Global Neonatal Mortality
Helping Babies Breathe

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International Pediatric Association
Faculty Disclosure

No, nothing to disclose

Off-Label Product Use

Will you be presenting or referencing off-label or investigational use of a therapeutic product?

No
Global Causes of Neonatal Death

- Severe infections (mainly sepsis and pneumonia): 26%
- Preterm birth: 27%
- Asphyxia: 23%
- Congenital anomalies: 7%
- Tetanus: 7%
- Diarrhoeal diseases: 3%

Other 7%

UNICEF 2007
FETAL/NEONATAL HIE

- Hypoxemia—Low Cardiac Output
- Compensation-Fantastic/ Efficient
- Energy Failure Progresses
- Injury
- Death or Recovery
# PERCENTAGE OF WORLD’S NB 4 MILLION NB DEATHS

<table>
<thead>
<tr>
<th>Country</th>
<th># x 000</th>
<th>%</th>
<th>NMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDIA</td>
<td>1098</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td>CHINA</td>
<td>416</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>PAKISTAN</td>
<td>298</td>
<td>7</td>
<td>57</td>
</tr>
<tr>
<td>NIGERIA</td>
<td>247</td>
<td>6</td>
<td>53</td>
</tr>
</tbody>
</table>

Ostergaard et al
PLOS Med 8: (8)e100-108, 2011
Head Growth One Year – Neonatal HIE

Survivors Followed 52

Microcephaly 28

% 54

Mercuri et al
### Perinatal HIE Cooling Trial

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolled</td>
<td>325</td>
<td></td>
</tr>
<tr>
<td>Died</td>
<td>86</td>
<td>26</td>
</tr>
<tr>
<td>Normal</td>
<td>116</td>
<td>49</td>
</tr>
<tr>
<td>Abnormalities</td>
<td>123</td>
<td>51</td>
</tr>
</tbody>
</table>

Azzopardi et al  
*NEJM* 361:1349, 2009
Neurodevelopment – Systemic Review
Intrauterine & Neonatal Insult

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIE Studies</td>
<td>27</td>
</tr>
<tr>
<td>Patients</td>
<td>2708</td>
</tr>
<tr>
<td>Cognition Issues</td>
<td>45%</td>
</tr>
<tr>
<td>CP</td>
<td>29%</td>
</tr>
</tbody>
</table>

Mwanoki, Atieno, Lawn, Newton
CONSEQUENCES OF POOR NEONATAL RESUSCITATION

- Increased Death
- Increased Disability
- Emotional & Financial Burden
- Direct Community Costs
- Loss of Productivity
Care Available at Birth

Wall SN, Lee ACC, Niermeyer S, et al. IJGO 2009; 107:S47
The Global Need for Neonatal Resuscitation

- <1 million babies need advanced resuscitation (bag-and-mask ventilation).
- Approx 6 million babies require basic resuscitation.
- Approx 10 million babies require simple stimulation (drying and rubbing) to help them breathe.
- 136 million babies were born.

All babies require immediate assessment at birth and simple newborn care:
- Assess breathing, dry, and put the baby skin-to-skin with mother.

Wall et al
Seminars in Perinatology 34(6):395-407, 2010
Big Target of Helping Babies Breathe

Stillbirths
3.2 million per year

Neonatal deaths
3.8 million per year

1 million “stillbirths” due to asphyxia
830,000 neonatal deaths due to asphyxia

Lawn JE et al. IJGO 2009; 107:S5
Neonatal Physiology

- Hypoxia-apnea, slow heart rate
- Breathing for the Baby-rapid reversal
- Delays-increase mortality, morbidity
Helping Babies Breathe

Prepare for birth*

Birth

If meconium, clear airway
Dry thoroughly

Crying

Crying?

Not crying

Keep warm
Check breathing

Breathing well

Not breathing

Cut cord

Cut cord

Breathing

Ventilate

Not breathing

Call for help

Monitor with mother

Breathing

improve ventilation

Not breathing

Heart rate?

Normal

Not breathing

Continue ventilation

Advanced care

*Prepare for birth

Gloves

CLAMPs

Sites

Scissors

Ties

Suction device

Ventilation bag-mask

Stethoscope

Oxygen

Clock, watch

60 sec
Need for help to breathe at birth

Assessment at birth and routine care 80-90%

Drying, warmth, clearing the airway, stimulation 8-10%

Bag and mask ventilation 3-6%

Chest compressions, medications < 1%
Routine Care

- Clearing the airway if meconium present
- Drying infant
- Recognize crying
- Keeping warm
- Cutting the umbilical cord
- Encouraging breastfeeding
The Golden Minute

- Recognizing infant not crying
- Positioning head
- Clearing the airway
- Stimulating
- Recognizing breathing
- Initiating ventilation by 1 minute
HBB Content

- First Golden Minute-Neonatal Physiology
- Best Evidence Available
- Simple Action Plan
- Future Editions-Evidence Focus
- WHO Harmony
Helping Babies Breathe

Emphasis on Adult Learning

- Blended learning
  - Verbal, visual (pictorial), experiential
- Participatory, experience-based
  - Questions for Discussion
- Practice of psychomotor skills
  - Performance Exercises-Frequent
- Case-based practice and evaluation
  - Objective Structured Clinical Evaluation (OSCE)
Paired Learning/Teaching
Hands on Practice
Educational Field Testing – Birth Attendants
Pakistan and Kenya

- High Level of Skills Attained
- Testing OSCE
- Revision of MCQs
- Revision of BMV Instruction
- Revision of OSCEs
<table>
<thead>
<tr>
<th>Description</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total LB</td>
<td>5689</td>
<td></td>
</tr>
<tr>
<td>No Spont Ventilation</td>
<td>920</td>
<td>16</td>
</tr>
<tr>
<td>Stim/Suction</td>
<td>461</td>
<td>50</td>
</tr>
<tr>
<td>Plus BMV</td>
<td>459</td>
<td>50</td>
</tr>
<tr>
<td>BMV Survival</td>
<td>414</td>
<td>90</td>
</tr>
</tbody>
</table>

Ersdal et al
Resusc 83:869, 2012
Meta analysis Neonatal Resuscitation and NMR – Facility Based

<table>
<thead>
<tr>
<th>N</th>
<th>Additional Training</th>
<th>RR 0.7 (0.59-0.84)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Overall</td>
<td>RR 0.62 (0.41-0.94)</td>
</tr>
</tbody>
</table>

Lee et al
BMC Publ Health 11(S3):512, 2011
## ENC Plus Resuscitation
### Zambian Urban Midwives

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post ENC</th>
<th>‘Extra’ Resusc</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB</td>
<td>12,922</td>
<td>26,907</td>
<td>30,884</td>
</tr>
<tr>
<td>7 Day-NMR</td>
<td>36.2*</td>
<td>25.1</td>
<td>15.9</td>
</tr>
</tbody>
</table>

*Corrected for ↑ FU

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Carlo et al
Pediatr 126:e1064, 2010
HBB: Clinical outcomes

- 60% of deaths <24 hours due to asphyxia - Tanzania
  N=4720 observational cohort

- ↓ death at 24 hours among babies not breathing at birth (RR = 0.46) - Tanzania
  N=6928/7277 pre/post training

- ↓ stillbirths (RR = 0.73) with no change in neonatal deaths – India
  N=4173/5427 pre/post training

Ersdal HL et al. Pediatrics 2012; 129:e1238
Msemo G, Pediatr 2013 & Goudar S, Pediatr 2013
## Abnormal Neuro Exam – 7 Days

<table>
<thead>
<tr>
<th>Rate</th>
<th>Pre ENC+</th>
<th>Post ENC+</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>8.0%</td>
<td>6.4%</td>
</tr>
</tbody>
</table>

\( P = 0.01 \)

Carlo et al  
NEJM 362:614, 2010
Implementation

- 50+ countries; 24 with USAID support
- 24 Languages: Arabic, Bangla, Burmese, Cambodian, Dari, French, Lao, Mandarin, Marathi, Mongolian, Nepalese, Pashto, Portuguese, Spanish, Swahili, Thai and Tibetan translations
- Trained: 88,291+
Helping Babies Breathe

**Sustainability**
- Simple and evidence-based
- Low-cost and effective
- Pictoral, Hands On
- Easy to integrate with other essential parts of NB care
Global Developmental Alliance

- Public Private Partnership
- Focus – Early NB Care
- Facilitate In Country Coordination
- AAP, Laerdal, USAID, STC, NICHD, J & J, IPA, LDS Charities
- Room for More
“Vertical” v. “Horizontal”

Must Fit With ENC
- Thermal Protection
- Clean Delivery
- Cord Management
- Early Breast Feeding
- Resuscitation As Required
- Preterm Care
Simulator - Neonatalie

- Affordable, Durable
- Functions - ventilation  
                    - heart rate
- Two Kilos
HBB Tool Kit

- Action Plan
- Learner’s Work Book
- Facilitator’s Flip Chart
- MCQs
- OSCE
- Simulator-Purpose Built
- Bag/Mask/Suction/Stethoscope
Neonatal Resuscitation – Early Developmental Intervention (EDI)

<table>
<thead>
<tr>
<th></th>
<th>MDI</th>
<th>PDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resus. No EDI</td>
<td>98.0*</td>
<td>103.3+</td>
</tr>
<tr>
<td>Resus. EDI</td>
<td>102.6*</td>
<td>108.7+</td>
</tr>
<tr>
<td>Control No EDI</td>
<td>97.7</td>
<td>99.3++</td>
</tr>
<tr>
<td>Control EDI</td>
<td>100.1</td>
<td>105.4++</td>
</tr>
</tbody>
</table>

*p=0.02,  +p=0.04,  ++p=0.02

Carlo et al
## Commodities with high impact around birth

*Estimated annual newborn lives saved at universal coverage*

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Estimated Lives Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case management of neonatal sepsis*</td>
<td>~ 500,000</td>
</tr>
<tr>
<td>Chlorhexidine umbilical cord cleaning*</td>
<td>(cannot yet estimate in LiST)</td>
</tr>
<tr>
<td>Antenatal corticosteroids for preterm labour*</td>
<td>~ 430,000</td>
</tr>
<tr>
<td>Neonatal resuscitation*</td>
<td>~ 230,000</td>
</tr>
<tr>
<td>Kangaroo Mother care</td>
<td>~ 450,000</td>
</tr>
</tbody>
</table>

* Prioritised by the UN Commission on Life Saving Commodities for Women and Children

Sources: Born Too Soon Chap 5 2012, Lawn J et al, IJGO, 2009
We know the causes of newborn deaths

3 main killers to address:

1. Preterm birth (born too soon)
2. Birth complications
3. Neonatal infections

Newborn deaths invisible in global estimates until 2005 – now visible


In 2010 40% of under five deaths were neonatal. In 2011 it as 43%
We can reduce the main causes of death
Newborn Survival Solutions – 3 by 2

1. **Preterm birth**
   1. Preterm labor management including antenatal corticosteroids*
   2. Care including Kangaroo mother care, *essential newborn care*

2. **Birth complications (and intrapartum stillbirths)**
   1. Prevention with obstetric care *
   2. *Essential newborn care*, resuscitation*

3. **Neonatal infections**
   1. Prevention, *essential newborn care*, breastfeeding, Chlorhexidine*
   2. Case management of neonatal sepsis *

* Prioritised by the UN Commission on Life Saving Commodities for Women and Children

Over two-thirds of newborn deaths preventable – actionable now without intensive care
India – HBB Pilot

<table>
<thead>
<tr>
<th>Metric</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Births</td>
<td>4063</td>
<td>5288</td>
</tr>
<tr>
<td>Suctioned %</td>
<td>26.7</td>
<td>10</td>
</tr>
<tr>
<td>BMV%</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>Total BMV%</td>
<td>2.17</td>
<td>3.3</td>
</tr>
<tr>
<td>Fresh SB%</td>
<td>1.7</td>
<td>0.9*</td>
</tr>
</tbody>
</table>

*p < 0.001

Godar et al
Pediatr 131:e344, 2013
Facilitators Flip Chart: Learner info plus advice re: course, content, conduct
Resuscitation Bag

- High Quality
- Reusable
- Cleaning Instruction
- ‘Affordable’
Educational Design

- Adult Learning - TOT, Visual
  - Tool kit
  - Hands on Performance
  - OSCE
  - Evidence Based

- Learner to Facilitator, 6:1
- Learning Pairs
HBB Curricular Concept

- Pictorial
- Limited Text
- Hands On Performance
- Frequent Skills Practice
- Simplest Steps “Possible”
- The Golden Minute
Web Sites

www.Helpingbabiesbreathe.org
HBB Concept

- ILCOR Science
- Harmonious With NRP & WHO Recommendation Where Feasible
- Non-Profit, Inclusive
- Directed To Resource Limited Conditions-Single Provider
Successful Examples

- Plan and Commitment
- Local Leadership
- +/- International Partnerships
Impact of HBB training on ENM within 24 hours (filled squares) and rates of FSB (filled circles) before implementation (N = 8124; mean number of births per hospital n = 820, range 362–2214) and at 1 year and 2 years after implementation (N = 78 500; mean nu...
Implementation Field Testing
India, Tanzania & Kenya

- Knowledge Acquisition +
- Skills Testing – 98% Pass
- Resuscitation Required
  29.9 to 9.5%
  ↑ Stimulation
  ↓ BMV, Suction
- 6-12 Hours of Training
Helping Babies Breathe
sites of implementation – July 2012

Now in 48 countries
Care at birth, analysis from The Lancet Stillbirth series

Deaths prevented:
- Stillbirths 1.1 million (45%)
- Newborn deaths 1.4 (43%)
- Maternal deaths 201,000 (54%)

TRIPLE RETURN ON INVESTMENT
Hypothesis From Experience

Improving Skill in Neonatal Resuscitation
Spurs Improvements in Other
Components of Early Neonatal Care.
Pathophysiologic Cardio-Pulmonary Consequences of Asphyxia

Schematic diagram of changes in rhesus monkeys during asphyxia and on resuscitation by positive pressure ventilation. Brain damage was assessed by histological examination some weeks or months later.

**Arterial**

- \( P_{O_2} \): 25, 5, <2
- \( P_{CO_2} \): 45, 100, 150, 200, 40
- pH: 7.3, 7.0, 6.8, 6.75, 7.1

**Gasps/min**

- PRIMARY APNOEA
- LAST GASP
- SECONDARY OR TERMINAL APNOEA
- ONSET OF GASPING

**Beats/min**

- HEART RATE

**Blood Pressure**

- RESUSCITATION

**Time from onset of asphyxia (min)**

- 0
- 5
- 10
- 15
- 20

**Brain Damage**
Exercise 3: Ventilation with normal heart rate

Present the scenario:
A baby is born.
She is not crying.
You stimulate breathing, but the baby still does not breathe. You begin ventilation with bag and mask.
What will you do next?

Ask the birth attendant to demonstrate appropriate assessment, care and treatment on the baby simulator.

Indicate the baby's condition both at the outset and in response to actions taken by the birth attendant.

Check birth attendant's performance by ticking boxes for taking relevant action steps, adding brief comments as necessary.

3. Ventilation with normal heart rate

- Recognized not breathing well.
- Provided improved ventilation.
- Recognized still not breathing well.
- Checked heart rate.
- Recognized normal heart rate.
- Recognized breathing well now.
- Positioned baby on mother's stomach for monitoring.
# Birth Asphyxia – Early Developmental Intervention

<table>
<thead>
<tr>
<th></th>
<th>Resuscitated</th>
<th>Not Resuscitated</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>59</td>
<td>64</td>
</tr>
<tr>
<td>mMDI</td>
<td>103</td>
<td>98*</td>
</tr>
</tbody>
</table>

*\(p < 0.05\)

Carlo et al  
*J Pediatr 162:705, 2013*
Wonderful Timing For The Newly Born Infant

- MDG Evolving Focus
- Country Interest
- Tools Available
- Global NB Action Plan
- UN Commission on Commodities
### Neurodevelopment – 18 months

**HIE – Head Cooling**

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survivors Followed</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Died</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Moderate/Severe Abn</td>
<td>7</td>
<td>(20%)</td>
</tr>
</tbody>
</table>

*Battin et al*  
*Pediatr 107:480, 2001*
## Neonatal Resuscitation: Cognition at 8 years

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>Asymptomatic</th>
<th>Encephalopathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>5527</td>
<td>400</td>
<td>26</td>
</tr>
<tr>
<td>% Apgar &lt;7</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>% IQ &lt;70</td>
<td>7</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>aOR</td>
<td>1.0</td>
<td>1.65*</td>
<td>6.22+</td>
</tr>
</tbody>
</table>

*p=0.01  +p=0.09

Odd, Lewis, Whitelaw, Gunnell
Lancet 373:1615, 2009
Field Testing

- Educational Approaches
  Tanzania, Kenya, India, Pakistan
- Modified MCQ, Problem-Solving, OSCE
- Simulator- India
- Implementation Studies
  Kenya, India
All-cause, early (7-day) neonatal mortality rates (deaths per 1000 live births), stillbirth rates (stillbirths per 1000 births), and perinatal mortality rates (deaths per 1000 births) before and after ENC training and after NRP training.

### HIE Cooling Study

<table>
<thead>
<tr>
<th></th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>218</td>
</tr>
<tr>
<td>Died</td>
<td>78  (36%)</td>
</tr>
<tr>
<td>Bayley &lt;70</td>
<td>45  (32%)</td>
</tr>
</tbody>
</table>

Gluckman et al
*Lancet* 365:663, 2005