Premature Infants & Their Development to Adulthood

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When you’re a nurse…
you know that every day you will touch a life
or a life will touch yours

Background
• Most intense experiences of adversity for infants is premature birth – delivery before 37 weeks gestation
• 70% of premature infants spend time in neonatal intensive care (NICU) (Hobbs et al., 2005; MOD 2011)
• Multiple jeopardy: immature body/organ system + NICU environment + medical/neuro illness + maternal seca ration

Scope
♦ Each year 1 in 10 babies are premature; >450,000 per year in the US, 15 million worldwide (NCHS 2014; WHO 2016)
♦ Annual cost ~ $26 billion (Behrman & Sith Butler 2007)
♦ Preterm infants are at risk - especially when prematurity is coupled with neonatal illness (Anderson, 2014; Saigal, 2014; Breeman et al., 2017).
♦ Poorer physical & mental health, lower cognition, academic, social, behavioral problems (e.g., Taylor 2017; Wolke 2016; Saigal et al., 2016)
♦ New problems can emerge at later ages

Purpose of Longitudinal Study
1. Examine developmental outcome of premature infants categorized by neonatal illness
2. Understand and predict outcomes using theoretical models that incorporated environmental context.
3. Understand the effects of neonatal morbidity, environmental context, and cumulative effects on salient developmental outcomes.
**Objectives**

1. Describe a nursing research program on the developmental outcomes of premature infants led by nurse scientists
2. Explain the theoretical perspective of Developmental Origins of Health & Disease
3. List 2 research findings from the longitudinal study of premature infants

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**Theoretical Framework**

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Cumulative Risk
- Medical Risk
- Environmental Risk

Cumulative Protection
- Family Protect
- Individual Protect
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Developmental Outcomes
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**Sample at Birth**

Prospective, longitudinal 5-group design
N=215 recruited at birth and followed in 9 waves to age 23y

<table>
<thead>
<tr>
<th>Preterm Groups</th>
<th>Neonatal Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Term Infants</td>
<td>Full term; medically &amp; neurologically healthy</td>
</tr>
<tr>
<td>Healthy Preterm</td>
<td>No medical/neurological complications</td>
</tr>
<tr>
<td>Medical Preterm</td>
<td>Neonatal medical illness (BPD, RDS, NEC, sepsis)</td>
</tr>
<tr>
<td>Neurological Preterm</td>
<td>Neonatal neurological illness (Grade III &amp; IV IVH, meningitis, shunted hydrocephalus)</td>
</tr>
<tr>
<td>Small for Gestational Age</td>
<td>Birth weight for gestational age &lt; 10th percentile</td>
</tr>
</tbody>
</table>

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**Infancy**

Birth, 1m, 3m, 9m, 18m, 30m
N = 215

```
Hospital Visit
- Recruitment
- Physiology/CRY acoustics
- Motor Skills
- Growth – Height, Weight
- Health – Medical, Neuro
- Neurobehavior (NBAS)
- Risk – Biological, Environmental
- Protect – Maternal, Family
```

```
Home Visit
- HOME environment
- Cognition
- Language Skills
```

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**Preschool Study**

Age 4
N = 184

```
Hospital Visit
- Health – Medical, Neuro
- Growth – Height, Weight
- Motor Skills
- Visual-Motor Integration
- Socioemotional Competence – Mastery, Problem Solving
```

```
Home Visit
- HOME environment
- Cognition
- Language Skills
```

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**School Age Study**

Age 8
N = 191

```
Hospital Visit
- Health – Medical, Neuro
- Growth – Height, Weight
- Motor Skills
- Problem Behaviors
- Socioemotional Competence
```

```
Home Visit
- HOME environment
- Visual-Perceptual Skills
- Social Skills
```

```
School Visit
- Cognition
- Academic Achievement
- School Record Review
- Peer Observation
- Teacher Questionnaires
```

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Early Adolescent Study
Age 12
N = 186

Hospital Visit
- Health – Medical, Neuro
- Growth – Height, Weight
- Motor Skills
- Problem Behaviors
- Socioemotional Competence
- Peer Interaction

Home Visit
- HOME environment
- Visual-Perceptual Skills
- Social Skills

School Visit
- School Record Review
- Teacher Questionnaires
- Risk – Biological, Environmental
- Protect – Maternal, Family

Late Adolescent Study
Age 17
N = 180

Hospital Visit
- Health – Medical, Neuro
- Growth – Height, Weight
- Functional Performance
- Executive Function
- Cognition
- Academic Achievement
- Problem Behaviors
- Risky Behaviors
- Social Skills

Risk – Biological, Environmental
- Protect – Maternal, Family

Preterm Infant to Adult Study
Age 23
N = 180

Home Visit
- Blood Glucose, Lipids
- Diurnal Cortisol & sAA
- Health Behaviors
- Health Related Quality of Life
- Work Competence
- Emotional Intelligence
- Diet

Hospital Visit
- Health – Medical, Neuro
- Growth – Height, Weight
- Functional Performance
- Executive Function
- Problem Behaviors
- Risk Taking Behaviors
- Cortisol & Salivary Alpha Amlylase
- Stress Reactivity

Heart Center Visit
- Cardiac Function
- Pulmonary Function

Risk – Biological, Environmental
- Protect – Maternal, Family

RESULTS

Longitudinal Sample Retention

Birth
N=215

Age 4
N=184

Age 8
N=191

Age 12
N=186

Age 17
N=180

Age 23
N=180

89% 99% 98% 97% 95% 99%

88% 87% 85%
Sample at Age 23 Years (M=23.2, SD =1.0)

Neonatal Groups

Sex

- Males: 53%
- Females: 47%

Sample distribution across neonatal groups:

- Full Term: 27
- Healthy PT: 46
- Medical PT: 31
- Neuro PT: 24
- DGA PT: 53

5 levels of SES equally distributed within each neonatal group.

Young Adult Education

- 92% completed high school (n = 152) NS, but wide variability
- No group differences on HS graduation rates
- 50% had Post Secondary education
  - vocational 6%
  - community college 4%
  - college 38%; (Neuro PT had lowest completion)
  - graduate school 1.8%

Young Adult Financial Support

Financial Support \( \chi^2(16,169)=17.74, p=.34 \)

- 66% self
- 24% partial parents
- 5% spouse
- 4% disability, workers compensation

Young Adult Employment & Occupation

- 69% employed at 23 years \( \chi^2(4,167)=3.71, p=.48 \)

- Occupation \( \chi^2(12,169)=15.41, p=.22 \)
  - 36% unskilled, semiskilled occupations
  - 27% skilled, sales/clerical, technician, semiprofessional
  - 14% management, administrative, executive
  - 23% students
  - 31% unemployed

Males have CVD risk at 23 years

Females have CVD risk at 23 years
Diurnal Cortisol Sampling at 23 Years

- 5 samples collected during typical day:
  1. Awakening
  2. 45 minutes after awakening
  3. 4 hours after awakening
  4. 8 hours after awakening
  5. Bedtime

Diurnal Cortisol Pattern by Preterm Group

- MPT & NPT groups: illustrate blunted response in diurnal cortisol pattern
- HPT & SGA groups: sharp increase in cortisol after awakening & sharp decline throughout the day
- FT group: normal diurnal pattern, with high cortisol concentration in morning, gradual decline throughout the day

Prematurity, Birth Weight, SES Influence Cortisol

Significant interaction of preterm group, birth weight, & SES

Cumulative Medical Risk Index: Birth to Age 17 Years

\[ \chi^2 = 246, df=1, \ p < 0.0001, R^2 = 0.750, \text{adj} R^2 = 0.143, \text{F}=3001 \]
Cumulative Protection Index from Birth to Age 12 Years

Revisit the Objectives....

- Describe a nursing research program on the developmental outcomes of premature infants led by nurse scientists
- Explain the theoretical perspective of Developmental Origins of Health & Disease
- List 2 research findings from the longitudinal study of premature infants

SUMMARY of 23 Year Outcomes

- Wide variability in education, employment, occupation at age 23 years
- Similar to FT, but slightly lower
- Not reaching markers of independent living
- More health problems than FT
- Health, including diet – not optimal; early risk for CVD

SUMMARY – Cortisol at 23 Years

- Distinct patterns for full term and preterm groups, in particular, preterm groups with neonatal illness.
- Blunted diurnal cortisol patterns were observed for the MPT and NPT groups
- Birth weight was an important contributor to diurnal cortisol pattern at age 23.
- SES and Protective factors affect cortisol rhythm
Findings support HPA axis as mechanisms underlying the Developmental Origins Theory.

Developmental Origins framework
- a mechanism underlying fetal origins of adult chronic disease.
- has impact on metabolic and stress response programming which affects long term physical and behavioral health.
- offers a lifespan perspective on preterm birth and adult outcomes, with potential for early identification of those at risk for later stress-related disease.

CONCLUSIONS

Longitudinal follow-up of premature infants and the stress response system, such as the HPA axis, suggests a greater understanding of the role of this stress-related biomarker in adulthood.

Continued health monitoring of prematurely born infants is important as they have higher risk for adult illness.

Roles for neonatal nurses include monitoring the physiological stability of preterm infants, careful assessment of stress behaviors, and collaborative decision making for interventions.

The ultimate reason to understand the etiology of long-term outcomes is identification of possibilities for preventative interventions.

IMPLICATIONS

Barry Lester, Margaret McGrath

Co-investigators: William Oh, Betty Vohr, Ron Seifer, Michael Msall, Doug Granger,

Biostatisticians: Mark Pueker, David Ahern, Steve Farrone, Mary Roberts

Our Gratitude – to the Participants & Families

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Institutions
University of Rhode Island, College of Nursing, Kingston, Rhode Island
Women & Infants Hospital, Brown Center for Children, Providence, Rhode Island
Institute for Interdisciplinary Salivary Bioscience Research, Arizona State University, Arizona State University, Tempe, AZ
University of Chicago, Pritzker School of Medicine/Comer & Larabida Children’s Hospital
Baby Talk: Unlocking the Secrets of the Infant Brain – RI PBS on youtube
https://www.youtube.com/watch?v=8jjxG2DNr_g

Project Director: Suzy Winchester

Research Assistants: Bernai Manna, Christine Andrade, Kelli Rocherolle, Jennifer Verme, Mattie Gonzalez, Courtney Clark, Allison Hille, April Duffy, Erin Hunt, Sarah Inlow, Deonarie Can, Karen Murphy, Lea Lockwood, Laura Moom, Tom Doyle, Marjorie Barron, Jennifer DePalma, Melissa Machado, Ryan Sayner, Erica Oliveira, Matt Sroch, Jennifer DePalma

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Publications from the RI Premature Infant Cohort
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Book chapters
PMDT # 18294577 NIHMSID # 172610


Peer-reviewed Publications
Effectiveness in Nursing, 1, 92-104.


Scott, A., Winchester, S. B., & Sullivan, M. C. (2017). Trajectories of problem behaviors from 4 to 23 years in

