“Neuro-Developmental Follow up 0-24 years: Lessons Learnt”

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Emeritus Professor Developmental, Behavioural & Adolescent Pediatrics
Child Development Centre
(CDC – Kerala)

Reduction of Childhood Disability

through

Reduction of Low Birth Weight

through

Reduction of Pre-Adolescent girls’ under nutrition
Causes of under-five deaths in India

Top five causes of death in Infants

- Perinatal conditions
- Malaria
- Unintentional injuries: others
- Nutritional deficiencies
- Ill defined conditions
- Congenital anomalies
- Other infections and parasitic diseases
- Diarhoeal diseases
- Respiratory infections

In India

Top five causes of death in Infants

- Others
- Perinatal conditions
- Malaria
- Unintentional injuries: others
- Nutritional deficiencies
- Ill defined conditions
- Congenital anomalies
- Other infections and parasitic diseases
- Diarhoeal diseases
- Respiratory infections
Prevention of Brain Damage:
Insults during pregnancy can cause Brain Damage or alter Brain Development

from: "The Newborn Brain: Neuroscience and Clinical Applications, Philippe Evrard, Mark Hanson, and Hugo Lagercrantz Cambridge University Press (2001)"
Prevention of Brain Damage: Developmentally Supportive Newborn Care

Avoiding Hostile! NICU environment
Infant Handling observing infant cues
Positioning to reduce energy losses
Body containment – Swaddling
Kangaroo Care – Community setting
Assessing Outcomes Change in NICU Practices Risk stratification Early Intervention Prevention of Brain Damage: Impairment → Disability → Handicap Assessing Outcomes Change in NICU Practices
### CDC-KIMS : Risk Stratification

<table>
<thead>
<tr>
<th>Score</th>
<th>Risk</th>
<th>Abnormal outcome</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>Low</td>
<td>9 (4.5%)</td>
<td>197 (87.5%)</td>
</tr>
<tr>
<td>3, 4 and 5</td>
<td>High</td>
<td>5 (17.8%)</td>
<td>28 (12.5%)</td>
</tr>
</tbody>
</table>

#### Bar Chart

- **Normal**
  - Score 1: 96
  - Score 2: 93.8
  - Score 3: 89.5
  - Score 4: 75
  - Score 5: 0

- **Abnormal**
  - Score 1: 4
  - Score 2: 6.3
  - Score 3: 10.5
  - Score 4: 25
  - Score 5: 100
Prevention of Brain Damage: 
↓$\text{O}_2$, ↓Glucose, ↓Perfusion
Prevention of Brain Damage:  
Prediction of Quality of Survival

Cystic Periventricular Leucomalacia (cPVL)

US Scan should be used like a Stethoscope
Prediction of Quality of Survival:
Compulsory ROP & Hearing Screening

ROP Screening
Oto-acuostic Emissions
### Prevention of Brain Damage

Pyritinol for Post-asphyxial Encephalopathy in Term Babies – an RCT

<table>
<thead>
<tr>
<th>Score</th>
<th>Trt. Group Mean (n=51)</th>
<th>Con. Group Mean (n=49)</th>
<th>Diff. Means</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDI</td>
<td>91.6 (2.9)</td>
<td>92.8 (2.5)</td>
<td>1.2</td>
<td>0.75</td>
</tr>
<tr>
<td>PDI</td>
<td>96.0 (3.2)</td>
<td>100.3 (2.7)</td>
<td>4.3</td>
<td>0.31</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>8.6 (0.2)</td>
<td>8.6 (0.2)</td>
<td>0.0</td>
<td>0.86</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>71.9 (1.4)</td>
<td>72.1 (1.5)</td>
<td>0.2</td>
<td>0.94</td>
</tr>
<tr>
<td>HC (cm)</td>
<td>44.8 (0.2)</td>
<td>45.0 (0.2)</td>
<td>0.2</td>
<td>0.63</td>
</tr>
</tbody>
</table>

### Prevention of Brain Damage: Reduction of LBW Babies: 

**Predictors of Birth Weight on Multivariate Analysis**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Models</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td>-8.92</td>
<td>0.000</td>
</tr>
<tr>
<td>2</td>
<td>Height</td>
<td>5.41</td>
<td>0.000</td>
</tr>
<tr>
<td>3</td>
<td>Gestational age</td>
<td>15.29</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td>Parity</td>
<td>4.18</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>Pregnancy induced hypertension</td>
<td>-2.06</td>
<td>0.039</td>
</tr>
<tr>
<td>6</td>
<td>History of LBW</td>
<td>-2.50</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Need for Early Stimulation: Plasticity of Brain

Newborn brain has remarkable potential for recovery

Early stimulation promotes synapse generation
## Prevention of Brain Damage

### Effect of Developmental Stimulation

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 2500 gms</td>
<td>84.2</td>
<td>91.2</td>
</tr>
<tr>
<td>Below 1500 gms</td>
<td>75.3</td>
<td>83.8</td>
</tr>
</tbody>
</table>

The likelihood ratio (LR) for +ve test was 4.6, which implies that the families with poor home environment are 4.6 times more likely to have the HSQ score ‘less than or equal to’ 19 as compared to normal families.

Simple Developmental Tool for Mother

DEVELOPMENTAL OBSERVATION CARD (DOC)

Social Smile - 2 m
Head Holding - 4 m
Sitting - 8 m
Standing - 12 m

Mother to make sure that the baby
See, Hear & Listen
CDC Kerala: Developmental Therapy Clinic
Use of CDC Grading for Motor Milestones

- Comparison at Enrolment &
- After 6 mo Intervention by Dev. Therapist: N 600

<table>
<thead>
<tr>
<th></th>
<th>Abnormal</th>
<th>At Enrolment %</th>
<th>6 months Intervention %</th>
<th>Reduction in Abn. %</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-8 m</td>
<td>Head Holding</td>
<td>29.5</td>
<td>3.8</td>
<td>87.1</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-12 m</td>
<td>TDSC</td>
<td>54.4</td>
<td>43.9</td>
<td>19.4</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Sitting grade</td>
<td>56.4</td>
<td>15.9</td>
<td>71.7</td>
<td>0.001</td>
</tr>
<tr>
<td>&gt; 12 m</td>
<td>TDSC</td>
<td>57.4</td>
<td>24.5</td>
<td>57.4</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Sitting grade</td>
<td>35.3</td>
<td>0</td>
<td>100</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Standing grade</td>
<td>97.1</td>
<td>20.6</td>
<td>78.8</td>
<td>0.001</td>
</tr>
</tbody>
</table>

• Monthly early intervention using a mother oriented systematic developmental stimulation package.

• Completed 6 m follow up & stimulation program: N 740

• Comparing outcome at 4 & 6 m, both grading for head holding & gross motor part of DDST showed reduction in abnormal findings.

• At 6 m assessment on DASII, motor DQ abnormalities

- 600–900 gms birth weight group 80%
- 1500–1800 gms birth weight group 17.1%

Prevalence of developmental delay at 12 m

- Diagnostic tool DASII : 13.3%
- Screening Tools:
  - CDC grading for standing : 24.8%
  - Amiel Tison angles : 24.0%
  - DDST (Denver II) gross motor: 24.3%

Together had high Specificity, NPV & Accuracy against DASII motor DQ
# DASII Results at 18 months

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mental age</th>
<th>Mental DQ</th>
<th>Motor age</th>
<th>Motor DQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBW: Intervention (N:240)</td>
<td>18.3</td>
<td>101.8</td>
<td>18.7</td>
<td>139.4</td>
</tr>
<tr>
<td>NBW: No Intervention (N:260)</td>
<td>18.2</td>
<td>98.7</td>
<td>18.5</td>
<td>135.4</td>
</tr>
<tr>
<td>Statistical Significance</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

## Clinical Diagnosis (n=3146)

- **Speech delay**: 35.9%
- **Behaviour problem**: 15.4%
- **Global delay/ IDD**: 15.4%
- **Learning problem**: 10.9%
- **Autism**: 07.7%
- **Seizure disorder**: 01.7%
- **Hearing impairment**: 00.7%
- **Visual impairment**: 00.7%
Validation of LEST (0–3 y) Against REELS (n=679)

CDC Kerala: Developmental Evaluation Clinic

Screening: LEST (0-3 yrs) by Dev. therapist
Gold Standard: REELS by Speech therapist

- Sensitivity: 84.4%
- Specificity: 80.3%
- Positive Predictive Value: 91.5%
- Negative Predictive Value: 67.1%
- Accuracy: 83.2%

Speech and Language Delay (0–3 yrs)
Effect of 6 mon Early Language Intervention: N 455

- Mean pre intervention LQ : 60.79
- Mean post intervention LQ : 70.62
- Observed increase (LQ) : 9.83 (Sig.)

- Developmental Diagnosis
  - Developmental delay : 62.4 %
  - Global developmental delay : 18.5 %
  - Trisomy, chromosome abn. : 10.5 %
  - Microcephaly, brain problems : 9.9 %
  - Misarticulation : 8.4 %
  - Autistic features : 5.3 %
  - Cleft palate and lip : 3.3 %
Trivandrum Autism Behaviour Checklist (TABC)- An Indian tool

- By trained health worker
- 4 domains – 20 questions
- Total score (min. 20, max. 60)
  - < 35 = no autism
  - 36 – 43 = mild to mod. autism
  - 44 & above = severe autism
- NPV against CARS = 98.6%

**CDC Kerala : Autism Intervention Clinic**

Effectiveness of Early Intervention for Children with ASD: Clinic Based, Low Intensity Intervention package (N 39)

CARS total pre intervention mean  35.46(4.44)  
CARS total post intervention mean 31.33(5.09)  
Difference −3.54 statistically significant (p: 0.001)

- Socialization
- Communication
- Attention Play
- behaviour
- Self help skills
- Sensory activities
- Cognition
- Imitation
- Cognition
- Perception
- Motor
- Self help

CDC Kerala : Autism Evaluation Clinic

Comparison of CARS against DSM-IV-TR

Diagnosis of Autism among Children Between 2 & 6 yrs: N 200

Prevalence of autism

• For CARS cut off points ≥30 : 71.5%
• For CARS cut off points ≥33 : 52.5 %
• DSM-IV-TR : 63 %

### CDC Kerala: Autism Intervention Clinic

Effectiveness of Low Intensity Home Based Early Intervention (n=52)

<table>
<thead>
<tr>
<th>Tool</th>
<th>Pre intervention</th>
<th>Post intervention</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSMS-SQ</td>
<td>62.9</td>
<td>73.9</td>
<td>0.001</td>
</tr>
<tr>
<td>REEL-EQ</td>
<td>42.8</td>
<td>56.9</td>
<td>0.001</td>
</tr>
<tr>
<td>REEL-RQ</td>
<td>43.5</td>
<td>57.7</td>
<td>0.001</td>
</tr>
<tr>
<td>CARS total</td>
<td>35.5</td>
<td>31.8</td>
<td>0.001</td>
</tr>
</tbody>
</table>

CDC Kerala: Autism Evaluation Clinic
Case Control Study - Socio-demographic Factors (2–6 yrs)

• Cases: Autism (CARS >30) : 143
• Control: Apparently Normal (WBC): 200

Pre-piloted questionnaire with 11-SE Variables

Sig. risk factors on Multivariate Analysis
• Upper & upper middle SE status: OR: 7.13
• Male gender: OR: 3.95

Protective factor for Autism
• Place of residence rural: OR: 0.41

CDC Kerala: Autism Evaluation Clinic

Case Control Study (Contd....)

Early Child Care Practices at Home (2–6 yrs)

Sig. risk factors on Multivariate Analysis

- Not playing with same age children: OR=19.57
- No outings for the child: OR=3.36
- Do not tell stories/sing songs to child: OR=3.21
- Breast feeding duration nil/ < 6 mo: OR=3.40
Step.1: Tool Development and Validation

TRIVANDRUM DEVELOPMENTAL SCREENING CHART (TDSC) 0 – 3 YRS

- Asks simple questions: 27
- Answers at least half understandable to others: 25
- On instruction places objects ‘IN’, ‘ON’ & ‘UNDER’: 26
- Tells gender when asked: 24
- Brush teeth with help: 23
- Points to 7 common objects: 22
- Differentiates big & small: 21
- Jumps in place: 20
- Uses words for personal needs: 19
- Removes garments: 18
- Points to parts of doll (3 parts): 17
- Walks upstairs with help: 16
- Walks backwards: 15
- Says two words: 14
- Walks alone: 13
- Throws ball: 12
- Transfers objects hand to hand: 11
- Puts a cake: 10
- Fine prehension pellet: 9
- Standing up by furniture: 8
- Raises self to sitting position: 7
- Rolls from back to stomach: 6
- Hold head steady: 5
- Eyes follow pen/pencil: 4
- Social smile: 3

AGE IN MONTHS

CHILD DEVELOPMENT CENTRE (CDC), MEDICAL COLLEGE, THIRUVANANTHAPURAM

MKC Nair, GS Harikumaran Nair, Babu George, N Suma, C Neethu, ML Leena, PS Russell.
Development and Validation of Trivandrum Developmental Screening Chart for Children aged 0 – 6 years (TDSC 0-6 years). Indian J Pediatr 2013
LANGUAGE EVALUATION SCALE TRIVANDRUM (LEST) 3 – 6 YEARS

- Writes at least 6 letters
- Uses ‘how’ question
- Uses past & future tense
- Says 2 opposites
- Understands left & right
- Follows instructions given to a group
- Engages in conversation
- Names days of week in order
- Counts 6 or more objects
- Combines 5-6 words in sentences
- Comprehends spatial concept
- Speech is usually intelligible to strangers
- Uses grammatically correct sentences
- Reads 75% of alphabets
- Tells long story sticking to the topic
- Has time concept
- Hears most of what is said at home or school
- Hears and answers questions properly
- Responds to commands involving 3 actions
- Uses ‘what’, ‘who’, & ‘why’ questions
- Comprehends simple present and future tense
- Uses words consist of any 8 out of p, m, n, w, h, b, k, g, t, d, ng, f sounds
- Says function of 3 objects
- Recognizes 3 or more colours
- Listens happily to a story for at least 5 minutes
- Hears TV at the same loudness level as other family members
- Hears when called from another room

AGE IN MONTHS

36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

CHILD DEVELOPMENT CENTRE (CDC), MEDICAL COLLEGE, THIRUVANANTHAPURAM


LEST 3 – 6 yrs
Childhood Disability – District Model
Step.2: Community Survey (80429)
Childhood Disability – District Model
Step.3: Evaluation

Developmental Therapist

Clinical Psychologist
Childhood Disability – District Model

Step.4: Therapy - CDRU

Physiotherapist

Speech Therapist
CDC Kerala: District Model
Early Detection of Dev. delay/ Disability (< 6 yrs)
(n= 1,01,438)

- Community survey- by ASHA workers
- TDSC 2 ≥ item delay 2,477 (2.45 %)

Dev. evaluation camps (80 PHCs): N 1329
- Normal: 43.1%
- Developmental delay: 49.89%
- Speech & language delay: 24.98%
- Multiple disabilities: 22.95%
- Intellectual disability: 16.85%
- Cerebral palsy: 08.43%
- Visual impairment: 03.31%
- Neuromuscular disorders: 01.35%
CDC Kerala: State wide Cross sectional Survey (<3 years)
Early Detection of Developmental Delay /Disability

- One randomly selected anganwadi/panchayath, ward
- Total screened by TDSC & LEST: 32,664
- Developmental delay using TDSC: 2.5%
- Speech & Language delay using LEST: 2.8%
- TDSC and/or LEST positive: 3.4%
- Confirmed by trained paediatrician (1,110)
  - Developmental delay: 69.3%
  - Speech delay: 14.3%
  - Global delay: 5.7%
  - Gross motor delay: 5.3%
  - Hearing impairment: 3.6%

## Early Detection of Delay - (n=32,664)

Hearing Impaired children (0-3 years) : 40 nos.

<table>
<thead>
<tr>
<th>District (14)</th>
<th>TDSC +ve No (%)</th>
<th>LEST +ve No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trivandrum</td>
<td>3.6</td>
<td>4.3</td>
</tr>
<tr>
<td>Kollam</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Pathanamthitta</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Alappuzha</td>
<td>3.3</td>
<td>3.2</td>
</tr>
<tr>
<td>Kottayam</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Idukki</td>
<td>2.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Ernakulam</td>
<td>1.8</td>
<td>2.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>District (14)</th>
<th>TDSC +ve No (%)</th>
<th>LEST +ve No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrissur</td>
<td>2.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Wayanadu</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Palakkadu</td>
<td>2.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Kozhikodu</td>
<td>2.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Kannur</td>
<td>2.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Kasargode</td>
<td>2.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Malappuram</td>
<td>1.6</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2.5</strong></td>
<td><strong>2.8</strong></td>
</tr>
</tbody>
</table>
Neuro-Developmental Disability (NDD) among children in India - An INCLEN Study

1. Neuro-developmental Disability Screening Tool (NDST)

2. Development of “Consensus Clinical Criteria (CCC)”

3. Validation of the NDST against CCC (sample: 5000)

4. Formative research for modifiable risk factors of NDD

5. Prevalence of NDD in India (Sample: 50,000)
1. INDT-ASD: INCLEN Diagnostic Tool for Autism Spectrum Disorder – Development and Validation


2. INDT-ADHD: INCLEN Diagnostic Tool for Attention Deficit Hyperactivity Disorder - Development and Validation

(Sharmila Mukherjee, Satinder Aneja, Paul Russell, Sheffali Gulati, Vaishali Deshmukh, Rajesh Sagar, Donald Silberberg, Bhatani VK, Jennifer M Pinto, Maureen Durkin, Ravindra M Pandey, MKC Nair, Narendra K Arora and INCLEN STUDY GROUP. Indian Pediatr 2014 Jun;51(6):457-62.)

3. INCLEN Diagnostic Tool for Epilepsy (INDT-EPI) for Primary Care Physicians: Development and Validation.


4. INCLEN Diagnostic Tool for Neuro-motor Impairment (INDT-NMI) for Primary Care Physician: Development and Validation.

CDC Research & National Capacity Building  
(CDC-IDE Kerala University Courses)

- **PG Diploma in Clinical Child Development** (2-year full-time paramedical course)  
  *Eligibility* B.Sc. Home Science

- **P.G Diploma in Developmental Neurology**  
  *Eligibility*: MBBS/MD/DNB/MNAMS/DCH

- **M.H.Sc. In Clinical Child Development (2 Yrs)**  
  *Eligibility*: MBBS/BDS/BSc Nursing/PG-DCCD or DCCD with graduation, BPT/ BOT/BSc (Speech & Hearing)/BSc (MLT)/ BPharm/ BAMS/ BHMS/BSMS

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