Health Over the Life Course: The Integration of Research, Health Care, and Policy

Neal Halfon MD MPH
Professor of Pediatrics, Health Services, Public Policy
UCLA Center for Healthier Children Families and Communities

Research for a Lifetime: A Scientific Colloquium to Commemorate the NICHD's 50th Anniversary

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National Health Policy Challenge

• Triple Aim
  – Better Health
  – Higher quality care
  – Lower cost
• Challenge
  – Enormous disparities-
  – Rapidly rising rates of chronic disease
  – Relentless cost increases
• Wrong Strategy
• Old Outdated Operating System
Think Differently

• Most health disparities start early in life with small differences compounding over time
• Most chronic diseases also start early in life –
  – Adversity
  – Behaviors
  – Pathways and Trajectories
• In order to Shift the Cost Curve we need to Shift the Health Curve
• New Approach: Developmental Health System using 3.0 operating system
Sub-optimal Child Health Development: What’s at Stake

• School failure and additional costs due to expenditures for second chance programs
  – Special education
  – Mental health, juvenile justice
• Diminished potential to form strong social and family relationships
• Long-term costs in social dependency
• Sub-optimal productivity-economic, social,
• Sub-optimal life-long health
  – Higher rates of chronic health conditions
  – Higher costs
Economic Adversity and Child Outcomes

- Born early, smaller, more fragile, and at risk
- Worse physical, cognitive, emotional health
- Hospitalized more, more obese, more asthma, more mental health problems, more disability
- Lower health trajectories, greater brain drain
- Carry the burden of their social status into adulthood
- Programmed into how their biology – an how their immune, endocrine, neurological systems develop, function and perform
Barriers to Educational Achievement Emerge at a Very Young Age

Down Stream Health Problems Related to Early Life

2nd Decade
- School Failure
- Teen Pregnancy
- Criminality
- Substance abuse
- Anxiety Disorders

3rd/4th Decade
- Obesity
- Elevated Blood Pressure
- Depression

5th/6th Decade
- Coronary Heart Disease
- Diabetes
- Renal Disease
- Arthritis

Old Age
- Premature Aging
- Memory Loss

From Hertzman
How are the Children?
Trends in Child Health

• Mortality Rates Continue to Decrease
• Morbidity is decreasing for many Medical Conditions
• Disparities in Health Outcomes are increasing (societal inequality + for profit medicine)
• Emergence of New Morbidities and Concerns (obesity, ADHD, mental health)
• Patterns of Exposure and Risk are changing (squeezed families, hurried children, toxic environments)
Changing Pattern of Childhood Morbidity

- Increase in chronic health problems (16%-33%)
- Growing prevalence of mental health disorders (15-20%)
- Greater appreciation of role and impact of developmental health problems – learning, language (10-17%)
- Growing number of children with multiple conditions (co-morbidities) e.g. asthma, obesity, ADHD
Trends in Childhood Disability- U.S.

(Limitation of Activity due to Chronic Conditions for U.S. Children, NHIS, 1960-2009)

From Halfon, Houtrow, Larson, Newacheck Future of Children 2012
Children at Risk

4-6% Severe Disabilities

12-16% Special Health Care Needs

30-40% Behavioral, Mental Health Learning Problems

50-60% Good Enough

What % are thriving?

30% ?

40% ?

50% ?
Poor Performance of Child Health System

- Fragmented service delivery
- Difficulty accessing services and huge inequities
- Low and Uneven quality
- Models of care is outmoded and don’t match current needs, or capability
- Limited local responsibility
- Operating under enormous constraints
The Quality of Ambulatory Care Delivered to Children in the United States

Rita Mangione-Smith, M.D., M.P.H., Alison H. DeCristofaro, M.P.H., Claude M. Setodji, Ph.D., Joan Keesey, B.A., David J. Klein, M.S., John L. Adams, Ph.D., Mark A. Schuster, M.D., Ph.D., and Elizabeth A. McGlynn, Ph.D.

### Table 3. Adherence to Quality Indicators, Overall and According to Type and Function of Care.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of Indicators</th>
<th>No. of Eligible Children</th>
<th>Total No. of Times Indicator Eligibility Was Met</th>
<th>Weighted Adherence Rate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall care</td>
<td>175</td>
<td>1536</td>
<td>11,886</td>
<td>46.5 (44.5–48.4)</td>
</tr>
<tr>
<td>Type of care</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventive</td>
<td>57</td>
<td>1528</td>
<td>8,809</td>
<td>40.7 (38.1–43.4)</td>
</tr>
<tr>
<td>For acute condition</td>
<td>77</td>
<td>862</td>
<td>2,077</td>
<td>67.6 (63.9–71.3)</td>
</tr>
<tr>
<td>For chronic condition</td>
<td>41</td>
<td>394</td>
<td>1,000</td>
<td>53.4 (50.0–56.8)</td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening</td>
<td>55</td>
<td>1514</td>
<td>6,419</td>
<td>37.8 (34.6–41.0)</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>32</td>
<td>378</td>
<td>1,018</td>
<td>47.2 (43.3–51.1)</td>
</tr>
<tr>
<td>Treatment</td>
<td>64</td>
<td>1056</td>
<td>2,981</td>
<td>65.9 (62.4–69.4)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>24</td>
<td>754</td>
<td>1,468</td>
<td>44.7 (40.9–48.5)</td>
</tr>
</tbody>
</table>
Not Optimizing Healthy Development

Addressing the factors shaping health development trajectories over the lifespan

- Ideal child-development trajectory
- Current practice
- At-risk child-development trajectory without intervention

Age
New Challenges
New Paradigms
New Strategies

New paradigm of systems biology
New paradigm of health development
New era of health care organization and delivery
Biological Systems Ideas and Theories

- **Darwinian Evolution**
- **Mendelian Genetics**
- **Population Genetics**
- **Epigenetics 1.0** (Waddington)
- **Development**
- **Neo-Darwinian Synthesis**: Molecular Biology (1 gene, 1 phenotype)
- **Systems Biology**
- **Genomics**
- **Biocomplexity**
- **Other “omics”**
- **Post-Genomic Synthesis** (relational gene networks)

Today
Life expectancy: 79
A) Genome

see Box 1 uniquely encodes

Gene network (GRN)

B) Gene expression pattern = network state

\[ S(t) = [x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9] \]

dynamics of network states

C) State space (2D)

all possible gene expression patterns \( S(t) \) projected to a \( YX \) plane - the distance reflects similarity of patterns

Assign a "quasi-potential energy" \( U \) to each state \( S \) in the 2D state space plot \( U \) as vertical axis

D) Epigenetic Landscape

unused attractors - not optimized by evolution; can be occupied after mutations

developmental trajectory from immature to mature regions - streamlined by evolution to avoid unused attractors

basin of attraction

Attractors of mature cell types

(same state space as in C.)
Evolving Conceptual Models of Health Development

- Mendelian Genetics
- Germ Theory
- Medical Anatomic/Pathologic Framework

BioMedical Models
- Behavioral Influences
  - Smoking
  - Eating
  - Exercise
  - Stress

BioPsychosocial Models
- Social Epidemiology
- Epidemiology
- Life Span Human Developmental Psychology
- Lifecourse Sociology

Lifecourse Health Development (LCHD) Synthesis
- Neurodevelopment
- Lifecourse Chronic Disease Epidemiology
- National Birth Cohort Studies

- Simple
- Mechanistic, Linear
- Complex
- Relational
- Dynamic
- Developmental

Pathway
Influence
Fig. 1. Annual number of publications listed in interdisciplinary databases using “life course” as a keyword, 1990–2009.
Source: Own elaboration on data from the Scopus and ISI Web of Science databases, extracted on September 26, 2009. Data for 2009 are estimates.
Life Course Health Development

• Health is an emergent quality of human development
• Health development is a complex, nonlinear, adaptive process that occurs continuously across the lifespan
• The health development process is multidimensional, multidirectional, multilevel, self-organizing, and multiphasic
Life Course Health Development

• Health development is imbued by evolution with plasticity strategies to promote resilience and adaptability to changing environmental contexts
  – Selective optimization
  – Predictive adaptive responses

• Health development pathways are
  – Time specific (sensitive periods /biological embedding)
  – Time dependent (cumulative impacts)
  – Socially Structured
Time Sensitive Pathways of Influence

Exposure

Toxic Stress

Epigenome

Endophenotype

Mid-Brain
affiliation/attachment
PFC
executive function/impulsivity
HPA
stress response

Phenotype

Health behaviors
Mental health

Chronic diseases

From Hertzman
Environments
- Home/Family Environment
  - Positive Parenting
  - Drug abuse
- School Environment
  - Enables learning
  - Dangerous
- Media/Information Environments
- Work Environment
  - Work-life balance
  - Job insecurity

Culture
- Social Valuation of parents
  - Low social status
- Social valuation of teachers
  - Obesogenic Env.
- Positive peers
  - Lack of control
- Social Support
  - Isolation

Bio-behavioral
- Nutritious diet
  - Low birth weight
- Exercise
  - Inflammation
- Social engagement
  - Negative HPA response
- Active peer relationships
  - Cognitive decline

Health Development Capacity

Life Course Health Development

Phases
- Preconception/Prenatal
- Birth
- Early Childhood
- Childhood
- Adolescence
- Adult
- Older Adult

100 yrs / 1000 days
Figure 8.6. Postnatal growth of the human brain. (A) Dorsal view of a normal brain at birth (left) and at age 6 years (right). (B) The duration of human brain growth (according to brain weight). The growth of the brain (here based on 2603 neurologically normal subjects) continues for a decade or more. (From Purves, 1994; (A) after Conel, 1939–67; (B) after Dekaban and Sadowsky, 1978.)
Figure 1. Schematic representation of the life course of ventilatory function measurements such as forced expiratory volume in one second.

Footnotes:
A = normal growth and decline.
B = impaired prenatal or postnatal growth, leading to reduced maximal function and increased risk of later disability and death from chronic respiratory disease despite a normal rate of decline.
C = normal growth but accelerated decline, leading to premature disability and risk of death from chronic respiratory disease.
D = episodes of reversible airflow obstruction, which may be superimposed on any of curves A, B or C.

LCHD: Reducing Risk & Optimizing Protective Factors at a Population Level (curve shifting)

Age

- Birth
- 6 mo
- 12 mo
- 18 mo
- 24 mo
- 3 yrs
- 5 yrs

- Early Infancy
- Early Toddler
- Late Toddler
- Early Preschool
- Late Preschool

- Read to learn
- "At Risk" Trajectory
- "Healthy" Trajectory
- "Delayed/Disordered" Trajectory

Factors:
- Parent education
- Emotional Health
- Literacy
- Reading to child
- Appropriate Discipline
- health services
- Toxic Stress
- Poverty
- Lack of health services
- Pre-school

Prevention:
- Parent education
- Emotional Health
- Literacy
- Reading to child
- Appropriate Discipline
- Health Services
- Toxic Stress
- Poverty
- Lack of health services
Transformation of the Health Care System

The Third Era
The Evolving Health Care System

The First Era (Yesterday)
- Focused on acute and infectious disease
- Biomedical
- Short time frames
- Medical Care
- Insurance-based financing
- Industrial Model
- Reducing Deaths

Health System 1.0

The Second Era (Today)
- Increasing focus on chronic disease
- Biopsychosocial-multiple risks
- Longer time frames
- Chronic Disease Mgmt & Prevention
- Pre-paid benefits
- Corporate Model
- Prolonging Disability free Life

Health System 2.0

The Third Era (Tomorrow)
- Increasing focus on achieving optimal health
- LCHD- Complex Systems
- Lifespan/ generational
- Investing in population-based prevention
- Network Model
- Producing Optimal Health for All

Health System 3.0
Shifting the Health Development Curve to Shift the Cost Curve

Health Development

Age (Years)

Optimal Health Trajectory
Low Health Trajectory
Higher LT Costs
Lower LT Costs
Symptomatic

Costs

3.0
2.0
1.0
3.0 Agenda of Discovery, Innovation and Advancement

• Science
  – Convergence Molecular and Population Health Pathways
  – Linking Social Epigenetics /Personalized Medicine
  – Creating Measures of Health Development over Life Course
  – New Longitudinal Cohort Data (NCS)
  – New Classification of Disease and Developmental Health

• Clinical Translation @ Individual and Population Level
  – Population health development – Curve Shifting Efforts
  – Early & Preemptive Interventions
  – Neurodevelopmental Optimization
3.0 Agenda of Discovery, Innovation and Advancement

• Organization
  – 3.0 Child Health Development Systems (ACOs++)
  – Greater integration
    • Population and Individual Approaches
    • Horizontal and Longitudinal
  – R/D Investment vehicles – invest in health capital

• Transformational
  – Collaborative Innovation networks to stimulate improvement and innovation
    • All levels
    • States and Local level
## Transitioning to a 3.0 Operating Logic

<table>
<thead>
<tr>
<th></th>
<th>Old Operating Logic</th>
<th>New Operating Logic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition of Health</strong></td>
<td>Absence of Disease</td>
<td>Development of Capacities and Realizing Potential (IOM2004)</td>
</tr>
<tr>
<td><strong>Goal of the Health System</strong></td>
<td>Maintain Health, Prolong Life</td>
<td>Optimize Population Health Development</td>
</tr>
<tr>
<td><strong>Client Model</strong></td>
<td>Individual</td>
<td>Individual, Population, Community</td>
</tr>
<tr>
<td><strong>Health Production Model</strong></td>
<td>Biomedical</td>
<td>Life Course Health Development</td>
</tr>
<tr>
<td><strong>Intervention Approach</strong></td>
<td>Diagnosis, Treatment and Rehabilitation</td>
<td>Disease prevention, Preemptive Interventions, Health Promotion, Optimization</td>
</tr>
<tr>
<td><strong>Time Frames</strong></td>
<td>Short/ Episodic</td>
<td>Life Long &amp; Continuous</td>
</tr>
</tbody>
</table>
Health System Transformation Critical Path

**Acute Care System 1.0**

- Episodic Health Care
  - Sick care focus
  - Uncoordinated care
  - High Use of Emergency Care
  - Multiple clinical records
  - Fragmentation of care
- Lack integrated care networks
- Lack quality & cost performance transparency
- Poorly Coordinate Chronic Care Management

**Coordinated Seamless Healthcare System 2.0**

- Patient/Person Centered
- Transparent Cost and Quality Performance
  - Results oriented
  - Assures Access to Care
  - Improves Patient Experience
- Accountable Provider Networks Designed Around the patient
- Shared Financial Risk
- HIT integrated
- Focus on care management and preventive care
  - Primary Care Medical Homes
  - Care management/prevention focused
  - Shared Decision Making and Patient Self Management

**Community Integrated Healthcare System 3.0**

- Healthy Population Centered
  - Community Health Linked
  - Cost, Quality, and Population Transparency
  - Accessible Health Care Choices
- Community Health Integrated networks capable of addressing psycho social/economic needs
- Population based reimbursement
- Learning Organization: capable of rapid deployment of best practices
- Community Health Integrated
  - Healthy People Goal Oriented
  - Community Health Capacity Builder
  - Shared community health responsibility
- E-health and telehealth capable
  - Patient remote monitoring and management
  - Health E-Learning resources
Putting Children First = Transformative

• **New Powerful Narrative** –
  • Not healthy, not investing, broken system

• **New “game changing” Strategic Approach**

• **Transformative Tactics for Confronting**
  - Challenges – Private love, public commitment
  - Barriers – structural, organization, finance
  - Constraints – old, medically oriented, adult focused

• **Creating & Leveraging Opportunities**
  - Affordable Care Act – emerging innovations
  - Science of health development – National Children’s Study
  - New measurement tool, social networking innovations
Big, Bold and Transformative- Change

• Child Health Community needs to commit itself to Child Health 2025 Initiative
• Adopt a 3.0 Strategic Framework for Research & Health System Transformation (children lead the way)
• Make the Unnecessary Catastrophic Loss Health Potential the unavoidable & inconvenient truth of our national destiny
• Child Health Futures Network – a national innovation network designed to
  – Develop 3.0 research, delivery, organization, payment, HIT, & other innovations that will jolt the system forward
  – Prototype new models of finance & delivery
    • Child Health Trusts,
    • Community Accountable Health Systems-Kids 3.0 ACO+
Center for Healthier Children Families and Communities
http://www.healthychild.ucla.edu/
Maternal Child Health Life Course
Research Network
Http://www.lcrn.net/
Investing in the right type of Research, Innovation,& Improvement Strategies

• Fixit – fix broken parts and pieces
• Incremental Improvement
  – Evidence based improvements in care
  – Most research (RO1s) & reforms
• Transitions
  – New way of performing; Quantum leap;
  – Breakthroughs & innovations
  – Requires nudges and jolts
  – T-R0-1s, ACOs, HIT, Prevention Trust Fund,
• Transformation: Paradigm Shift
  – New Operating System
Current Model
Vertical Silos, Little Integration

Organization: Individual Health Care Delivery

Private/Self
- Health Plan A
  - Primary Care Network
    - MD
    - MD
    - MD
    - SPCLST

Employer
- Health Plan B
  - Primary Care Center
    - MD
    - MD
    - MD
  - SPCLST

Medicaid/CHIP
- Health Plan C
  - MD
  - MD
  - MD

Financing Streams
- Pop. Health / Public
  - Head Start
  - Title V

Population Health Services
- Mental Health
- Early Intervention
- School Health
- Head Start
3.0 Children’s ACO

Integrated Finance Mechanism
- Employer
- Medicaid CHIP
- Individual
- Prevention Trust Fund
- Other: Title V, HeadStart, Title X, CDC, etc

Measurement/IT System
- Decision Support and care mgmt
- Quality & Performance
- Clinical & Population Registries (surveillance and other analyses)
- Health information exchanges

Value Portfolio
- Population Health Trajectories
- Diagnosis-specific outcomes
- Geographic Outcomes
- Short/Long Term Costs Savings