The Outcomes of Preterm Birth – looking beyond discharge

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Aim:

Understand the effects of the Neonatal Unit environment on the neonate’s developing:

- brain,
- sensory system,
- motor development,
- sleep patterns
- behavioural states
## Statistics!

- Approx. 621,000 babies a year born in England
- Highest rate of Low Birthweight (<2.5 kgs) babies in W. Europe

<table>
<thead>
<tr>
<th>Weight Range</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>&lt;1,000 grams</td>
<td>3,600</td>
</tr>
<tr>
<td>1,000-1,500 gms</td>
<td>4,100</td>
</tr>
<tr>
<td>1,500-2,000 gms</td>
<td>8,100</td>
</tr>
<tr>
<td>2,000-2,499 gms</td>
<td>26,600</td>
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</tbody>
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and........More Statistics!

- Numbers of preterm births:
  - 22-23 weeks 550
  - 24-28 weeks 3,600
  - 29-34 weeks 14,900
  - 35-37 weeks 57,300

Survival rates

Survival to discharge:-

- < 24 weeks – 8%
- 24 weeks – 32%
- 25 weeks – 59%
- 27 weeks – 74%

*Marlow N 2004 Current Paediatrics*
Survival and Disability

Of the children followed up from the EPICure study (babies born before 26 weeks gestation in 1995)

- 22% had severe disability at 6 years
- 24% had moderate disabilities
- 32% had mild disabilities
- 20% had no difficulties

(Based on 283 of the original 314 children)
11-year follow-up

- 219 of 308 survivors (71%) assessed and compared with 153 classmates
- Reading scores - 18 points
- Cognitive scores - 20 points
- Maths scores - 27 points
- 25% serious cognitive impairment
- 25% reading impairment
- 44% impairment in maths

Johnson S, Trickie R, Smith R, Marlow N 2008 for the EPICure Study Group
Perhaps of more significance......

At 11 years
- 70% had manual dexterity problems
- 70% had cognitive difficulties
- They showed significantly lower cognitive performance than their full-term comparisons

A study in Oxford in 2001 showed that
- up to 33% of 32-35 w. gestation babies may have educational and behavioural problems affecting school performance).

( Huddy C et al)
The developing brain (4 months to 9 months) Carlson 1999
Brain Development

- In the first 10 – 14 weeks foetal brain growth is determined by genes
- Thereafter brain growth is an active process
- In the third trimester processes are almost entirely driven by responses to the environment

Graven
Brain Development

- Most neurones in the brain are in existence by 24 weeks pca
- The brain triples in size in the third trimester.
- Myelination begins at 24 weeks
- The frontal lobe – responsible for complex thought processes, judgement and attention-develop
- Programmed cell death – apoptosis – takes place between 28 weeks and term
- The germinal matrix is vulnerable to bleeds mostly before 32 weeks.
Brain Development

- 1st trimester: Proliferation
- 2nd Trimester: Migration, Cortical folding
- 3rd Trimester: Organisation, Myelination
- Post-term
Brain Maturation

- Development of the brain that occurs over time:
  - Nerves become covered with myelin sheath
  - Neurons grow larger (dendritic growth) (# is set by term age)
  - Neurons connect with thousands of others to produce thoughts, actions, feelings
  - Redundant neurons die off
  - Neurons travel from central germinal matrix to periphery to form cortex in lobes and areas of brain
  - Communication between R and L hemispheres occurs ➔ intelligence
MRI Studies of the 22-25 week brain

- Recent MRI studies show:
  - decreased cerebral volume
  - regional abnormalities of the brain
  - decreased complexity in the cortical surface area in preterm children at 8 years.

Huppi, Edwards
Sensory development

The sensory systems of the human foetus develop in sequence:

- **Tactile** 7.5 – 18 weeks Begins around mouth, hands at 10 weeks
- **Vestibular** 20-25 weeks system developed but inhibited
- **Taste/smell** Flavours in amniotic fluid sensed at 22 weeks
- **Auditory** 24-35 weeks – rhythm of mother’s voice, gastric sounds
- **Visual** 30 weeks – 24 months

Inappropriate sensory experience may interfere with normal development during critical periods.
Motor Development

The preterm infant in utero exhibits:

- A flexed, midline posture
- Hand-to-mouth movements
- Grasping reflex present from 24 weeks
- Movements that provide sensory (proprioceptive) feedback
- Movements not affected by gravity
The uterine environment

- Controlled light and sound
- Diurnal rhythms
- Constant temperature
- Symmetric growth
- Nutrition
- Tactile and vestibular input (uterine boundaries support posture, tone and movement)
- Calming behaviour supported
The NICU Environment – a rude awakening

- Bright, harsh lighting
- Noise
- Often no diurnal rhythms
- Temperature variations
- Effects of gravity and position can hinder symmetric growth
- Tactile and vestibular input impaired
- Difficulty with self-calming measures
- Painful procedures
- Isolation
From this......

To this
From this..........

To this..........

How Noisy is NICU?

- NICU: 50 dB
- NICU: 70 dB
- NICU: 90 dB
- NICU: 110 dB
- NICU: 130 dB
So – what are we doing to these babies?

We:-

- Disturb their sleep with sometimes abrupt handling
- Subject them to painful procedures – often with little or no pain control
- Subject them to harsh lighting
- Subject them to loud noise
- Place them on hard surfaces where they are affected by gravity
- Isolate them from their parents’ touch
Handling and painful procedures

“*It is by accident, rather than intent, that infants are left to rest*” (Korones 1976)

Is it really any better today?–

More recent research suggests that the mean number of infant contacts over 24 hours was 113 with rest periods of between 2 and 59 minutes (Appleton S. 1997)

The figures for noxious procedures are equally as alarming:

Over a two week period neonates underwent a median of 10 painful procedures a day – 79% without analgesia (Carbajal 2008)
Effects of Nursing

- Vital Signs are very disruptive to cerebral blood flow and
  - Reduce blood flow by 14%
  - Reduce blood volume by 8%
  - Reduce oxygenation by 7-56%
  - Changing nappies is similarly disruptive

The Short and Long Term Effects of Handling

- Reduction in cerebral blood flow, volume and oxygenation
- Ischaemic injury to the brain → long-term neurological sequelae.
- Disrupted sleep cycles → sleep pattern may be disrupted for up to two years.

Parental touch does not cause distress to infants and should not be discouraged (Appleton S, 1999)
The Short -term Consequences of Pain

↑ heart rate, blood pressure, venous & intracranial pressure.

Variability in heart rate

↓ oxygen saturation and skin blood flow

All increasing the risk of IVH and PVL and subsequent neurological sequelae.

Craig, Whitfield, Grunau et al 1999
Anand, Barton, McIntosh et al 1999
Long Term consequences of the neonatal pain experience

- Local cutaneous hypersensitivity (e.g. heel stabs)
- Perception of non-noxious stimuli - such as nappy change - being perceived as noxious.
- Animal evidence suggests that early pain experience may effect neural development, leading to permanent abnormalities in the brain
- Altered (muted) pain response as a result of chronic pain
- Attention-deficit disorders, learning disorders, and behavioural problems in later childhood may be linked to repetitive pain in the preterm infant.

The Effects of Inappropriate Lighting

- Raising light can cause oxygen saturation levels to fall
- Sudden switching on bright lights can trigger episodes of hypoxia
- Light can disrupt the baby’s natural sleep patterns
- We do not know how lighting cycles affect the body rhythms of preterm infants
- May have an effect on the development of the auditory system

Graven S 2007
The short-term effects of Noise

- Noise can cause ↑blood pressure, tachycardia, and altered blood flow to the brain.
- It can interfere with sleep and the baby’s ability to pay attention and be sociable.
- It interferes with the infant’s ability to hear it’s mother’s voice → longer term language problems.
- The preterm infant’s inability to habituate (tune out to a repetitive sound) means he will keep making a response to a sound and not “tune out”.

The long-term effects of noise

- Speech and language problems are more common among children born prematurely.
- Hearing loss is more common (& can have a significant negative effect on academic progress).
- MRI scans of brains of school age children have shown differences in the auditory cortex of preterm infants compared to term infants.

Positioning

- In utero the fetus is able to move within consistent and predictable boundaries.
- Limited intrauterine space at term creates physiologic flexion.
- In the NICU the infant assumes a flattened posture, often with arching and excessive neck and trunk hyperextension.
Foetal Flexion and Midline Development
Acute and chronic effects of inappropriate positioning

- ↑stress and agitation with ↓physiologic stability
- Restlessness and ↓sleep
- ↓weight gain
- Acquired positional deformities
- Poor midline development
- Narrow, elongated head shape (dolichocephaly)
Preterm v. Term
Poor prone positioning

The longer term effects
Dolichocephaly
The effects of isolation

- Parental stress & anxiety – separation is painful\(^1\)
- Poor bonding \(^2\)
- Behavioural problems in later childhood and adolescence \(^3\)
- Different personality styles from term-born peers.\(^4\)

Isolation
Is Developmental Care the Way Forward?

- “Developmental care may promote better family, infant and child outcomes by both reducing neonatal stress and its neurobiological sequelae, and fostering an appropriate interactional relationship between mother and infant”

Any Questions?

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