Those who have knowledge, don't predict. Those who predict, don't have knowledge.

~ Laozi
Predicting long term outcomes in NICU

Naveen Jain
Kerala Institute of Medical Sciences
Trivandrum
Outcomes are not just brain outcomes

• CP / cognition
• Behaviour / learning
• Neurosensory
• Chronic lung disease
• Renal – hypertension
• Growth ...
Intact survival?
Why predict

• Improve Care processes

• Individual case – anticipatory guidance
“The best way to predict the future is to create it.”

Abraham Lincoln
Antenatal steroids - dose-dependent protective effect – death or neurodevelopmental impairment - extremely preterm

<table>
<thead>
<tr>
<th></th>
<th>No ANS</th>
<th>Partial ANS</th>
<th>Complete ANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>848</td>
<td>1581</td>
<td>3692</td>
</tr>
<tr>
<td>Mortality %</td>
<td>43</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Severe IVH</td>
<td>23</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Death / NDI %</td>
<td>68</td>
<td>54</td>
<td>48</td>
</tr>
</tbody>
</table>

infants (birth weight range, 401-1000 g; gestational age, 22-27 weeks)
## Effects and safety of MagSulf in neuroprotection

<table>
<thead>
<tr>
<th></th>
<th>Magsulf</th>
<th>No magsulf</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate to severe CP</td>
<td>45 / 3504</td>
<td>75 / 3588</td>
<td>0.61 (0.42 – 0.89)</td>
</tr>
</tbody>
</table>

*Medicine 2016 Jan*
Human Milk Feeding as a Protective Factor for Retinopathy of Prematurity: A Meta-analysis

<table>
<thead>
<tr>
<th>Severe ROP</th>
<th>Any BM vs formula</th>
<th>Exc BM vs formula</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.42 (0.08 to 2.18)</td>
<td>0.10 (0.04 to 0.29)</td>
</tr>
</tbody>
</table>

5 studies with 2208 preterm infants, observational studies

Pediatrics 2015 dec
Care process – QI

• Best science
• Best implementation
Avoiding excess of Therapies

- Hyperoxia
- Hypocarbia
- Alkali
- Steroids
- Hyperthermia ...
- Caffeine
- Fluids
- Parenteral nutrition
Family centered development supportive care

Role of stimuli – PATCHED EYE – POOR SYNAPSE

Exogenous activity!

BEYOND INJURY
Thyroid function

• Repeat even if newborn TFT n
Eye

• Rop

• Refraction
Hearing

• Picking up mild to moderate hearing loss is critical
Predicting long term outcome in NICU

Naveen Jain
Kerala Institute of Medical Sciences
Trivandrum
MRI + GM assessment
Predictive value of qualitative assessment of general movements for adverse outcomes at 24 months of age in infants with asphyxia

- 114 full-term asphyxiated infants
- qualitative assessment of GMs within 3 months after birth
- Bayley Scales of Infant Development at 24 months of age
- cramped-synchronized movements during the writhing movements period
  - predictive validity 98.2%,
  - positive predictive value 85.7%, and negative predictive value 99.1%.
- absence of fidgety movements during the fidgety movements period
  - predictive validity 97.4%,
  - positive predictive value 75.0%, and negative predictive value 99.1%.
Figure 2.
A 15 mm³ voxel box was placed in the basal ganglia (BG) and frontal white matter (WM) for magnetic resonance spectroscopy data acquisition.

Figure 1. Kinematic analysis of prone head lift and pull-to-sit tasks using Dartfish®. Anatomical markers: I = posterior iliac crest, II = tragus, III = temporal window, IV = acromion process, V = anterior superior iliac crest
1A. Maximum prone head lift angle measured with Dartfish® Analyzer tracking tool. An embedded Dartfish® Analyzer data table is shown.
1B. Head angle at a 90° trunk angle during pull-to-sit measured with Dartfish® Analyzer tracking tool.
1C. Head angle at a 90° trunk angle during pull-to-sit measured with Dartfish® Analyzer tracking tool.

Anatom
Figure 3.
Relationships between average prone head lift angle and motor developmental tests. Average prone head lift angle was associated with TIMP at term and 12 weeks CGA (A) and Bayley gross motor scores at 12 months CGA (B).
Neonatal MRI Pattern of Brain Injury as a Biomarker of Childhood Outcomes following a Trial of Hypothermia for Neonatal Hypoxic-Ischemic Encephalopathy

• Death or IQ <70
  • 4 of 50 (8%) of children with pattern 0 (normal MRI),
  • 1 of 6 (17%) with 1A (minimal cerebral lesions),
  • 1 of 4 (25%) with 1B (extensive cerebral lesions),
  • 3 of 8 (38%) with 2A (basal ganglia thalamic, anterior or posterior limb of internal capsule, or watershed infarction)
  • 32 of 49 (65%) with 2B (2A with cerebral lesions)
  • 7 of 7 (100%) with pattern 3 (hemispheric devastation)

• IQ
  • 90 ± 13 -46 children with a normal MRI
  • 69 ± 25 -50 children with an abnormal MRI
MRI – HIE

• Benefit of cooling

Figure 2. Progression of brain injury. Normothermic newborn demonstrates (a,b) basal nuclei pattern on day 1, (e,f) progression to total brain injury on day 3, and (i,j) ongoing diffusion abnormalities on day 10. Hypothermic newborn shows (c,g) normal T₁ and (d,h) apparent diffusion coefficient (ADC) maps on days 1 and 3. (k) Note the T₁ shortening in the posterior lentiform nuclei and ventrolateral thalami that develops on day 10. Area of signal abnormality indicated by white arrows. (l) Normal ADC map.
MRI

- Minor/moderate white matter changes: Normal outcome
- Severe white matter lesions: Cerebral palsy (CP) but delayed
- Mild/moderate BGT: Cognit. Dev.
- Severe BGT: Mental retard ++, Visual abnorm ++
How early?
One can't predict the weather more than a few days in advance.

—— Stephen Hawking ——
At birth – gestation

<table>
<thead>
<tr>
<th>Vs 30</th>
<th>Odds</th>
<th>Severe vs no morbidity</th>
<th>Mortality vs no morbidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-24</td>
<td></td>
<td>36 (22-58)</td>
<td>171 (87-334)</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>1.6</td>
<td>2</td>
</tr>
<tr>
<td>Probability</td>
<td>Severe vs no morbidity</td>
<td>Mortality vs no morbidity</td>
<td></td>
</tr>
<tr>
<td>23-24</td>
<td></td>
<td>0.35</td>
<td>0.164</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>0.18</td>
<td>0.034</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>0.04</td>
<td>0.004</td>
</tr>
</tbody>
</table>
At discharge from NICU
Prediction of neurodevelopment outcome of preterm babies using a risk stratification score

<table>
<thead>
<tr>
<th>Score</th>
<th>Risk</th>
<th>Normal</th>
<th>abnormal</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2</td>
<td>Low</td>
<td>188 (95.5%)</td>
<td>9 (4.5%)</td>
<td>197</td>
</tr>
<tr>
<td>3, 4, 5</td>
<td>High</td>
<td>23 (82.2%)</td>
<td>5 (17.8%)</td>
<td>28</td>
</tr>
</tbody>
</table>

- This scoring helped to stratify preterm babies into low and high risk
- This will help in planning intensity of follow up and intervention

Radhika S, Naveen Jain Indian Pediatrics July 2016
<table>
<thead>
<tr>
<th>Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation in weeks</td>
<td>$\geq 28$</td>
<td>$&lt; 28$</td>
<td>Extensive resuscitation</td>
</tr>
<tr>
<td>Resuscitation at birth</td>
<td>No resuscitation/only Positive pressure ventilation</td>
<td>Duration</td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td>Not ventilated/ Duration $\leq 7$ d</td>
<td>$&gt; 7$ d</td>
<td></td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>No/Asymptomatic</td>
<td>Symptomatic</td>
<td></td>
</tr>
<tr>
<td>Neurosonogram findings</td>
<td>No intraventricular hemorrhage (IVH) / Periventricular leucomalacia (PVL)</td>
<td>Grade 1, 2 IVH</td>
<td>Grade 3 IVH/ ventriculomegaly/ PVL</td>
</tr>
</tbody>
</table>
HD Neonatal Research Network (NRN): Extremely Low Birth Outcome Data

I use the data to determine individual outcomes?

The data are not intended to be predictive of individual infant outcomes. Instead, the data provide a range of possible outcomes based on specific characteristics.

If you choose to use these data to determine possible outcomes, please remember that the information provided is not intended to be the sole basis for care decisions, nor is it intended to be a definitive prediction of outcomes if intensive care is provided. Users should keep in mind that every infant is an individual, and that factors beyond those used to formulate these standardized assessments may influence an infant’s outcomes.

For the characteristics below:

- **Gestational Age (Best Obstetric Estimate in Completed Weeks):** 25 weeks
- **Birth Weight (401 Grams to 1,000 Grams):** 660 grams
- **Sex:** Female Male
- **Method of Delivery:** Spontaneous Vaginal Birth
- **Maternal Corticosteroids (Within Seven Days Before Delivery):** Yes No
- **Antenatal Steroid Treatment:** Yes No
- **Asthmocytin Pretreatment:** Yes No

### Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Outcomes for All Infants</th>
<th>Outcomes for Mechanically Ventilated Infants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survival</strong></td>
<td>77%</td>
<td>78%</td>
</tr>
<tr>
<td><strong>Survival Without Moderate to Severe Neurodevelopmental Impairment</strong></td>
<td>48%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Death</strong></td>
<td>23%</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Death or Moderate to Severe Neurodevelopmental Impairment</strong></td>
<td>36%</td>
<td>34%</td>
</tr>
</tbody>
</table>

*These estimates are based on standardized assessments of outcomes at 18 to 22 months of infants born at NRN centers between 1998 and 2003; infants were 22 to 25 weeks, between 401 and 1,000 grams at birth. Infants not born at a Network center and Infants with a major congenital anomaly were excluded. The first column of estimates is based on findings for all 4,446 infants in the study. The second column of estimates is based only on the 3,702 infants who received intensive care. The rate of a given outcome had intensive care been attempted for all infants is likely to be intermediate between these two estimates. Sonographic estimates of fetal weight may be used in anticipating birth weight, while assessing the minimum and maximum likely birth weight consistent with the potential error of sonographic estimates.*

These data are not intended to be predictive of individual outcomes. Instead, the data provide a range of possible outcomes based on...
Neonatal Outcome Trajectory Estimator
Infants Admitted to the NICU with GA 22-32 Weeks & Birth Weight 401-1000g

One or more results were not calculated because of input errors: More

I want to calculate results for ...
- Birth - Death or NDI / Death
- Birth - NDI
- Day 7 - Death or NDI / Death
- Week 36 - Death or NDI / NDI
- Week 36 - Death

At Time of Birth or on Day 7
- Gestational Age at birth
- Birth Weight
- Sex
- Apgar Score at 5 minutes
- Receipt of Antenatal Steroids

On Day 28 or at 36 Weeks
- Mean FIO2 on Day 28
- Number of Days on CPAP by Day 28
- Number of Days of Parenteral Nutrition by Day 28
- Number of Episodes of Late Onset Culture Negative Clinical Infection by Day 28

Estimates of Death/NDI outcome will not be the additive sum of the Death outcome and the NDI outcome. These estimates...
### Neonatal Outcome Trajectory Estimator

**Infants Admitted to the NICU with GA 22-32 Weeks & Birth Weight 401-1000g**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Death or NDI</th>
<th>Death</th>
<th>NDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>28</td>
<td>4</td>
<td>29</td>
</tr>
<tr>
<td>Day 7</td>
<td>24</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Day 28</td>
<td>28</td>
<td>1</td>
<td>44</td>
</tr>
<tr>
<td>36 weeks</td>
<td>25</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

**Probability of Outcome (expressed as a percent)**

- **Gestational Age at birth:**
  - GA 22-32 Weeks:
  - 29

- **Birth Weight:**
  - 1000

- **Sex:**
  - Male: 6
  - Female: 4

- **Apgar Score at 5 minutes:**
  - 22

- **Receipt of Antenatal Steroids:**
  - Yes: 21
  - No: 6

- **Mean FIO2 on Day 7:**
  - 21

- **Number of Days on CPAP by Day 7:**
  - 3

- **Grade of IVH by Day 7:**
  - None: 3
  - Grade I: 3

- **Delivery Room Intubation:**
  - Yes: 6
  - No: 6

- **Outborn:**
  - Yes: 6
  - No: 6

- **Number of Days on High Frequency Ventilation by Day 7:**
  - 0

- **Number of Days on Conventional Ventilation by Day 7:**
  - 2

- **Number of Days on High Frequency Ventilation by Day 28:**
  - 0

- **Number of Days on Conventional Ventilation by Day 28:**
  - 3

- **Mean FIO2 on Day 28:**
  - 21

- **Number of Days on Parenteral Nutrition by Day 28:**
  - 3

- **Number of Episodes of Late Onset Culture Negative Clinical Infection by Day 28:**
  - 6

- **Number of Days on High Frequency Ventilation by 36w PMA:**
  - 0

- **Number of Days on Conventional Ventilation by 36w PMA:**
  - 2

- **Bronchopulmonary dysplasia at 36w PMA:**
  - On Ventilator: 0
  - Not On Ventilator: 0

- **Enlarged ventricles on cranial ultrasound by 36w PMA:**
  - No: 6

- **Pertinent history of RDS at 36w PMA:**
  - Yes: 6
  - No: 6

- **Mean FIO2 at 36w PMA:**
  - 21

- **Number of Episodes of Late Onset Culture Negative Clinical Infection:**
  - 3

- **Number of Episodes of Late Onset Culture Positive Septis:**
  - 1

- **Number of Days on CPAP by 36w PMA:**
  - 3

- **Proven NEC to 36w:**
  - No

- **Enter the FIO2 content in percent, e.g., enter 25 as 25 or 33.3% as 33.5.**

- **Late onset culture-negative clinical infection and infection with late onset is defined as occurring >72 hours after birth and treated with antibiotics for >5 days.**

- **NDI is defined as a composite of MDR+70 or P/DH-70 or moderate to severe CP or blindness or deafness.**

Estimates of Death/NDI outcome will not be the additive sum of the Death outcome and the NDI outcome independently arrived at using models with different covariates. NDI was estimated only on infants who were evaluated at the 18-22 month follow-up visit.

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**New Calculation**

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Publications | Studies | Tools

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Weight growth velocity and ND outcomes of extremely low birth weight infants

Will nutrition enhancement improve outcomes

Fig 3. Relationship between weight growth velocity (WGVI) scores 6–14 and their adjusted odds ratios (AORs) with 95% confidence intervals (CI95). WGVI scores 6 and 7 predicted death or NDI at 5 years of age.
Correlation of serum KL-6 and CC16 levels with neurodevelopmental outcome in premature infants at 12 months corrected age

• KL-6 is preferentially expressed on alveolar type II cells in human lungs, and is a marker of specific lung injury

• Following alveolar injury, regenerating type II cells strongly express KL-6 antigen and this can lead to increased plasma KL-6 levels

• CC16, a lung-specific protein produced by the tracheobronchial epithelium where non-ciliated Clara cells are predominant, is believed to increase in the circulating blood of subjects with pathological conditions that are characterized by increased permeability of the alveolar–capillary barrier
<32 / < 1500 at 12 mo CGA

<table>
<thead>
<tr>
<th>Table 5</th>
<th>KL-6 (ng/ml) and CC16 (pg/ml) cut-off levels for predicting poor neurodevelopmental outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut-off</td>
<td>Sensitivity (%)</td>
</tr>
<tr>
<td>KL-6 (ng/ml)</td>
<td>489.99</td>
</tr>
<tr>
<td>CC16 (pg/ml)</td>
<td>≤320.27</td>
</tr>
</tbody>
</table>
Earlier – gives window for intervention
Early assessment of structure and function

- MRI at ETA combined with GMA at 12 weeks CA is currently the most accurate method for early prediction of cerebral palsy at 12 months corrected age
- earlier magnetic resonance imaging combined with neuromotor and neurobehavioural assessments (at 30 weeks postmenstrual age)?
• A combination of neurological

  • (Hammersmith Neonatal Neurologic Examination),
  • neuromotor (General Movements, Test of Infant Motor Performance),
  • neurobehavioural (NICU Network Neurobehavioural Scale, Premie-Neuro)
  • visual assessments will be performed at 30 and 40 weeks PMA
PPREMO Study Procedure Consort Flowchart

**Recruitment**

**Preterm Group**
- All eligible families with infants ≤30 weeks approached (n=80)
- Perinatal data collection

**Term Reference Group**
- Healthy term born infants (n=20)

**30-32 weeks GA**
- MRI (HARDI model)
- Prechtl’s General Movements Assessment (GM’s)
- NICU Neonatal Neurobehavioural Scale (NNNS)
- Hammersmith Neonatal Neurological Examination (HNNE)
- Premie-Neuro

**Term (40-42 wks)**
- MRI (HARDI model) and EEG
- Prechtl’s General Movements Assessment (GM’s)
- NICU Neonatal Neurobehavioural Scale (NNNS)
- Hammersmith Neonatal Neurological Examination (HNNE)
- Test of Infant Motor Performance (TIMP)
- Visual Assessment
- SES questionnaire

**12 weeks CA**
- Prechtl’s General Movements Assessment (GM’s)
- Test of Infant Motor Performance (TIMP)
- Visual Assessment

**12 months CA**
- Bayley Scales of Infant & Toddler Development (BSITD III)
- Alberta Infant Motor Scale (AIMS)
- Neurosensory Motor Developmental Assessment (NSMDA)
- Independent Medical examination to confirm CP/ not CP

**Term (40-42 wks)**
- MRI and EEG
- NICU Neonatal Neurobehavioural Scale (NNNS)
- Hammersmith Neonatal Neurological Examination (HNNE)
- Visual Assessment

Fig. 1: Consort Flowchart of PPREMO Study Procedure
Even earlier ????
Prognosis of psychomotor and mental development in premature infants by early cranial ultrasound

• By day 3
• Cranial ultrasonic gray-scale value measurement
• Ultrasonic anomalous area of 1 cm² of -calculate the average of gray-scale value for ultrasonic anomalous areas.

Figure 1 Correlation between ultrasonic gray-scale values of premature infants and both PDI and MDI.
Cortical burst dynamics predict clinical outcome early in extremely preterm infants

• EEG of extremely preterm infants (22-28 weeks) as early as 12 hours
• N=43

Typical EEG at 12 hrs – discontinuous at 72 hours
Burst and inter – burst
What we practice
## Risk Categories For Neurodevelopmental Outcomes

<table>
<thead>
<tr>
<th>Category</th>
<th>Mild risk</th>
<th>Moderate risk</th>
<th>Severe risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation</td>
<td>33-34 weeks</td>
<td>30-32 weeks</td>
<td>&lt;30 weeks</td>
</tr>
<tr>
<td>Birth weight</td>
<td>&gt;1500 gm</td>
<td>1250 - 1499 gm</td>
<td>&lt;1250 gm</td>
</tr>
<tr>
<td>IUGR</td>
<td>Fetal growth 3rd – 10th centile</td>
<td>Fetal growth &lt;3rd centile</td>
<td></td>
</tr>
<tr>
<td>Intra-uterine insults</td>
<td>Abnormal NST</td>
<td>BPP &lt; 5</td>
<td>Severe maternal pre-eclampsia (seizures)</td>
</tr>
<tr>
<td></td>
<td>Maternal fever</td>
<td>pROM</td>
<td>Monochorionic twins/triplets or higher order</td>
</tr>
<tr>
<td></td>
<td>Dichorionic twins</td>
<td></td>
<td>Clinical choioamnionitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cord prolapse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Abruptio placenta</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AEDF, reversal EDF</td>
</tr>
<tr>
<td>Antenatal steroids (ANS)</td>
<td>Incomplete course</td>
<td>No ANS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or 24 hours not elapsed from last dose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need for resuscitation at birth</td>
<td>Need for Extensive resuscitation (Chest compressions, Epinephrine)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need for ventilation</td>
<td>Ventilation with normal blood gases and no airleaks</td>
<td>Ventilation abnormal blood gases and air leaks</td>
<td></td>
</tr>
<tr>
<td>Days on ventilator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfusion</td>
<td>Shock (poor perfusion) with normal blood pressure</td>
<td>Shock (poor perfusion) with hypotension</td>
<td></td>
</tr>
<tr>
<td>Shock therapy</td>
<td>Saline bolus</td>
<td>Inotropes</td>
<td>Steroids</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>Hypoglycemia (asymptomatic)</td>
<td>Symptomatic hypoglycemia</td>
<td></td>
</tr>
<tr>
<td>Blood sugars mg/dl</td>
<td>32 – 46</td>
<td>&lt;32</td>
<td></td>
</tr>
<tr>
<td>Days of hypoglycemia</td>
<td>1-4 days</td>
<td>&gt; 5 days</td>
<td></td>
</tr>
<tr>
<td>Neurosonogram/MRI</td>
<td>IVH &lt; grade III</td>
<td>Grade III IVH or IPE in NICU or ventriculomegaly, PVL at 36-40 wks</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>Sepsis</td>
<td>Sepsis with hypotension / Meningitis</td>
<td></td>
</tr>
<tr>
<td>NNJ</td>
<td>Jaundice (PT)</td>
<td>NNJ (ET)</td>
<td>BIND (MRI/BERA/clinical)</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>Hypothyroidism</td>
<td>Treatment delayed (not normalized by one month)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Neurodevelopment Assessment & Development Supportive Care

Day 1:
- Parental counseling and Early Parent Participation Program (EPPP)
- Medical risk factors recorded in risk stratification chart
- Encourage mother for expressed breast milk

Day 3-7:
- Screening for congenital hypothyroidism
  - OFC
- Medical risk factors recorded in risk stratification chart
- Early stimulation once hemodynamically stable
- Parents touch and talk to baby, get involved in care of baby

1-2 Week:
- Neurosonogram
  - OFC
- Repeat Thyroid screening
- Multivitamin, HMF (or Calcium phosphate) once on full feed
- Medical risk factors recorded in risk stratification chart
- Early stimulation once hemodynamically stable: KMC, NNS
  - NNS may be started as soon as baby is on full feeds (use oral stimulant oro-gastric feeds are given), put to breast after expressing milk. May breast feeding / and paladai feeding at 32-34 weeks

2-3 weeks:
- ROP screening for those at risk of AP-ROP#
  - OFC
  - Weight (should have regained birth weight)

1 month:
- ROP screening- subsequent visits based on Ophthalmologist’s opinion till 4
  - S. Ca/P/ALP / Hb
  - OFC
  - Weight
  - S. ferritin, start Iron supplement

6-8 Weeks:
- Vaccination
- Neurobehavior
  - OFC
  - Weight
  - Early stimulation

PRE DISCHARGE CHECK LIST

1. Active Medical Problems
   a.  
   b.  

2. Nutrition: Breast milk / formula (---: ---), paladai, DBF

3. Medications (ref table)

4. Weight: Tracking postnatal growth chart / NO

5. OFC: Tracking postnatal growth chart / NO

6. Physical Exam

7. ROP

8. Hearing

9. Labs

10. Imaging

11. Neuroexam & Neurobehavior Before Discharge

13. Immunization and Advice

14. Early stimulation: KMC Duration

15. Parent coping: Concerned / Adjusting well / Need guidance
## Hammesmith Form

### Movements

<table>
<thead>
<tr>
<th>Name</th>
<th>Code</th>
<th>No of Exam</th>
<th>O.B</th>
<th>D.O.E</th>
<th>Age</th>
<th>GA</th>
<th>Sex</th>
<th>SW</th>
</tr>
</thead>
</table>

#### Spontaneous Movement

- **No Movement**
- Few stretches, no other movement
- Jerky movement, stretches, but also some smooth movement
- Smooth movements of arms + legs

#### Abnormal Hand or Toe Postures

- Hands open
- Hands fist is thumb adducted intermittently but open
- Hands flat or thumb adducted or fingers thumb opposed
- Big toe up (reversed) or all toes flex

#### Tremor

- No tremor
- Tremor only when crying or after food

#### Startle

- No Startle
- Startle to sudden noise or bang on table

#### Reflexes + Test Both Sides

- **Suck & gag**
  - Watch on breast, if no breast, put little finger into mouth with gap of finger upwards
  - Weak suck only
  - Feeding only
  - Feeding only
  - Feeding only

- **Palmar grasp**
  - Stroke inside of hand
  - DO NOT TOUCH BACK OF HAND!!

- **Plantar grasp**
  - Press on sole below toes
  - No response
  - Short, weak flexion of fingers
  - Strong flexion of fingers
  - Strong flexion, shoulder
  - Strong flexion, whole body

#### Placing

- Hold infant sitting, stroke front of the baby’s lower leg on edge of table

#### Orientation and Behaviour

- **Eyes**
  - Does not open eyes
  - Normal eye movement, eyes move together
  - Abnormal eye movements, describe

- **Auditor orientation**
  - Pulls head towards sound
  - Hold ear, lift 15 cm

- **Visual alertness**
  - Wrap infant, wake up
  - Does not follow above red ball or angel

- **Alertness**
  - Tested as response to red ball or target

- **Peak of excitation**
  - Circle of life with dry

#### Posture

- Baby lying on back, look at position of the legs, but also draw attention if necessary
- Arms and legs extended
- Legs slightly flexed
- Legs well flexed
- Legs well flexed and dulted near baby
- Arm very flexed, legs very extended

- Arm does not flex
- Arm moves slowly and slowly
- Arm moves and remains flexed
- Arm remains flexed when baby is moved

- Arm remains straight - no resistance
- Arm moves slowly or some resistance felt
- Arm moves well tilted, then straighten
- Arm remains flexed when baby is moved

- No flexion
- Incomplete flexion, not every time
- Complete flexion
- Complete fast flexion

- Leg flexed - no resistance
- Leg moves slowly or some resistance felt
- Leg moves well tilted, then straighten
- Knee flexes, then re-extends, then flexes

#### Postural Angle

- Fix knee or add up baby, try to extend knee with first finger, notice distance (angle) between upper and lower leg

#### Head Control

- Baby sitting upright, enoil with both hands holding shoulders
  - Let head drop forward
  - No attempt to raise head
  - Baby has kokki
  - Baby has Kokki: baby has head, head is tilted
  - Baby has head, head is tilted

#### Head Lag

- Pull baby to sit by the wrists & support head slightly

#### Ventral Suspension

- Baby lying face down, look at posture of the legs, and head, if it looks odd, draw attention

#### Reflexes

- No reflex
- Weak suck only
- Feeding only
- Feeding only
- Feeding only

- No reaction
- Short, weak flexion of fingers
- Strong flexion of fingers
- Strong flexion, shoulder
  - Strong flexion, whole body

- Nothing happens
- Baby flexes ankle
  - Baby flexes hip, knee and ankle & steps on table

#### Fixation

- Eye does not follow above
- Eyes move together
  - Abnormal eye movements, describe

- Do not give
  - Red ball
  - Target

- Does not respond
  - Red ball
  - Target

- Do not give
  - Red ball
  - Target

- Baby always
  - Cannot be calmed

- Baby always
  - Cannot be calmed

- Does not respond
  - Red ball
Parent information

Screening for hearing impairment is recommended for all babies, irrespective of NICU care. Some disease process increase risk of hearing impairment. Rapid check (OAE) and assessment of nerve and brain hearing (BERA) are both recommended to sick NICU babies, to be completed before 6 months age.

Summary statement

Hearing

right  left

Hearing impairment

Hearing aid (assistive listening device)

<table>
<thead>
<tr>
<th>OAE (discharge)</th>
<th>OAE (repeat, if necessary before 3 months)</th>
<th>BERA (as per appointment, before 6 months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OAE may show retest in babies with normal hearing, if baby has a common cold, wax in ear, or in very small ears. A request for repeat test doesn’t suggest impaired hearing.

BERA requires that the baby to remain still, hence, the baby will be sedated (safe) for the procedure. If BERA is abnormal, the baby will be evaluated for hearing intervention. *BERA is interpreted as normal if graph is good at 35 db
false reassurance, or create false anxieties.

N- normal on the day assessment
   No further investigations or treatment required on the same day.
   Development is a continuous process and needs periodic reassessment
R- some differences from normal noted, needs reassessment (on date specified)
A- abnormal – significant deviation from normal, needs further investigations and treatment.

**18 MONTHS (corrected age)**

Language assessment:
- **REEL**
- **DASII**
  - Mental development quotient
  - Motor development quotient
  - Clusters
  - Interpretation:
    - Score >85 is Normal
    - <75 is Abnormal

Any abnormal movements
- Choreaathetoid / Tremors / Ataxia
  - Oral motor function – Excessive drooling, poor coordination of suck and swallow, inability to chew in children with molars

Diagnosis at 18 months

**Normal**
- Cerebral palsy
- Hearing problem
- Language delay
- Cognitive problems
- Visual problem
- Chronic medical problem

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**Gross Motor Function Classification System – Expanded and Revised (GMFCS – E & R)**

**BEFORE 2ND BIRTHDAY**

**LEVEL I:** Infants move in and out of sitting and floor sit with both hands free to manipulate objects. Infants crawl on hands and knees, pull to stand and take steps holding on to furniture. Infants walk between 18 months and 2 years of age without the need for any assistive mobility device.

**LEVEL II:** Infants maintain floor sitting but may need to use their hands for support to maintain balance. Infants creep on their stomach or crawl on hands and knees. Infants may pull to stand and take steps holding on to furniture.

**LEVEL III:** Infants maintain floor sitting when the low back is supported. Infants roll and creep forward on their stomachs.

**LEVEL IV:** Infants have head control but trunk support is required for floor sitting. Infants can roll to supine and may roll to prone.

**LEVEL V:** Physical impairments limit voluntary control of movement. Infants are unable to maintain antigravity head and trunk postures in prone and sitting. Infants require adult assistance to roll.
Prediction - ??

In any moment of decision, the best thing you can do is the right thing, the next best thing is the wrong thing, and the worst thing you can do is nothing.

(Theodore Roosevelt)
Early detection and intervention - does it really matter?

Please mail Naveen_19572@Hotmail.com for free copy of blue book