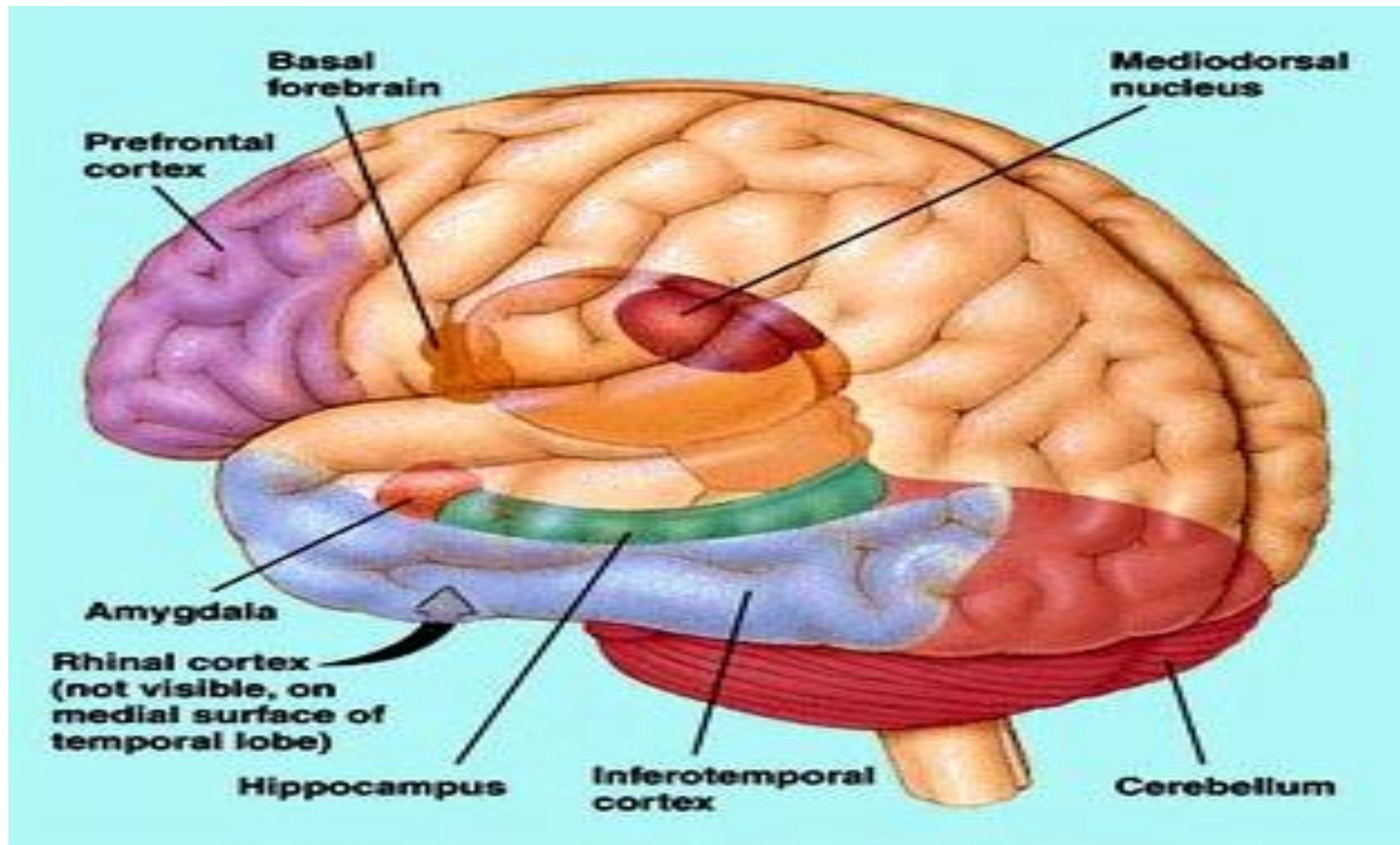


Refers to a group of neurocognitive processes in the brain that direct, connect, and organize information that is manifested in planned behavior.



# Chief Executive Officer

**She's the CEO of her brain**



# Early Childhood and EF



- Components follow their own developmental trajectory
- Growth spurts in the last half of the first year and then from 3 to 6 years of age  
(Diamond, 2006)

# Why are these so important in Early Childhood?

- Inability to plan and organize actions, maintain attention to tasks, and recall past experience to apply to new learning experiences lead to:
- Learning disabilities (LD) as well as problems with Attention-deficit/hyperactivity disorder (ADHD) (Lyon & Fletcher, 2001).

# Neurocognitive Processes



- Self Regulation
- Inhibition
- Working Memory
- Cognitive Flexibility
- Goal Selection
- Planning and Organization

# Self-Regulation



Self-regulation functions are developing from the first years of life on throughout a person's entire lifetime.

# Inhibit



Ability to control behavior and impulses

Redirect Activity

Stop, Think & Action

Challenging Behavior

# Working Memory



- Ability to hold and process “stored” information !
- A not B tasks

# A not B Task



# First Year of Life



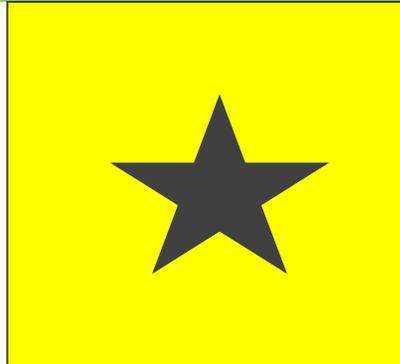
- By 12 months, infants should be able to:
  - Engage in a simple problem-solving task requiring working memory of an item (find a hidden toy under a cloth when it is changed)
  - Regulate behaviors (inhibit actions, waking, sleeping, eating, etc.)

# Toddlers and Three

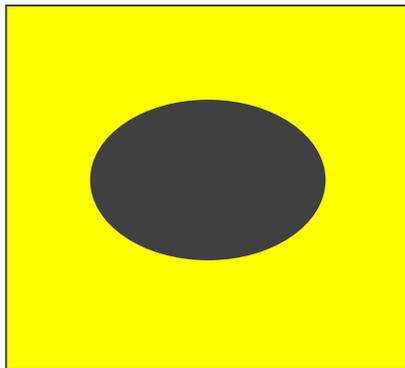
- Cognitive Flexibility – shift between changing attributes/requests
- Dimensional Card Category Sort (DCCS)
  - Cards depicting colored shapes
  - Child sorts cards by 1 dimension then another
- Knock tap
  - Child knocks when examiner taps

# Dimensional Change Card Sort- Separated Task

Rule: Sort by  
Color



Rule: Sort by  
Shape



# What about children born LBW



- Major medical conditions, such as cerebral palsy and other severe disabilities, are well known outcomes of low birth weight (LBW) ( $\leq 2500$  grams) and preterm birth ( $\leq 37$  weeks).

# Research on LBW



Longitudinal research has shown that, although a large portion of this population did not have major disabilities, many had lasting cognitive impairments, particularly in executive functions (EF)

(Anderson & Boyle, 2004; Vohr, Wright, Poole, & McDonald, 2005)

# Research on LBW

- Very preterm infants (  $\leq 2500$  g,  $\leq 37$  weeks gestation) scored lower on tasks of executive functioning than full-term infants.
- Outcomes include poor cognitive function, learning difficulties, and behavior problems.

(Aarnoudse- Moens et. al., 2009; Sun, Mohay, & O'Hallahan, 2008).

# Research on LBW



- “At school age among very preterm children, key processing skills and working memory seem to underpin problems both generally and in math” (Marlow, p.F442).
- Recent research also demonstrated late preterm (34 to 36 weeks gestation) learning difficulties in the early school years (Chan & Quigley, 2014).

# National Early Intervention Longitudinal Study (NEELS) (Hebbeler et al., 2007)

- First and only national study that followed infants and young children from entry into Part C Early Intervention (EI) through Kindergarten
- 32% of children in EI were born at a low birth weight
  - 15% 1500 – 2499 grams (LBW)
  - 7% 1000 – 1499 grams (VLBW)
  - 10% <1000 grams (ELBW)

# National Early Intervention Longitudinal Study (NEELS) (Hebbeler et al., 2007)

- CDC Data (2002)
  - 7.8% LBW (n = 314,077) ELBW (n = 58,544)
- Part C Data (2002)
  - <12 months (n = 39,000) ELBW (n = 19,000)
- “...national LBW data suggest that EI is serving only a fraction of the total population of the LBW babies around the country.” (pg. 2-10)
- “...it is clear that even many VLBW babies are not entering EI programs.” (pg. 2-10)

# Results for Yes EI vs. No EI

## N = 268

Attends EI by BW	Yes	No
LBW	26 %	74 %
VLBW	49.5 %	50.5 %
ELBW	44.9 %	55.1 %

For the purpose of this analysis, Group 1 are labeled LBW (<2500 grams > 1500 grams), Group 2 VLBW (<1500 grams > 1000grams); Group 3 ELBW (<1000 grams).

# EI or No EI?



While we can only speculate, this population is highly at risk not only because of LBW but many of these children are from low SES and high poverty communities with limited resources.

# Project EF - Project EF: Executive Function in Infants and Toddlers Born Low Birth Weight (LBW) and Preterm

U. S. Department of Health and Human Services

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# Purpose of the Study

The purpose of Project EF: Executive Function in Infants and Toddlers Born Low Birth Weight (LBW) and Preterm is to examine whether traditional assessment methods that have components of EF in their structure can discern early indicators of executive function.

- a) children born LBW and preterm at low risk,
- b) children born LBW and preterm at high risk,
- c) children born full term.

# Previous Research using BSID

- Lowe, et al., (2009) used items from BSID II Mental Scale (#84, 96, and 102) to extrapolate working memory in 233 toddlers born ELBW at 18 to 22 months-old of age.
- Findings indicated gender differences favoring girls on object permanence tasks.

# Replication Research

- We replicated Lowe's study of early working memory.
  - 96 children born LBW (9 to 36 months,  $m = 19.98$  months) administered BSID-III in a NICU Follow-up Clinic (Duvall, Blasco, Dolata, Atkins & Saxton, 2014).
- Findings indicated:
  - Object permanence scores were significantly higher for females; this remained after co-varying for Cognitive Composite and age (ANCOVA).

# Measures

- Bayley Scales of Infant & Toddler Development III (Bayley, 2005)
- Dimensions of Mastery Questionnaire (DMQ 18) (Morgan, et. al. 2015)
- Child Behavior Checklist (Achenbach & Rescorla (2001)
- The Behavior Rating Scale of Executive Functioning – Preschool version (BRIEF-P) (Gioia, Espy & Isquith, 2002)
- EF Touch (Willoughby, Kuhn, & Blair, 2015)

# Bayley Scales of Infant and Toddler Development III (BSID) (Bayley, 2005)

- Designed to measure physical, motor, sensory, and cognitive development in infants and toddlers from birth to age 42 months.
- Consist of one form that provides:
  - Cognitive Composite and Scaled Score
  - Language Composite
    - Receptive and Expressive Scaled Scores
  - Motor Composite
    - Fine and Gross Motor Scaled Scores

# Dimensions of Mastery Questionnaire (DMQ 18) (Morgan et al., 2015)

- A parent-completed questionnaire that is designed to assess their children's mastery motivation and mastery pleasure related behaviors.
- Mastery Motivation is the intrinsic drive to explore and master one's environment through goal-directed behavior with challenging tasks.

# Child Behavior Checklist



- Measures children's emotional, behavioral, and social development.
- The preschool checklist (CBCCL/1½-5) is intended for use with children aged 18 months to 5 years.

# The Behavior Rating Scale of Executive Functioning – Preschool version (BRIEF-P)

- A 63 item rating form for parents or caregivers to rate a child's executive function within the context of his or her daily environments.

(Gioia, Espy & Isquith, 2002)

# EF Touch



- 7 EF computer tasks using a touch window and 2 non-EF (one warm-up/orientation, the other simple reaction time) tasks.

# Age



6 to 8 months corrected age

18 to 20 months corrected age

36 months

- ASSESSMENTS

- BSID III, DMQ 18

- BSID III, DMQ 18, CBC

- BSID III, DMQ 18, CBC, BRIEF-P, EF TOUCH

# Project EF Participants To Date

	N	%
<i>Typical</i>	13	46.4
<i>LBW</i>	15	53.6
Low Risk (bw = 1500 g+)	9	32.1
High Risk (bw <1500g)	6	21.4

# Sample Demographics

	Typical (N = 13)	LBW (N = 15)
<i>Gender</i>		
Male	61.5%	33.3%
Female	38.5%	66.7%
<i>Race/Ethnicity</i>		
American Indian/Alaska Native	--	7.1%
Asian	15.4%	7.1%
Hispanic/Latino	15.4%	21.4%
White, non-Hispanic	69.2%	64.3%

# Sample Demographics

	Typical (N = 13)	LBW (N = 12)
<i>Mother's Education</i>		
Less than college	--	16.7%
Some college	23.1%	16.7%
College grad+	76.9%	66.6%
<i>Father's Education</i>		
Less than college	15.4%	18.2%
Some college	46.2%	9.1%
College grad+	38.5%	72.7%

# LBW Sample Demographics

	Mean	Ranges
Corrected Age (months)	7.1	5.7 - 8.9
Gestational Age (weeks)	32.1	26.4 – 37.1
Birth Weight (grams)	1605	750 – 2466

# Early Intervention



- Five of the LWB children have been referred to Early Intervention
  - Three based on child assessment
  - Two as a result of a medical condition

## DMQ Scales – Average Scores

Typical and LBW children did not differ significantly on six DMQ scales with one exception:

Parents of Typical children rated them significantly higher on General Competence ( $t(26) = 3.70, p < .001$ ) than parents of LBW children.

	Typical (N=13)	LBW (N=15)
Object Oriented Persistence	3.5	3.34
Social Persistence with Adults	3.23	2.52
Social Persistence with Children	2.85	2.13
Gross Motor Persistence	3.85	3.33
Mastery Pleasure	4.17	3.77
Negative Reaction to Failure	2.46	2.36
<i>General Competence</i>	3.58	2.67

## Bayley III Scales – Average Scores

Typical children score statistically significantly higher on two scales:

- Expressive Scaled  
( $t(26) = 2.39, p = .025$ )
- Gross Motor Scaled  
( $t(26) = 2.56, p = .017$ )

	Typical (N=13)	LBW (N=15)
Cognitive Scaled	9.92	9.40
Cognitive Composite	99.62	97.00
Receptive Scaled	8.31	7.93
<i>Expressive Scaled</i>	9.08	8.00
Language Composite	92.54	88.40
Fine Motor Scaled	10.15	9.33
<i>Gross Motor Scaled</i>	11.15	8.20
Motor Composite	103.54	92.21

# BSID III Item components of EF

- Cognitive Scale
  - Emotional Control, Attention, Working Memory, Shift, Plan/Organize
- Language (both Receptive and Expressive)
  - Emotional Control, Attention, Working Memory, RC – Inhibit, EX – Plan/Organize
- Fine Motor
  - Plan/Organize
  - Working Memory
- Gross Motor
  - Plan/Organize
  - Attention

## Bayley III and EF Scales – Average Scores

- Concern for item density at 6 months on the Bayley III.
- Correcting for age often inflates scores for children who are LBW in their standard scores.

	Typical (N=13)	LBW (N=15)
Attention	.87	.81
Working Memory	.33	.30
Inhibit	.38	.39
Plan/Organize	.59	.56



How do we advocate for infants and toddlers who are LBW and their families to ensure their needs are met early?

# LBW and Preterm Infants

- 2014 Birthrates (Hamilton, Martin, Osterman & Curtis, 2015)
  - 8.00% Low Birth Weight (LBW;  $\leq 2500$  grams)
  - 1.40% Very Low Birth Weight (VLBW;  $\leq 1500$  grams)
  - 9.57% Preterm ( $\leq 37$  weeks)
- Dramatic improvement in survival rates for infants born low birthweight and/or premature have occurred over the past 30 – 40 years.

# Eligibility Criteria for Part C

- Determined by each state's definition of developmental delay
- Includes children with established physical and mental conditions with a high probability of resulting in developmental delay
- State may choose to include children at risk for eligibility (303.21)
- Informed clinical opinion of experienced professionals is an important part of evaluation process

# Part C Definitions

- *At-risk infant or toddler* – defined as an individual < 3 years who could be at risk of experiencing a substantial developmental delay if EI services were not provided
- *Developmental delay* – when used with respect to an individual residing within a State, has the meaning given such term by the state under section

# Eligibility Criteria and Influence of State Variability

- Category C – Restrictive, 33% delay in two or more domains, 40% delay in one domain, 50% delay in one domain, 1.5 standard deviations in 2 or more domains, 1.75 standard deviations in one domain, 2 standard deviations in one domain, 2 standard deviations in two or more domains
- States are not required to serve *at risk* infants and toddlers; however, the following states and territories do:
  - Illinois, Massachusetts, West Virginia, American Samoa, Guam

# Implications for Policy, Procedures, Position Statements, and Professional Development

- Consistent eligibility criteria based on infant-toddler development
  - Definition of informed clinical opinion
  - Approaches for assessing young infants
- Contemporary developmental science and early intervention evidence base
  - New approaches to assessment are needed, including measures of EF capacity

# Proposal: National Guidelines

- Conceptual Framework
  - National standard for the identification of and eligibility of children born LBW and preterm for Part C EI
- Standard criteria for including LBW as an established condition
  - LBW and preterm infants are vulnerable population at-risk of long-term developmental delays and disabilities
  - LBW infants and families are being underserved in EI
- Standard referral procedure with feedback loop

“Not everything that counts can be counted; and not everything that can be counted counts.”

-Albert Einstein

The End!  
Thank You  
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