Polyvictimization and the Biology of Toxic Stress:

Translating Developmental Science into Healthier Lives

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Disclaimer

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My 3 Objectives For Today

• Provide a very general overview of advances in developmental science

• Present an organizing, integrated, ecobiodevelopmental framework

• Discuss a public health approach towards the prevention of toxic stress and its lifelong consequences
**Critical Concept #1**

Childhood Adversity has Lifelong Consequences.

Significant adversity in childhood is strongly associated with unhealthy lifestyles and poor health decades later.
# ACE Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Women (n=9,367)</th>
<th>Men (n=7,970)</th>
<th>Total (n=17,337)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abuse</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Emotional</td>
<td>13.1%</td>
<td>7.6%</td>
<td>10.6%</td>
</tr>
<tr>
<td>- Physical</td>
<td>27.0%</td>
<td>29.9%</td>
<td>28.3%</td>
</tr>
<tr>
<td>- Sexual</td>
<td>24.7%</td>
<td>16.0%</td>
<td>20.7%</td>
</tr>
<tr>
<td><strong>Household Dysfunction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mother Treated Violently</td>
<td>13.7%</td>
<td>11.5%</td>
<td>12.7%</td>
</tr>
<tr>
<td>- Household Substance Abuse</td>
<td>29.5%</td>
<td>23.8%</td>
<td>26.9%</td>
</tr>
<tr>
<td>- Household Mental Illness</td>
<td>23.3%</td>
<td>14.8%</td>
<td>19.4%</td>
</tr>
<tr>
<td>- Parental Separation or Divorce</td>
<td>24.5%</td>
<td>21.8%</td>
<td>23.3%</td>
</tr>
<tr>
<td>- Incarcerated Household Member</td>
<td>5.2%</td>
<td>4.1%</td>
<td>4.7%</td>
</tr>
<tr>
<td><strong>Neglect</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Emotional</td>
<td>16.7%</td>
<td>12.4%</td>
<td>14.8%</td>
</tr>
<tr>
<td>- Physical</td>
<td>9.2%</td>
<td>10.7%</td>
<td>9.9%</td>
</tr>
</tbody>
</table>

*Wave 2 data only (n=8,667)*

Data from [www.cdc.gov/nccdphp/ace/demographics](http://www.cdc.gov/nccdphp/ace/demographics)
ACE Scores

Number of categories of adverse childhood experiences are summed ...

<table>
<thead>
<tr>
<th>ACE score</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>36%</td>
</tr>
<tr>
<td>1</td>
<td>26%</td>
</tr>
<tr>
<td>2</td>
<td>16%</td>
</tr>
<tr>
<td>3</td>
<td>9.5%</td>
</tr>
<tr>
<td>4 or more</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

• More than half (almost 2/3) have at least one ACE
• 1 in 8 have 4 or more ACEs
• Average pediatrician will see 2-4 children with an ACE score of 4 or more each day

Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.
ACEs and Obesity

AOR = 1.9 (1.6-2.2)

Prevalence (% with BMI >35)

ACE Score

Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.
ACEs and Current Smoking

AOR = 1.8 (1.5-2.1)

Also earlier onset!!

Slide modified from V. J. Felitti
ACEs and Alcoholism

AOR = 7.2 (5.9-8.9)

Also earlier onset!!

Slide modified from V. J. Felitti
ACEs and Illicit Drug Use

AOR = 4.5 (3.9-5.3)

Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.
ACEs and IV Drug Use

AOR = 11.1 (6.2-19.9)

Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.
ACEs and Promiscuity ($\geq 30$)

**AOR = 3.6 (3.0-4.4)**

Also earlier onset!!

Adapted from Anda RF et al., 2006. Eur Arch Psychiatry Clin Neurosci 256: 174-186.
Mechanisms By Which Adverse Childhood Experiences Influence Adult Health Status

The True Nature of Preventive Medicine

Slide modified from V. J. Felitti
Developing a Model of Human Health and Disease

Early childhood ecology strongly associates with lifelong developmental outcomes.

How do you begin to define or measure the ecology?

What are the mechanisms underlying these well-established associations?
Defining **Adversity or Stress**

- How do you define/measure adversity?

- Huge **individual variability**
  - **Perception** of adversity or stress (subjective)
  - **Reaction** to adversity or stress (objective)

- National Scientific Council on the Developing Child (Dr. Jack Shonkoff and colleagues)
  - **Positive** Stress
  - **Tolerable** Stress
  - **Toxic** Stress

Based on the **REACTION** (objective physiologic responses)
Defining **Adversity** or **Stress**

- **Positive** Stress
  - Brief, infrequent, mild to moderate intensity
  - Most normative childhood stress
    - Inability of the 15 month old to express their desires
    - The 2 year old who stumbles while running
    - Beginning school or daycare
    - The big project in middle school
  - **Social-emotional buffers** allow a return to **baseline**
    - (responding to non-verbal clues, consolation, reassurance, assistance in planning)
  - **Builds motivation and resiliency**
  - Positive Stress is **NOT** the **ABSENCE** of stress
Defining Adversity or Stress

- **Toxic** Stress
  - Long lasting, frequent, or strong intensity
  - More extreme precipitants of childhood stress (ACEs)
    - Physical, sexual, emotional abuse
    - Physical, emotional neglect
    - Household dysfunction
  - Insufficient social-emotional buffering
    (Deficient levels of emotion coaching, re-processing, reassurance and support)
  - Potentially permanent changes and long-term effects
    - Epigenetics (there are life long / intergenerational changes in how the genetic program is turned ON or OFF)
    - Brain architecture (the mediators of stress impact upon the mechanisms of brain development / connectivity)
Critical Concept #2

Epigenetics:

- **Which** genes are turned on/off, **when**, and **where**

- **Ecology** (environment/experience) influences how the genetic blueprint is read and utilized

- Ecological effects at the **molecular level**

- Stress-induced changes in gene expression

“**Genes** may load the gun, but the **environment** pulls the trigger”
Through epigenetic mechanisms, the early childhood ecology becomes biologically embedded, influencing how/which genes are used.
Critical Concept #3

Developmental Neuroscience:

• **Brain Architecture** is experience dependent (individual connections or “synapses” and complex circuits of connections or “pathways” are both dependent upon activity)

• **Ecology** (environment/experience) influences how brain architecture is formed and remodeled (plasticity)

• **Diminishing cellular plasticity** limits remediation

• Early childhood adversity -> **vicious cycle of stress**

• Potentially permanent alterations in brain architecture and functioning
Two Types of Plasticity

- **Synaptic Plasticity** –
  - Variation in the **STRENGTH** of individual connections
  - “from a whisper to a shout”
  - Lifelong (how old dogs learn new tricks)

- **Cellular Plasticity** –
  - Variations in the **NUMBER (or COUNT)** of connections
  - “from one person shouting to a stadium shouting”
  - Declines dramatically with age (waning by age 5)
Differential Brain Maturation

- **The Brake – PFC** (with some hippocampal help)
  Frontal lobes:
  Abstract thought, reasoning, judgment, planning, impulse and affect regulation, consequences

- **Temporal lobe (outside):**
  Processing sound and language

- **Limbic System (inside):**
  Emotions and impulsivity
  + The Gas Pedal + Amygdala

- **Brain Stem & Cranial Nerves:**
  Vital functions Swallowing

- **Cerebellum:**
  Smooth movements Coordination

- **Occipital Lobe:**
  Visual processing

- **Parietal Lobe:**
  Integration of sensory data and movement
Out of Balance?

**Prefrontal Cortex**
- Cold Cognition
- Judgmental
- Reflective
- Calculating
- Think about it

**Amygdala**
- Hot Cognition
- Emotional
- Reactive
- Impulsive
- Just do it

Biological maturity by 24

Biological maturity by 18

Adapted from Ken Winters, Ph.D.
Impact of Early Stress

- Childhood Stress
  - Hyper-responsive stress response; calm/coping
  - Chronic “fight or flight;” cortisol / norepinephrine

Changes in Brain Architecture
Declining plasticity in the developing brain results in potentially permanent alterations in brain functioning and development.
Eco-Bio-Developmental Model of Human Health and Disease

Biology
Physiologic Adaptations and Disruptions

The Basic Science of Pediatrics

Ecology
The social and physical environment

Development
Learning, Behavior, and Health

Ecology Becomes Biology, Development
And together they drive development across the lifespan
The critical challenge now is to translate game-changing advances in developmental science into effective policies and practices for families with children to improve education, health, and lifelong productivity.
Advantages of an EBD Framework

• Though grounded in developmental science, the simplicity of the EBD framework may promote understanding as well as support for translation (early investments are the right thing to do biologically).

• Psychosocial stressors and other salient features of the ecology are every bit as biological as nutrition or lead (no distinction between mental and physical health, just healthy vs. unhealthy development).

• Emphasizes the dimension of time – to reflect the ongoing, cumulative nature of benefits and threats to health and wellness.
Development results from an on-going, re-iterative, and cumulative dance between nurture and nature.
Advantages of an EBD Framework

• Underscores the need to improve the early childhood ecology in order to:
  – Mitigate the biological underpinnings for educational, health and economic disparities
  – Improve developmental/life-course trajectories
    • Changing the early childhood ecology will require a PUBLIC HEALTH approach!!

• Highlights the pivotal role of toxic stress
  – Not just “step on the gas” or enrichment
  – But “take off the brake” by treating, mitigating or immunizing against toxic stress
Reinventing the Wheel - All over again?

Models

Maslow's Hierarchy of Needs
(Theoretical - 1943)

Needs

Self-Actualization
Need to know, explore and understand

Unmet needs are potential sources of STRESS!!
Linking **Childhood Experiences** and **Adult Outcomes**

- **Childhood Adversity**
- **Toxic Stress**
  - Epigenetic Modifications
  - Disruptions in Brain Architecture
  - Behavioral Allostasis
- **Poor Adult Outcomes**
The **BIG** Questions are...

If **TOXIC STRESS** is the missing link between **ACE exposure** and **poor adult outcomes**, it raises the following **BIG** questions:

- Are there ways to:
  - treat,
  - mitigate, and/or
  - immunize against the effects of toxic stress?

- If so, is there a mismatch between:
  - what we **KNOW** ... and ...  
  - what we actually **DO**?  

(If there is time!)
Addressing **Toxic** Stress

- **Treatment** of the consequences
  - TF-CBT and PCIT are evidence-based
  - **Reactive** – some “damage” already done!
  - Efficacy linked to age and chronicity
    - Declining brain plasticity?
  - Can be **costly**
  - Insufficient **number** of / **access** to providers
    - Limited reimbursements; carve-outs
- Mental Health **Parity**?
- Persistent **STIGMA**
  - “Character Flaws” vs “Biological Mal-adaptations”
Addressing Toxic Stress

- **Secondary / Targeted Preventions**
  - Focused, targeted interventions for those deemed to be “at high risk”
  - Visiting Nurse Programs (Nurse Family Partner.)
  - Parenting Programs (Triple-P, Nurturing Parent.)
  - More likely to be effective; minimize “damage”
  - Requires screening
  - Still issues with stigma, numbers of/access to providers
Addressing *Toxic* Stress

- **Primary / Universal Prevention**
  - Proactive, universal interventions to make stress *positive*, or tolerable instead of toxic
  - Acknowledges that preventing all childhood adversity is *impossible* and even *undesirable*
  - **Actively building resiliency** (“immunizing” through positive parenting, 7C’s, promoting optimism, formalized social-emotional learning)
  - **SE Buffers** allow the physiologic stress response to return to baseline
    - **Parenting/Caregiving** skills for younger children
    - **SEL** skills for older children (*www.casel.org*)
Social-Emotional Skills Can Be Taught / Learned

Illinois Learning Standards

Social/Emotional Learning (SEL)

The standards describe the content and skills for students in grades K - 12 for social and emotional learning. Each standard includes five benchmark levels that describe what students should know and be able to do in early elementary (grades K - 3), late elementary (grades 4 - 6), middle/junior high (grades 6 - 8), early high school (grades 9 -10), and late high school (grades 11 -12). These standards build on the Illinois Social/Emotional Development Standards of the Illinois Early Learning Standards.

These standards have been developed in accordance with Section 15(a) of Public Act 93-0495. This Act calls upon the Illinois State Board of Education to “develop and implement a plan to incorporate social and emotional development standards as part of the Illinois Learning Standards.”

Introduction

Goals
- Goal 1 - Develop self-awareness and self-management skills to achieve school and life success.
- Goal 2 - Use social-awareness and interpersonal skills to establish and maintain positive relationships.

Navigation:
- Social/Emotional Learning Goals & Standards
- Social/Emotional Learning Descriptors
- Social/Emotional Learning Resources
- Illinois Assessment Frameworks
- ISBE Home
Critical Concept #5

SOCIAL-EMOTIONAL SKILLS...
(a.k.a – Affect Regulation, Non-Cognitive Skills, Mindfulness)

...Are learned (they can be modeled, nurtured, taught, practiced, and reinforced)

...Effectively buffer against toxic stress
(by helping to turn off the physiologic stress response)

...Increase test scores
(an average of 11 points by meta-analysis!)
Parenting as **Primary Prevention**

- Promoting **Parenting Skills** in the first 1000 days
  - Parenting is personal – makes pediatricians **NERVOUS**!
  - “Positive/Nurturing/Supportive” Parenting
  - A Poor investment?
    - Are parenting skills “teachable?” **YES!!**
    - Is there a “ceiling effect” on returns?
  - Or the “Gold Standard?”
    - Shouldn’t this be THE reference point (NOT routine, general, or control populations)

- Recent article from Luby *et al.*, PNAS
  - **Maternal support** and **Child depression severity** at ages 3-5
    - “Waiting Test” assessed the dyad (Bright Gift + Parental Surveys)
  - **Hippocampal volumes** at school age (7-13)
• Early maternal support exerts a positive influence on hippocampal development
• The positive effect of maternal support on hippocampal volumes was greater in nondepressed children

Luby et al., 2012. Available at: www.pnas.org/cgi/doi/10.1073/pnas.1118003109
Critical Concept #6

For young children, **parent/caregiver support is critical**: 

- Turns off physiologic stress response by **addressing physiologic and safety needs** (**PROTECT** = Maslow levels 1+2)
- Turns off the physiologic stress response by **promoting healthy relationships and attachment** (**RELATE** = Maslow level 3)
- Notes and encourages **foundational coping skills** as they emerge (**NURTURE** = Maslow levels 4+5)

**Early Childhood Professionals** are ideally placed to:

- Promote this sort of “Purposeful” Parenting
- Advocate / participate **public health approach** to address TS
Social-Emotional Safety Nets
A Public Health Approach to “Toxic Stress”

Universal Primary Preventions
Anticipatory guidance
Consistent messaging (CTC)
No identification
No stigma
Ceiling effects = Limited evidence base

Targeted Interventions
(for those “at risk”)
Nursing home visits (NFP)
Parenting programs (PPP)
Early Intervention
Less ceiling = More evidence
Requires screening
Issues with stigma

Evidence-Based Treatments
(for the symptomatic)
PCIT; TB-CBT; Pharmacotx
Treatment works!
Screening / stigma / access
Public Health Implications

- ACE data provide a working model for understanding and addressing the childhood antecedents of adult disease.

- Is there a gap between what we do and what we know?

- What we DO:
  - 95% of the trillions of dollars that we spend on health is on treatment and NOT prevention.
Public Health Implications

• What we **KNOW**:
  
  – That **70% of early deaths are preventable**, with...

  – The **majority (40% overall)** due to **behavioral patterns** that lead to **chronic disease**.

  – **Behavioral Allostasis** due to toxic stress?

McGinnis, Williams-Russo and Knickman, 2002
**Proximal Causes of Death: Chronic Disease**

**EXHIBIT 2**
Total Deaths And Age-Adjusted Death Rates (Per 100,000 Population) For The Fifteen Leading Causes Of Death In The Total U.S. Population, 2003

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Number of Deaths (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases of heart</td>
<td>(232.3)</td>
</tr>
<tr>
<td>Malignant neoplasms (cancer)</td>
<td>(190.1)</td>
</tr>
<tr>
<td>Cerebrovascular diseases (stroke)</td>
<td>(53.5)</td>
</tr>
<tr>
<td>Chronic lower respiratory diseases</td>
<td>(43.3)</td>
</tr>
<tr>
<td>Accidents (unintentional injuries)</td>
<td>(37.3)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>(25.3)</td>
</tr>
<tr>
<td>Influenza and pneumonia</td>
<td>(22.0)</td>
</tr>
<tr>
<td>Alzheimer’s disease</td>
<td>(21.4)</td>
</tr>
<tr>
<td>Nephritis, nephrotic syndrome, nephrosis</td>
<td>(14.4)</td>
</tr>
<tr>
<td>Septicemia</td>
<td>(11.6)</td>
</tr>
<tr>
<td>Intentional self-harm (suicide)</td>
<td>(10.8)</td>
</tr>
<tr>
<td>Chronic liver disease and cirrhosis</td>
<td>(9.3)</td>
</tr>
<tr>
<td>Essential hypertension/hypertensive renal disease</td>
<td>(7.4)</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>(6.2)</td>
</tr>
<tr>
<td>Assault (homicide)</td>
<td>(6.0)</td>
</tr>
</tbody>
</table>


**NOTE:** Numbers in parentheses are age-adjusted death rates per 100,000 population.

Acute causes of death are the exception, not the rule
Distal Causes of Death: Unhealthy Lifestyles

Table 2. Actual Causes of Death in the United States in 1990 and 2000

<table>
<thead>
<tr>
<th>Actual Cause</th>
<th>No. (%) in 1990*</th>
<th>No. (%) in 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>400 000 (19)</td>
<td>435 000 (18.1)</td>
</tr>
<tr>
<td>Poor diet and physical inactivity</td>
<td>300 000 (14)</td>
<td>400 000 (16.6)</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>100 000 (5)</td>
<td>85 000 (3.5)</td>
</tr>
<tr>
<td>Microbial agents</td>
<td>90 000 (4)</td>
<td>75 000 (3.1)</td>
</tr>
<tr>
<td>Toxic agents</td>
<td>60 000 (3)</td>
<td>55 000 (2.3)</td>
</tr>
<tr>
<td>Motor vehicle</td>
<td>25 000 (1)</td>
<td>43 000 (1.8)</td>
</tr>
<tr>
<td>Firearms</td>
<td>35 000 (2)</td>
<td>29 000 (1.2)</td>
</tr>
<tr>
<td>Sexual behavior</td>
<td>30 000 (1)</td>
<td>20 000 (0.8)</td>
</tr>
<tr>
<td>Illicit drug use</td>
<td>20 000 (&lt;1)</td>
<td>17 000 (0.7)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1 060 000 (50)</strong></td>
<td><strong>1 159 000 (48.2)</strong></td>
</tr>
</tbody>
</table>

*Data are from McGinnis and Foege. The percentages are for all deaths.

If these unhealthy lifestyles are manifestations of behavioral allostasis, a **FUNDAMENTAL** cause of death is **TOXIC STRESS**!
By 2030, **90%** of the morbidity in high income countries will be due to **Non-Communicable Diseases**.

- NCDs are related to **unhealthy behaviors** (overeating, smoking, alcohol, promiscuity, and illicit drugs)

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**Fig. 1.** The proportional distribution of disability-adjusted life-years, contributable to infectious diseases and NCDs for (top) the world, (middle) high-income countries, and (bottom) low-income countries for 2002 and 2030 (3).
How do those automatic processes form in the first place!?
A **Public Health** Dilemma:

Do we continue to treat **disease**, the **unhealthy lifestyles** that lead to disease, or the **TOXIC STRESS** that leads to the adoption of unhealthy lifestyles??
A **Public Health** Parable:

- Man by the river hears someone **drowning**
- Being a good swimmer, he **rescues** the person
- Before catching his breath, he hears another **another** in need, and **another** and **another**...
- The man, exhausted, begins to **walk away**
- Asked where he’s going, he responds...
A Public Health Parable:

“I’m going upstream to prevent others from falling in!!”
What is Toxic Stress?

- A physiologic stress response that is excessive or prolonged (reflects an inability to “turn it off”)

- Results in potentially permanent changes in:
  - Gene expression (epigenetics)
  - Brain development (neuroscience)
  - Behavior (allostasis)
SUMMARY

Why should I care?

- **Toxic stress** is a **MEDIATOR** between early childhood **adversity** and less than optimal outcomes in **learning**, **behavior** and **health**

- Understanding the **BIOLOGY** underlying these well established associations opens up new opportunities for **primary prevention** and **early intervention**
Linking **Childhood Experiences** and **Adult Outcomes**

- **Childhood Adversity**
- **Poor Adult Outcomes**

Advocacy to minimize childhood adversity (e.g. - efforts to address poverty, food scarcity, domestic violence, parental substance abuse)

Health and social services to deal with adverse outcomes (e.g. - efforts to address the behavioral, social, health and economic consequences)
Linking Childhood Experiences and Adult Outcomes

**Toxic Stress**
- Epigenetic Modifications
- Disruptions in Brain Architecture

**Behavioral Allostasis**
- Maladaptive behaviors
- Non-communicable Diseases

Improve caregiver/community capacity to prevent or minimize toxic stress (e.g. efforts to promote the safe, stable and nurturing relationships that turn off the physiologic stress response)

Improve caregiver/community capacity to promote healthy, adaptive coping skills (e.g. efforts to encourage rudimentary but foundational SE, language, and cognitive skills)
SUMMARY

• What can I do?
  – **Understand** the **ecobiodevelopmental framework** (advocate for a public health approach to address toxic stress)
  – **Help** children figure out **how to turn off** their stress response (in a healthy way!)
  – **Intervene early** for those children who are at high risk or appear **unable to turn off** their stress response
CONCLUSION:

It is easier to build strong children than to repair broken men.

Frederick Douglass