Behavioral Phenotype of Prematurity

The Perfect Storm of ‘Minor’ Morbidities

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Director, Neonatal Follow Up Program
University of Toronto
Disclosure

I have no actual or potential conflict of interest in relation to this program. I also assume responsibility for ensuring the scientific validity, objectivity, and completeness of the content of my presentation.
Objectives

At the end of the session, you will be able to:

1. Review behavioural phenotype of prematurity
2. Review ethology of phenotype
3. Discuss gaps in current system for preterm infants
   a. Community/school systems
   b. Neonatal follow up
“Knowing that we can be loved exactly as we are gives us all the best opportunity for growing into the healthiest of people.”

-Fred Rogers
Background

Figure 1: Rates of Preterm Birth in Canada, 2011/12

[Bar chart showing rates of preterm birth in different provinces and territories of Canada.]

Canadian Premature Babies Foundation – Fondation pour Bébés Prématurés Canadiens

Sunnybrook
Health Sciences Centre
Figure 2: Global burden of preterm birth in 2010

11 countries with preterm birth rates over 15% by rank:
1. Malawi
2. Congo
3. Comoros
4. Zimbabwe
5. Equatorial Guinea
6. Mozambique
7. Gabon
8. Pakistan
9. Indonesia
10. Mauritania
11. Botswana
Background

Age of viability decreasing

- 22 x/7 weeks versus 23 weeks versus 24 weeks
Outcomes of prematurity fairly stable 6-25%

• Impairment defined by the presence of
• Cerebral palsy
• Vision impairment
• Hearing impairment
• Cognitive impairment

Neonatal Outcomes

• 50-70% of children born very preterm will have difficulty with school performance

• Proposed factor = ‘minor’ morbidities

• ’Minor’ morbidity because considered non-disabling in nature

Aylward GP. Neurodevelopmental Outcomes of Infants Born Prematurely. JDBP 2014;35:394-407
‘Minor’ Morbidities

Challenges with:

• Language comprehension and expression (Verbal and nonverbal communication)
• Learning (Spatial relationships)
• Impulse control, busy behaviour
• Organizational abilities

Aylward GP. Neurodevelopmental Outcomes of Infants Born Prematurely. JDBP 2014;35:394-407


Autism Spectrum Disorder

Deficits in social communication and social interaction

• Social emotional reciprocity
• Nonverbal communication
• Difficulty making, sustaining, or understanding relationships

Restricted repetitive patterns of behavior

• Stereotyped movement patterns
• Inflexible adherence to routines
• Fixated interests with abnormal intensity and focus

Prevalence and Associated Features of Autism Spectrum Disorder in Extremely Low Gestational Age Newborns at Age 10 Years

Autism Spectrum Disorder

Figure. Frequency distribution showing proportion of children with each total SCQ score in the extremely preterm cohort (n = 183) and term-born classmates at 11 years of age (n = 137).

M-CHAT Preterm

M-CHAT (Modified Checklist for Autism in Toddlers)

Please fill out the following about how your child usually is. Please try to answer every question. If the behavior is rare (e.g., you’ve seen it once or twice), please answer as if the child does not do it.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
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</thead>
<tbody>
<tr>
<td>1. Does your child enjoy being swung, bounced on your lap, etc.?</td>
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<td>2. Does your child take an interest in other children?</td>
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<td>3. Does your child like climbing on things, such as stair steps?</td>
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<td>4. Does your child enjoy peek-a-bootie-and-peek?</td>
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<tr>
<td>5. Does your child ever pretend, for example, to talk on the phone or take care of dolls, or pretend other things?</td>
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<tr>
<td>6. Does your child ever use his/her index finger to point, to ask for something?</td>
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<tr>
<td>7. Does your child ever use his/her index finger to point, to indicate interest in something?</td>
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<tr>
<td>8. Can your child play properly with small toys (e.g., cars or blocks) without just mouthing, holding, or dropping them?</td>
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<tr>
<td>9. Does your child ever bring objects over to you (parents) to show you something?</td>
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<tr>
<td>10. Does your child look you in the eye for more than a second or two?</td>
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<td>11. Does your child ever seem overemotional to noise? (e.g., plugging ears)</td>
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<td>12. Does your child smile in response to your face or your smile?</td>
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<tr>
<td>13. Does your child imitate you? (e.g., you make a face; will your child imitate it?)</td>
<td></td>
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<tr>
<td>14. Does your child respond to his/her name when you call?</td>
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<tr>
<td>15. If you point at a toy across the room, does your child look at it?</td>
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<tr>
<td>16. Does your child walk?</td>
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<tr>
<td>17. Does your child look at things you are looking at?</td>
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<tr>
<td>18. Does your child make unusual finger movements near his/her face?</td>
<td></td>
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<tr>
<td>19. Does your child try to attract your attention to his/her own activity?</td>
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<tr>
<td>20. Have you ever wondered if your child is deaf?</td>
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<td></td>
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<tr>
<td>21. Does your child understand what people say?</td>
<td></td>
<td></td>
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<tr>
<td>22. Does your child sometimes stare at nothing or wander with no purpose?</td>
<td></td>
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<tr>
<td>23. Does your child look at his/her face to check his/her reaction when faced with something unfamiliar?</td>
<td></td>
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</tbody>
</table>

Anxiety
Cognitive delay/impairment
Cortical vision impairment

ADHD
ADD
CP
Hearing impairment
AN/AD
Neonatal Outcomes-Terminology

Spectrum in development from typical to atypical

- Normal
- Variant
- Problem
- Disorder

Neonatal Outcomes

• Spectrum of outcomes possible
• Isolated ‘minor’ morbidity is rare
• Cluster of conditions more common
• Detection requires discrete assessments

Aylward GP. Neurodevelopmental Outcomes of Infants Born Prematurely. JDBP 2014;35:394-407
Neonatal Outcomes

Behavioral Phenotype

• Describes a constellation of behavioral, cognitive, motor, and social strengths & difficulties observed in a population with a common biological disorder

• Premature survivors have a phenotype

• Common biological disorder = alterations in brain development


Back SA, Miller SP. Brain Injury in Premature Neonates: A Primary Cerebral Dysmaturation Disorder? Ann Neurol 2014;75;469-86.

Behavioral Phenotype of Prematurity
Behavioral Phenotype of Prematurity
Alex Libby: From Bully to the Bully Effect

https://www.youtube.com/watch?v=gWI0kSG4FP0
"This is not rocket science, people."
Etiology

Behavioral Phenotype of Prematurity

Dysmaturation:
• Gray matter architecture distorted
• White matter connectivity altered
• Cerebellum under-developed
• Sensory system disorganization

Secondary cortical dysplasia

Back SA, Miller SPM. Brain Injury in Premature Neonates: A Primary Cerebral Dysmaturation Disorder? Ann Neurol 2014;75:469-489


Etiology
Behavioral Phenotype of Prematurity

Altered synaptogenesis
- Experience expectant versus experience dependent
- Similar experience with different effects
- Impact of pain and stress
- Plasticity can be good or bad

Etiology
Behavioral Phenotype of Prematurity

Loss of controlled sensory exposure

Alterations to timing (too much too soon, too little too late)
  • Impact perceptual organization

Loss of redundancy
  • Impacts selective attention, perceptual organization, learning

Heightened parental stress potentiates:
• Disrupted attachment
• Diminished parental capacity
• Goodness of Fit
• Vulnerable child syndrome
Risk of psychological distress in parents of preterm children in the first year: evidence from the UK Millennium Cohort Study

Claire Carson, Maggie Redshaw, Ron Gray, Maria A Quigley

Post-traumatic Symptomatology in Parents with Premature Infants: A Systematic Review of the Literature

Athanasios Karatzias, PhD¹, Zoë Chouliara, PhD², Fiona Maxton, PhD³, Yvonne Freer, PhD⁴, and Kevin Power, PhD⁵

Prematurity, maternal posttraumatic stress and consequences on the mother–infant relationship

Margarita Forcada-Guex a, Ayala Borghini b, Blaise Pierrehumbert b, François Ansermet c, Carole Muller-Nix b,*

STATE-OF-THE-ART

Screening parents of high-risk infants for emotional distress: rationale and recommendations

MT Hynan¹, KO Mounts² and DL Vanderbilt³
“The title of my science project is ‘My Little Brother: Nature or Nurture.’”
Going home: Facilitating discharge of the preterm infant

Ann L Jefferies; Canadian Paediatric Society
Fetus and Newborn Committee

POLICY STATEMENT

Hospital Discharge of the High-Risk Neonate

Committee on Fetus and Newborn
## High Rates of School Readiness Difficulties at 5 Years of Age in Very Preterm Infants Compared with Term Controls

Gehan Roberts, PhD,†‡‖ Jeremy Lim, BHIthSc (Hons),§ Lex W. Doyle, MD,*‡‖ Peter J. Anderson, PhD*‡‖§

<table>
<thead>
<tr>
<th>School Readiness Domain</th>
<th>Individual Measures</th>
<th>VPT (N = 195)</th>
<th>Control (N = 70)</th>
<th>Mean Difference (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and physical development</td>
<td>PEDS-QL score</td>
<td>87.7 (16.0)</td>
<td>95.4 (7.1)</td>
<td>−7.7 (−10.5 to −4.8)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td></td>
<td>Movement-ABC percentile</td>
<td>23.1 (23.1)</td>
<td>44.5 (26.5)</td>
<td>−21.4 (−28.6 to −14.2)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td></td>
<td>Visual-motor integration score</td>
<td>94.4 (14.2)</td>
<td>100.2 (15.5)</td>
<td>−5.8 (−9.8 to −1.8)</td>
<td>&lt;.005*</td>
</tr>
<tr>
<td>Social-emotional skills</td>
<td>Total difficulties score, SDQ</td>
<td>9.6 (5.7)</td>
<td>7.1 (4.3)</td>
<td>2.5 (1.2 to 3.8)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Approaches to learning</td>
<td>Global composite score, BRIEF-P</td>
<td>54.6 (13.1)</td>
<td>47.2 (10.6)</td>
<td>7.4 (1.6 to 4.2)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td></td>
<td>Digit recall, WMTB-C</td>
<td>89.5 (15.5)</td>
<td>101.3 (16.0)</td>
<td>−11.8 (−16.2 to −7.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Nonword recall, WMTB-C</td>
<td>98.9 (19.4)</td>
<td>109.3 (15.0)</td>
<td>−10.4 (−15.0 to 5.8)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Communication</td>
<td>Expressive language score, K-SEALS</td>
<td>97.0 (13.8)</td>
<td>105.8 (12.5)</td>
<td>−8.9 (−12.5 to −5.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Receptive language score, K-SEALS</td>
<td>97.6 (13.0)</td>
<td>107.2 (9.6)</td>
<td>−9.6 (−12.5 to −6.7)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Cognition and general knowledge</td>
<td>Number skills score, K-SEALS</td>
<td>97.4 (12.6)</td>
<td>104.5 (9.9)</td>
<td>−7.1 (−10.4 to −3.8)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Letter/word skills score, K-SEALS</td>
<td>96.6 (16.5)</td>
<td>107.0 (14.9)</td>
<td>−10.4 (−14.8 to −6.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Early academic composite score, K-SEALS</td>
<td>96.9 (12.9)</td>
<td>106.4 (10.9)</td>
<td>−9.5 (−12.9 to −6.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Nonverbal general ability score, K-BIT 2</td>
<td>96.1 (12.7)</td>
<td>102.9 (10.1)</td>
<td>−6.7 (−10.1 to −3.4)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
The long-term consequences of preterm birth: what do teachers know?

SAMANTHA JOHNSON | CAMILLA GILMORE | IAN GALLIMORE | JULIA JAEKEL | DIETER WOLKE

1 Department of Health Sciences, University of Leicester, Leicester; 2 Mathematics Education Centre, Loughborough University, Loughborough, UK; 3 Department of Developmental Psychology, Ruhr-University Bochum, Bochum, Germany; 4 Department of Psychology and Division of Medical Health and Wellbeing, Warwick Medical School, University of Warwick, Coventry, UK.
Knowledge of Educators

Educators (n=138) less knowledgeable about outcomes of prematurity

- 75% aware and/or knowledgeable about ADHD/ADD
- 62.5% aware and/or knowledgeable about learning disabilities
- 60.6% aware and/or knowledgeable about ASD
- 24.8% aware and/or knowledgeable about developmental outcomes of prematurity

Factors that enhanced educators’ knowledge

- Having experience with a child born preterm
- Having a child with an individualized education plan
- Additional educator qualifications


Church, October 2017
Knowledge of Educators

What **did not enhance** educators’ knowledge: being a parent of a preterm?

- 91.7% reported that medical history would help them teach more effectively
- No consistency on enrolment by due date vs. birthday; 1/3 disagree with enrolment by due date, 1/3 neutral, 1/3 agree
- 86.4% of educators reported that they would benefit from additional education on preterm children
"It sort of makes you stop and think, doesn't it."
Concept of Plasticity

Dysmaturation infers that it is modifiable

• Nature through nurture
• Not nature vs nurture

Rosenbaum, P. & Gorter, JW. The ‘F-words’ in childhood disability: I swear this is how we should think! Child: Care, Health and Development, 2012; 38: 457-463. doi:10.1111/j.1365-2214.2011.01338x
Lessons from NIDCAP

NIDCAP approach based on 3 assumptions:

• Detailed observation of behavior provides basis for recommendations in how to minimize stress and optimize development

• Caregivers benefit from supportive education, as well as guidance and modeling in implementing recommendations

• Resultant changes lead to improved medical and neurobehavioral functioning

SO HOW DOES THIS TRANSLATE TO NEONATAL FOLLOW UP?
Lessons from NIDCAP

1. Detailed observation of behavior provides basis for recommendations in how to minimize stress and optimize development

Addition of Behavior Analyst to provide evidence-based approaches to behavioral issues

Use applied behaviour analysis
  • Applied: real world
  • Behaviour
  • Analysis: demonstrate functional relationships


Cooper JO, Heron, TE, Heward WL. Applied behavior analysis 2nd ed, 2007; Upper Saddle River, NJ: Pearson Prentice Hall.
Lessons from NIDCAP

2. Caregivers benefit from supportive education, as well as guidance and modeling in implementing recommendations

Shift to group based services:
- Triple P
- Incredible Years
- Transition to School session

Website/social media
Lessons from NIDCAP

3. Resultant changes lead to improved medical and neurobehavioral functioning
• Feasibility of Acceptance Commitment Therapy in the NICU

• Impact on parental stress

• Pilot to start Fall 2017


• Behavioral Phenotype of Prematurity associated with increased difficulty functionally

• Gaps in resources exist

• Integration of Neonatology and Dev Peds essential to drive change in outcomes
"Stop fact-checking my story."
Acknowledgements

- Rudaina Banihani, MD, Neo-Dev Paeds
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- Lesley Barreira, Beh Anal
- Mallory Owen, OT
- Isabel Lam, OT/PT

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- Ruth Kim, admin
THANK YOU!

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QUESTIONS?

Sunnybrook
HEALTH SCIENCES CENTRE
when it matters MOST