

THE TRUTH ABOUT ACEs

WHAT ARE THEY?

ACEs are
ADVERSE
CHILDHOOD
EXPERIENCES

The three types of ACEs include

ABUSE



Physical



Emotional



Sexual

NEGLECT



Physical

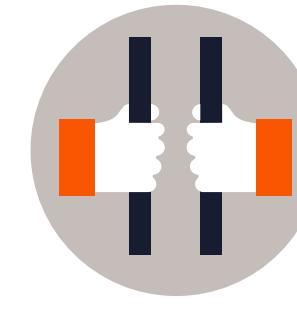


Emotional

HOUSEHOLD DYSFUNCTION



Mental Illness



Incarcerated Relative



Mother treated violently



Substance Abuse

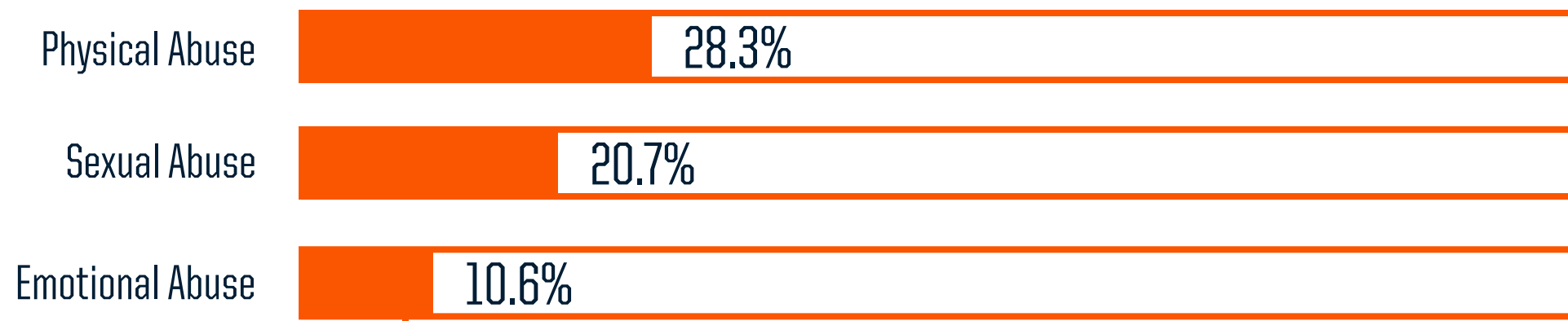


Divorce

HOW PREVALENT ARE ACEs?

The ACE study* revealed the following estimates:

ABUSE

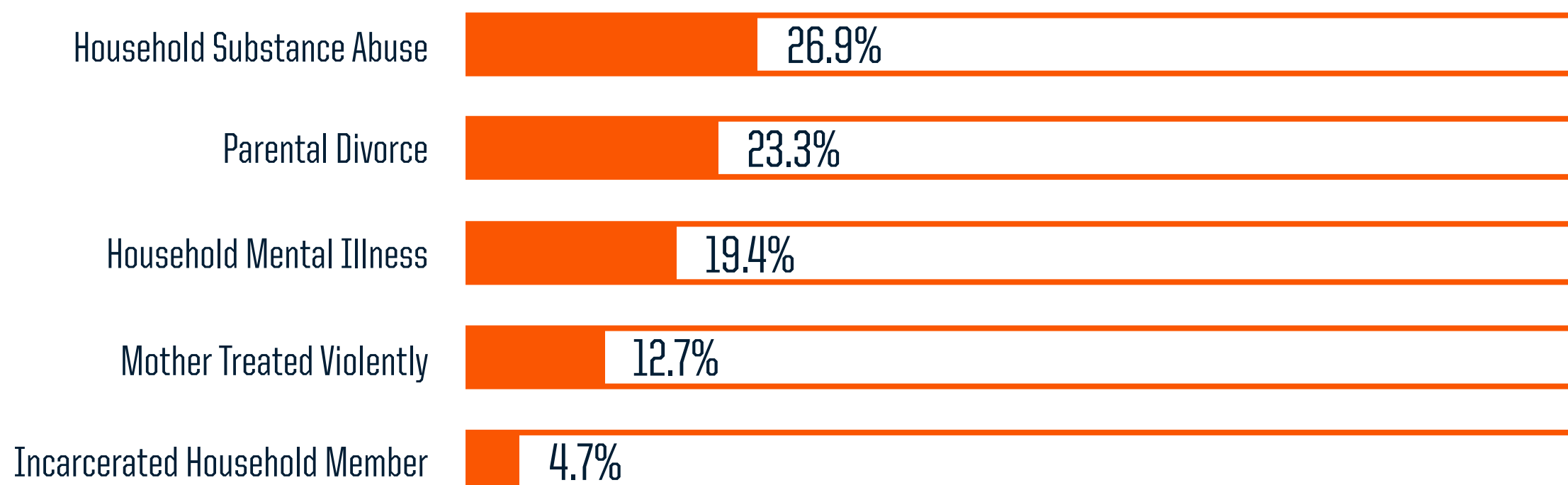


percentage of study participants that experienced a specific ACE

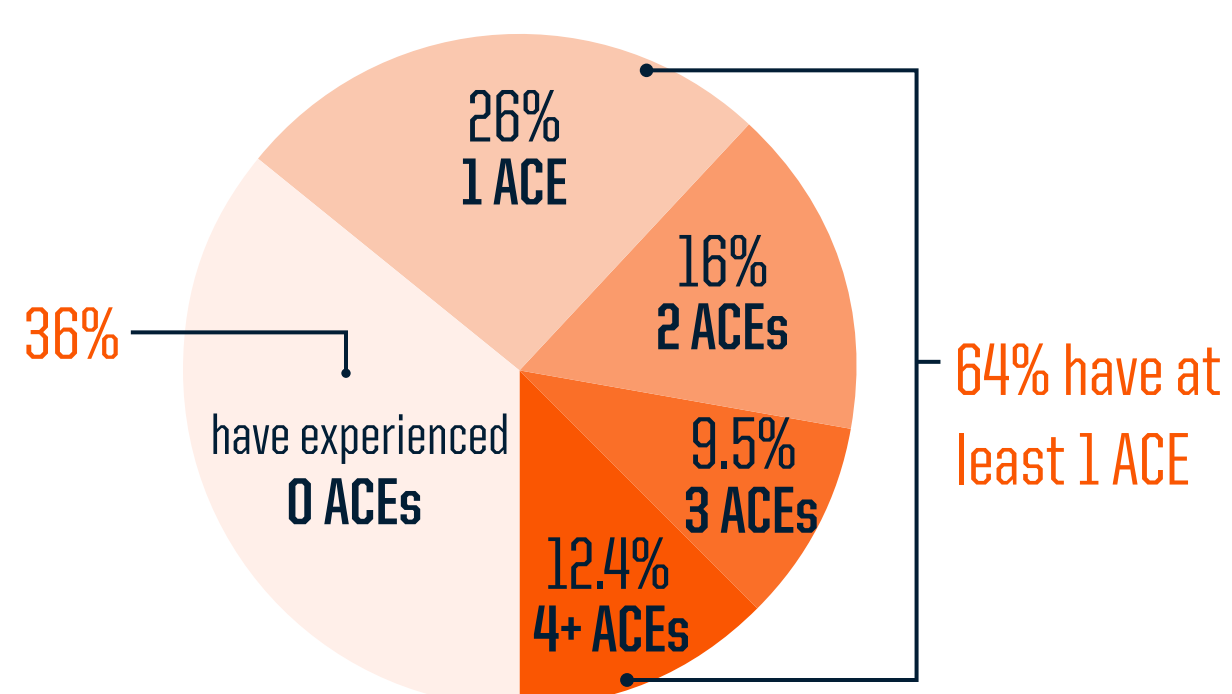
NEGLECT



HOUSEHOLD DYSFUNCTION

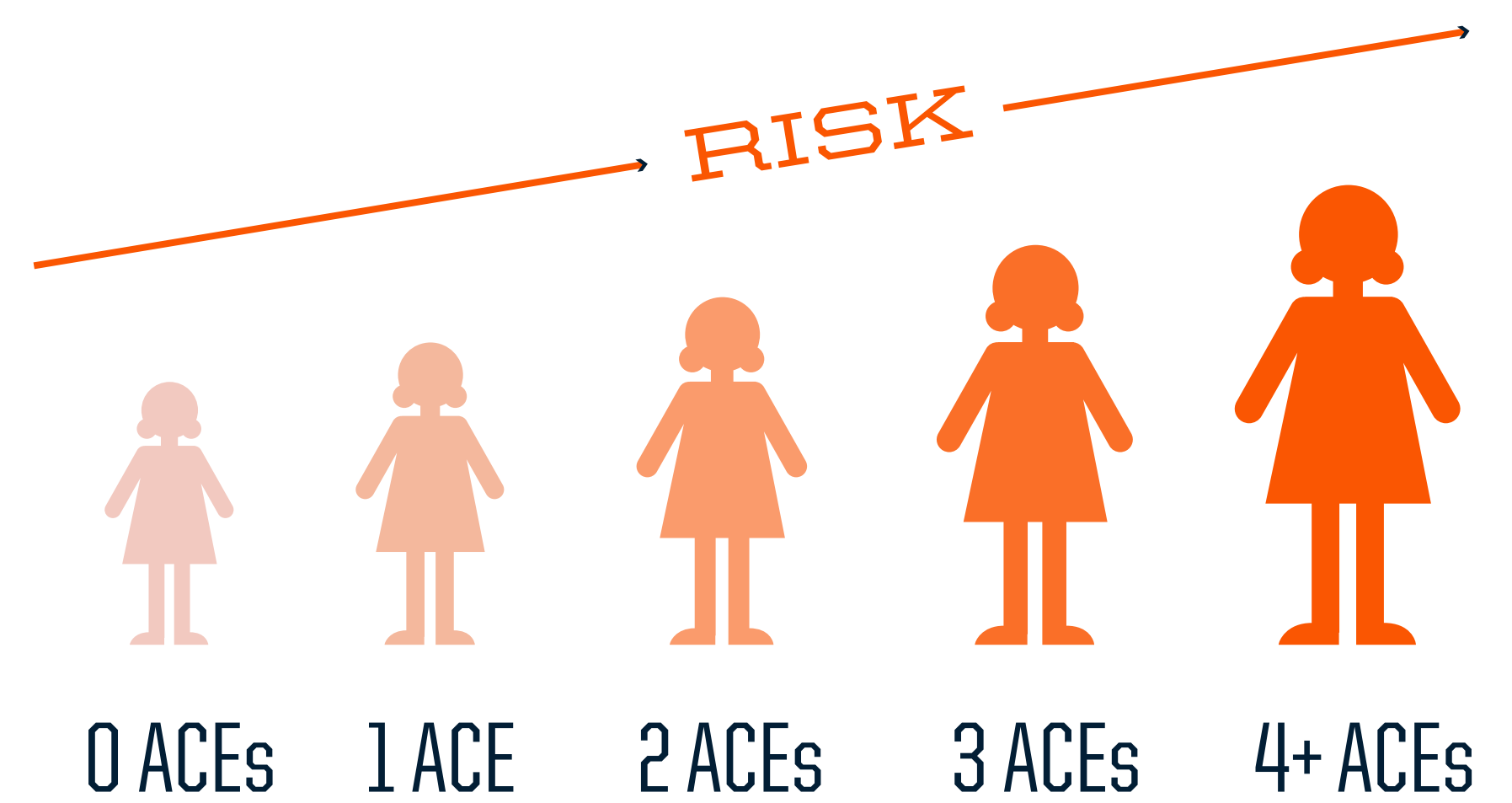


Of 17,000 ACE study participants:



WHAT IMPACT DO ACEs HAVE?

As the number of ACEs increases, so does the risk for negative health outcomes

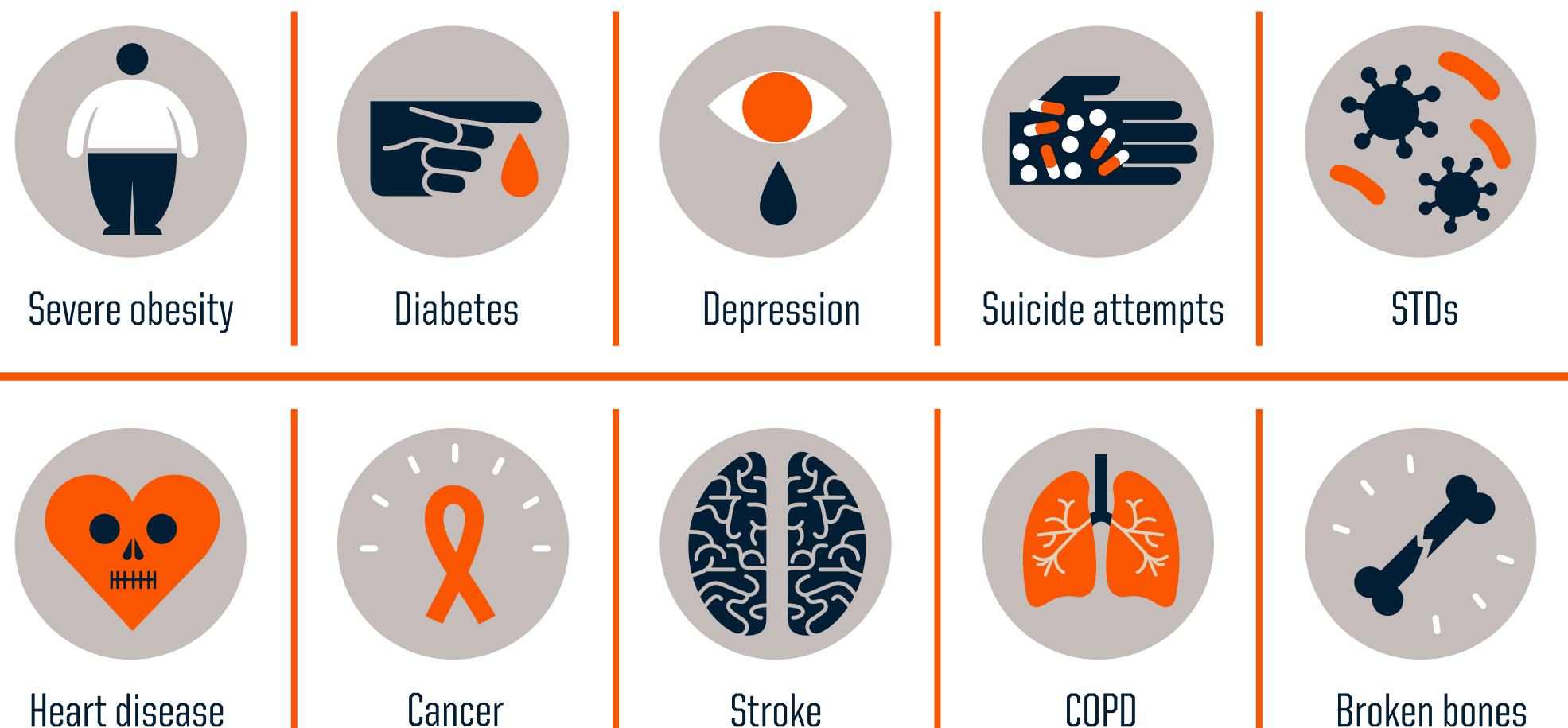


Possible Risk Outcomes:

BEHAVIOR



PHYSICAL & MENTAL HEALTH



Adverse Childhood Experience (ACE) Questionnaire

Finding your ACE Score ra hbr 10 24 06

While you were growing up, during your first 18 years of life:

1. Did a parent or other adult in the household **often** ...
Swear at you, insult you, put you down, or humiliate you?
or
Act in a way that made you afraid that you might be physically hurt?
Yes No If yes enter 1 _____
2. Did a parent or other adult in the household **often** ...
Push, grab, slap, or throw something at you?
or
Ever hit you so hard that you had marks or were injured?
Yes No If yes enter 1 _____
3. Did an adult or person at least 5 years older than you **ever**...
Touch or fondle you or have you touch their body in a sexual way?
or
Try to or actually have oral, anal, or vaginal sex with you?
Yes No If yes enter 1 _____
4. Did you **often** feel that ...
No one in your family loved you or thought you were important or special?
or
Your family didn't look out for each other, feel close to each other, or support each other?
Yes No If yes enter 1 _____
5. Did you **often** feel that ...
You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you?
or
Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?
Yes No If yes enter 1 _____
6. Were your parents **ever** separated or divorced?
Yes No If yes enter 1 _____
7. Was your mother or stepmother:
Often pushed, grabbed, slapped, or had something thrown at her?
or
Sometimes or often kicked, bitten, hit with a fist, or hit with something hard?
or
Ever repeatedly hit over at least a few minutes or threatened with a gun or knife?
Yes No If yes enter 1 _____
8. Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?
Yes No If yes enter 1 _____
9. Was a household member depressed or mentally ill or did a household member attempt suicide?
Yes No If yes enter 1 _____
10. Did a household member go to prison?
Yes No If yes enter 1 _____

Now add up your "Yes" answers: _____ This is your ACE Score

NCTSN

The National Child
Traumatic Stress Network



Complex Trauma in Children and Adolescents

White Paper from the
National Child Traumatic Stress Network
Complex Trauma Task Force

This project was funded by the Substance Abuse and Mental Health Services
Administration, U.S. Department of Health and Human Services

Complex Trauma in Children and Adolescents
White Paper
from the
National Child Traumatic Stress Network
Complex Trauma Task Force

Editors: Alexandra Cook, Ph.D., Margaret Blaustein, Ph.D., Joseph Spinazzola, Ph.D., and
Bessel van der Kolk, M.D.

Contributors: Margaret Blaustein, Ph.D.,^{1,2} Alexandra Cook, Ph.D.,^{1,2} Marylene Cloitre, Ph.D.,³ Ruth DeRosa, Ph.D.,⁴ Julian Ford, Ph.D.,⁵ Michele Henderson, LICSW,^{1,2} Rebecca Hubbard, LMFT,⁶ Kristine Jentoft, LICSW,¹ Cheryl Lanktree, Ph.D.,⁷ Jill Levitt, Ph. D.,³ Joan Liataud, Psy.D.,⁸ Erna Olafson, Ph.D., Psy.D.,⁹ Richard Kagan, Ph.D.,¹⁰ Karen Mallah, Ph.D.,¹¹ Dan Medeiros, M.D.,¹² David Pelcovitz, Ph.D.,⁴ Paul Pagones, M.Ed.⁸ Frank Putnam, M.D.,⁹ Raul Silva, M.D.,³ Sabina Singh, M.D.,¹² Stefanie Smith, Ph.D.,¹ Joseph Spinazzola, Ph.D.,^{1,2} Bessel van der Kolk, M.D.^{1,2}

Affiliations: 1Trauma Center, Massachusetts Mental Health Institute; 2National Center on Family Homelessness; 3New York University/Child Study Center Institute for Urban Trauma; 4North Shore University Hospital Adolescent Trauma Treatment Development Center, 5Yale/University of Connecticut Center for Children Exposed to Violence; 6Directions for Mental Health, Inc., 7Miller Children’s Abuse and Violence Intervention Center; 8Heartland Health Outreach International FACES; 9Child Abuse Trauma Treatment Replication Center, Cincinnati Children’s Hospital; 10Parsons Child Trauma Study Center; 11Family Trauma Treatment Program, Mental Health Corp of Denver; 12Mount Sinai Adolescent Health Center.

The authors wish to acknowledge the invaluable feedback, support, and technical assistance of Robert Pynoos, John Fairbank, William Harris, Lisa Amaya Jackson, Jenifer Wood, Debbie Ling, Melissa Brymer, Judy Holland, Christine Siegfried, Becky Warlick, Marla Zucker, Julie Foss, the Learning from Research and Clinical Practice Core, and the staffs of the National Center for Child Traumatic Stress and the Duke Clinical Research Institute. This project was supported by the SAMHSA grants U79 SM 54284, 54587, 54254, 54251, 54318, 54314, 54272, 54282, 54292, 54276, 54300, and 54311; as well as by SAMHSA grant UD1 SM56111.

National Child Traumatic Stress Network

www.NCTSNet.org

2003

The National Child Traumatic Stress Network is coordinated by the National Center for Child Traumatic Stress, Los Angeles, Calif., and Durham, N.C.

This project was funded by the Substance Abuse and Mental Health Services Administration (SAMHSA), U.S. Department of Health and Human Services (HHS). The views, policies, and opinions expressed are those of the authors and do not necessarily reflect those of SAMHSA or HHS.

Illustration Credits: Cover art and illustrations featured throughout text were selected from submissions to a drawing contest on how children cope with difficult experiences. All artists were children or adolescents receiving therapeutic services at the Trauma Center, Allston, MA. All illustrations used by permission of the children and their legal guardians.

Correspondence to Dr. Spinazzola, The Trauma Center, 14 Fordham Rd., Allston, MA, 02134.
E-mail: spinazzola@traumacenter.org

Table of Contents

Vignette	4
What is Complex Trauma?	5
The Cost of Child Complex Trauma	5
Diagnostic Issues for Complex Trauma in Children	6
Table 1: Domains of Impairment in Children Exposed To Complex Trauma	7
Impact of Complex Trauma on Development	8
Adaptation to Complex Trauma in Familial Context	16
Adaptation to Complex Trauma in Ethnocultural Context	18
Coping and Protective Factors	20
Approaches to Comprehensive Assessment of Complex Trauma in Children	21
Approaches to Treatment of Complex Trauma in Children	23
Recommendations and Future Directions	28
National Child Traumatic Stress Network Complex Trauma Survey	30
References	34

Vignette

Michael is a 14-year-old Caucasian boy who was placed with his maternal grandparents after he and his two younger siblings were removed from the home of their biological parents. Although multiple reports had been made to Child Protective Services, there had been insufficient evidence to remove the children because neither Michael nor his siblings had been willing to speak with authorities. At the age of 11, however, Michael showed his school guidance counselor some bruises, stating that his father had hurt him and that he didn't want to go home anymore. He and his two siblings were removed that day. Following their removal from the home, the children described: frequent fights in which their parents screamed and threw things; unpredictable violence by their father, including his hitting them with a miniature baseball bat; being isolated and denied food and water for over a day at a time; and ongoing substance use by both parents. The youngest sibling reported that his father had touched his private parts. Although both older siblings denied any memory of sexual abuse, Michael was found to have a sexually transmitted disease on physical exam. All three children indicated that Michael had been particularly targeted in the home, with each parent aligning with one of the other siblings. Michael was frequently restricted to his room, and both of his parents made statements blaming him for the family's problems. Michael reported that he purposefully made himself a target to protect his younger siblings from being hurt. Based on the children's statements, their father was charged and criminally prosecuted for assault and battery against his two older children.

After their removal from the home, the three siblings were separated. After court proceedings terminated parental rights, the youngest sibling was placed in a pre-adoptive foster home, and the two oldest were placed in different relatives' homes. Michael initially presented as withdrawn and quiet after removal and placement with his maternal grandmother. He spent long periods alone in his room and created an inner world that he scrupulously hid from his grandmother. Although he was polite and cooperative with adults, he had difficulty with peer relationships and was unable to sustain involvement in activities. Despite testing which indicated that he had an above average IQ with no evidence of learning disability, Michael consistently received failing grades in his classes, due in large part to a refusal to complete homework assignments. Michael also suffered from repeated migraine headaches, and numerous tests had ruled out a physical etiology. At night, Michael surrounded himself with stuffed animals, stating that they made him feel safer.

Michael's behavior became increasingly dysregulated after his middle sibling was placed in the home with him; he was strongly reactive to indications that she was receiving more attention than him and became easily angered by her statements. He stated in therapy that being around his sister was like "all this old stuff coming back again." His presentation shifted from constricted to volatile, with frequent angry outbursts, verbal and physical aggression toward family members, and multiple indications of arousal (e.g., difficulty sleeping, impaired concentration, edginess and irritability). His grandmother, who had her own history of childhood trauma, became increasingly depressed and overwhelmed by his emotional outbursts and had difficulty providing consistent caretaking to either sibling. Child Protective Services became re-involved and considered more intensive level of care for each sibling.

What Is Complex Trauma?

The term complex trauma describes the dual problem of children's exposure to traumatic events and the impact of this exposure on immediate and long-term outcomes. Complex traumatic exposure refers to children's experiences of multiple traumatic events that occur within the caregiving system – the social environment that is supposed to be the source of safety and stability in a child's life. Typically, complex trauma exposure refers to the simultaneous or sequential occurrences of child maltreatment—including emotional abuse and neglect, sexual abuse, physical abuse, and witnessing domestic violence—that are chronic and begin in early childhood. Moreover, the initial traumatic experiences (e.g., parental neglect and emotional abuse) and the resulting emotional dysregulation, loss of a safe base, loss of direction, and inability to detect or respond to danger cues, often lead to subsequent trauma exposure (e.g., physical and sexual abuse, or community violence).

Complex trauma outcomes refer to the range of clinical symptomatology that appears after such exposures. Exposure to traumatic stress in early life is associated with enduring sequelae that not only incorporate, but also extend beyond, Posttraumatic Stress Disorder (PTSD). These sequelae span multiple domains of impairment and include: (a) self-regulatory, attachment, anxiety, and affective disorders in infancy and childhood; (b) addictions, aggression, social helplessness and eating disorders; (c) dissociative, somatoform, cardiovascular, metabolic, and immunological disorders; (d) sexual disorders in adolescence and adulthood; and (e) revictimization (Dube, Anda, Felitti, Chapman, et al., 2001; Dube, Anda, Felitti, Croft

et al., 2001; Felitti et al., 1998; Gordon, 2002; Herman, Perry, & van der Kolk, 1989; Lyons-Ruth & Jacobovitz, 1999; Simpson & Miller, 2002; van der Kolk, Roth, Pelcovitz, Mandel, & Spinazzola, in press; Yehuda, Spertus, & Golier, 2001).

The Cost of Child Complex Trauma

Exposure to complex trauma in children carries an enormous cost to society, both in lives impacted and dollars spent. Although in many ways the costs are inestimable, the repercussions of childhood trauma may be measured in medical costs, mental health utilization, societal cost, and the psychological toll on its victims.

Incidence of childhood abuse and neglect may be estimated from the records of public Child Protection Service agencies and from national epidemiological research. Although both methods are thought to underestimate actual trauma incidence, the rising incidence of childhood maltreatment is indisputable even when relying upon the most conservative estimates gleaned from official records. In 2001, according to the National Child Abuse and Neglect Data System developed by the Children's Bureau of the U.S. Department of Human Services, 903,000 cases of child maltreatment were substantiated, including neglect, medical neglect, physical abuse, sexual abuse, and psychological maltreatment.

Epidemiological research has yielded evidence of considerably higher incidence of children's exposure to complex trauma. The Third National Incidence Study of Child Abuse and Neglect (NIS-3; 1996), a congressionally mandated study, examined incidence of abuse and neglect using a nationally representative sample of

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

5,600 professionals spanning 842 agencies in 42 counties (Sedlak & Broadhurst, 1996). Using the Harm Standard, which includes only children who have already experienced harm from abuse or neglect, an estimated 1,553,800 children were abused or neglected in 1993. This figure includes 217,700 sexually abused children, 338,900 physically neglected children, 212,800 emotionally neglected children, and 381,700 physically abused children. Using the Endangerment Standard, defined as children who experience abuse or neglect that puts them at risk of harm, the estimated incidence of child abuse or neglect in 1993 nearly doubled (2,815,600 children). These rates reflect sharp increases from the previous NIS-2 study in 1986; the total number of abused or neglected children based upon both the Harm and Endangerment Standards quadrupled between 1986 and 1993.

Using the Harm Standard incidence numbers from NIS-3, the total annual cost of child abuse and neglect has been estimated at 94 billion dollars (Fromm, 2001). Direct costs associated with child abuse and neglect (24.4 billion dollars) included hospitalization, chronic health problems, mental health, child welfare, law enforcement, and judicial system costs. Indirect costs (69.7 billion dollars) included special education, juvenile delinquency, adult mental health and health care, lost productivity to society, and adult criminality. The daily cost of childhood abuse and neglect is estimated to be \$258 million (Pelletier, 2001).

Diagnostic Issues for Complex Trauma

The current psychiatric diagnostic classification system does not have an adequate category to capture the full range of difficulties that traumatized children experience. Although the

narrowly defined PTSD diagnosis is often used, it rarely captures the extent of the developmental impact of multiple and chronic trauma exposure. Other diagnoses common in abused and neglected children include Depression, Attention Deficit Hyperactivity Disorder (ADHD), Oppositional Defiant Disorder (ODD), Conduct Disorder, Generalized Anxiety Disorder, Separation Anxiety Disorder, and Reactive Attachment Disorder. Each of these diagnoses captures an aspect of the traumatized child's experience, but frequently does not represent the whole picture. As a result, treatment often focuses on the particular behavior identified, rather than on the core deficits that underlie the presentation of complexly traumatized children.

An Organizing Framework of Complex Trauma Outcomes in Children

The present paper highlights seven primary domains of impairment observed in children exposed to complex trauma. These phenomenologically based domains have been identified based on the extant child clinical and research literatures, the adult research on "Disorders of Extreme Stress Not Otherwise Specified" (Pelcovitz et al, 1997; van der Kolk, Pelcovitz, Roth, Mandel, McFarlane, & Herman, 1996; van der Kolk, Roth, et al., in press), and the combined expertise of the NCTSN Complex Trauma Taskforce. These domains of impairment include: (I) Attachment; (II) Biology; (III) Affect regulation; (IV) Dissociation; (V) Behavioral regulation; (VI) Cognition; and (VII) Self-concept. Impairment is considered to occur within a developmental context and in turn to impact further development. Table 1 provides a list of each domain along with examples of associated symptoms. Valid diagnostic classification of complex trauma sequelae in children awaits formal epidemiological research. However, we believe that this phenomenologically based framework for the impact of complex trauma exposure possesses sufficient clinical utility to

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

serve as a vitally needed starting place for research, treatment development, and policy

initiatives bearing on children's adaptation to complex trauma exposure.

**Table 1:
Domains of Impairment in Children Exposed to Complex Trauma**

I. Attachment

Uncertainty about the reliability and predictability of the world
Problems with boundaries
Distrust and suspiciousness
Social isolation
Interpersonal difficulties
Difficulty attuning to other people's emotional states
Difficulty with perspective taking
Difficulty enlisting other people as allies

II. Biology

Sensorimotor developmental problems
Hypersensitivity to physical contact
Analgesia
Problems with coordination, balance, body tone
Difficulties localizing skin contact
Somatization
Increased medical problems across a wide span, e.g., pelvic pain, asthma, skin problems, autoimmune disorders, pseudoseizures

III. Affect Regulation

Difficulty with emotional self-regulation
Difficulty describing feelings and internal experience
Problems knowing and describing internal states
Difficulty communicating wishes and desires

IV. Dissociation

Distinct alterations in states of consciousness
Amnesia
Depersonalization and derealization
Two or more distinct states of consciousness, with impaired memory for state-based events

V. Behavioral Control

Poor modulation of impulses
Self-destructive behavior
Aggression against others
Pathological self-soothing behaviors
Sleep disturbances
Eating disorders
Substance abuse
Excessive compliance
Oppositional behavior
Difficulty understanding and complying with rules
Communication of traumatic past by reenactment in day-to-day behavior or play (sexual, aggressive, etc.)

VI. Cognition

Difficulties in attention regulation and executive functioning
Lack of sustained curiosity
Problems with processing novel information
Problems focusing on and completing tasks
Problems with object constancy
Difficulty planning and anticipating
Problems understanding own contribution to what happens to them
Learning difficulties
Problems with language development
Problems with orientation in time and space
Acoustic and visual perceptual problems
Impaired comprehension of complex visual-spatial patterns

VII. Self-Concept

Lack of a continuous, predictable sense of self
Poor sense of separateness
Disturbances of body image
Low self-esteem
Shame and guilt

Impact of Complex Trauma on Development

Complex trauma outcomes are most likely to develop and persist if an infant or child is exposed to danger that is unpredictable and uncontrollable because the child's body must allocate resources that are normally dedicated to growth and development instead to survival (Ford, in press; van der Kolk, in press). The greatest source of danger, unpredictability, and uncontrollability for an infant or young child is the absence of a caregiver who reliably and responsively protects and nurtures the child (Cicchetti and Lynch, 1995). The caregiver's ability to help regulate bodily and behavioral responses provides experiences in "co-regulation" that contribute to the acquisition of self-regulatory capacities (Schoore, 2002; Siegel, 1999). Lack of sustaining regulation with a primary caregiver puts the child at risk for inadequate development of the capacity to regulate physical and emotional states.

Hence, when examining traumatized children, the status of the attachment relationship is often a critical element. In the current conceptualizations of traumatic stress in children, little effort has been spent on distinguishing between the impact of specific traumatic events and that of disruptions in the attachment relationship. In order to understand the behavior of these children and to formulate an adequate treatment plan, the impact of disruptions in the early caregiving relationship must be integrated into developmental models of trauma exposure and outcome.

Attachment

The early caregiving relationship provides a relational context in which children develop their earliest models of self, other, and self in relation to others. This attachment relationship also

provides the scaffolding for the growth of many developmental competencies, including the capacity for self-regulation, the safety with which to explore the environment, early knowledge of agency (i.e., the capacity to exert an influence on the world), and early capacities for receptive and expressive communication. The child-caregiver relationship can be the *source* of the trauma, and/or it can be greatly impacted by another type of traumatic exposure; therefore, many of these critical developmental competencies are disrupted.

A *secure* attachment pattern, present in approximately 55-65% of the normative population, is thought to be the result of receptive, sensitive caregiving. The caregiver responds in a contingent way to infant cues, providing the infant with both stimulation and nurturing. Infants are able to internalize regulation strategies offered to them by their caregivers, and learn to communicate and interpret nonverbal signals. Responsive caregiving in the face of traumatic stress provides the young child with a supportive environment in which to recover from and metabolize overwhelming experience.

Insecure attachment patterns have been consistently documented in over 80% of maltreated children. These failures to create a secure dyadic relationship may leave an environment of vulnerability which may allow for the occurrence of complex trauma exposure. In the aftermath of exposure, insecure or anxious attachments may be further compounded if children perceive a caregiver as too distressed to deal with their experience (e.g., due to the caregiver's own level of stress, dissociation, avoidance, intoxication or own unresolved trauma history).

Children with insecure attachment patterns may be classified as *avoidant*, *ambivalent*, or *disorganized*. The *avoidant* attachment style has

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

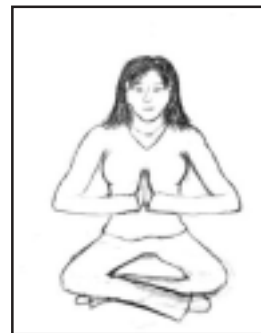
been associated with predictably rejecting caregiving. Children whose parents repeatedly dismiss or reject them may learn to disregard or distrust their emotions, relationships, and even their own bodies. Moreover, they may avoid, dismiss, or feel profoundly ambivalent about attachment relationships, not only with caregivers, but also with other adults and with peers (Ainsworth, 1978).

When children experience parents alternating between validation and invalidation in a predictable manner, they may develop *ambivalent* attachment patterns (Ainsworth, Blehar, & Waters, 1978) and learn to anticipate the adults' change from detachment and neglect to excessive intrusiveness in predictable patterns. These children often cope by disconnecting themselves from others at the first signs that parents, teachers, or other important adults are acting in either a rejecting or overly engaging manner.

When co-regulation is not provided or results in aversive consequences early in life, the child is at risk for a complex and severe type of disruption of all of the core biopsychosocial competencies that has been described as *disorganized attachment* (Cassidy & Mohr, 2001; Cicchetti & Toth, 1995; Lyons-Ruth & Jacobovitz, 1999; Maunder & Hunter, 2001). Disorganized attachment in young children involves erratic behavior in relation to caregivers (e.g., alternately clingy, dismissive, and aggressive). In older children, adolescents, and adults, disorganized attachment appears to reflect primitive survival-based relational working models that are rigid, extreme, and thematically focused (Lyons-Ruth & Jacobovitz, 1999). These working models focus on either helplessness (e.g., abandonment, betrayal, failure, dejection—"Any expression of anger is deadly," "I'm damaged and deserve to be rejected") or coercive control (e.g., blame, rejection, intrusiveness, hostility—"I have to force

people to do what I want," "No one can be trusted to help—they'll just use you"). Parents of children with these behaviors have been described as often failing to protect their children and feeling helpless in their roles as mothers (George & Solomon, 1996).

Children living with unpredictable violence and repeated abandonment often fail to develop appropriate language and verbal processing abilities. They then cope with threatening events and feelings of helplessness by restricting their processing of what is happening around them. Thus, these children are repeatedly unable to organize a coherent response to challenging events in their lives and instead act with disorganization (Siegel, 1999).



Disorganized attachment has been hypothesized to interfere with the development of neural connections in critical brain areas (e.g., the left and right hemispheres of the orbital prefrontal cortex and their connective pathways; Schore, 2001). This attachment style may result in impairment in affect regulation, stress management, empathy and prosocial concern for others, and the use of language to solve relational problems. Over time, disorganized attachments lead to symptoms of PTSD, as well as borderline and antisocial personality disorders (Herman, Perry, & van der Kolk, 1989; Main, 1995).

In a recent review, Maunder and Hunter (2001) concluded that disrupted attachment in animals and humans often is not transient but can lead to a lifelong risk of physical disease and psychosocial dysfunction. This risk occurs along three pathways that reflect impairments in the core biopsychosocial competencies which parallel the key features of disorganized attachment: (1) increased susceptibility to stress (e.g., difficulty focusing attention and modulating arousal; i.e., detection, activation, conservation, orientation); (2) an inability to regulate emotions without external assistance (e.g., feeling and acting overwhelmed by intense or numbed emotions; i.e., activation, conservation, exploration; consolidation), and (3) altered help-seeking (e.g., excessive help-seeking and dependency or social isolation and disengagement; i.e., deficiencies in affiliation and in exploration). Moreover, it is not only separation, but also the disruption of the development of a secure attachment bond, that appear to produce lasting biological dysregulation.

Biology

Neurobiological development follows genetically “hard-wired” programs that are modified by external stimuli. Extreme (low or high) levels of stimulation (i.e., stress) are thought to trigger adaptive adjustments that depend on the brain structures and pathways that were formed in the course of development (Perry & Pollard, 1998). Thus, the brain “sculpts” itself in response to external experiences at the same time as it is developing via genetically-based maturation.

During the first few months after birth, only the brainstem and midbrain (i.e., locus coeruleus and cerebellum) are sufficiently developed to sustain and alter basic bodily functions and alertness. These primitive structures regulate the “autonomic nervous system” (ANS), mobilizing arousal through the sympathetic

branch of the ANS and modulating arousal through the parasympathetic branch. Deprivation of responsive caregiving due to persistent maltreatment, neglect, or caregiver dysfunction (e.g., maternal depression) can lead to lifelong reactivity to stress. Following a history of early deprivation, even *mild* stress later in life can elicit severe reactivity and dysfunction (Gunnar & Donzella, 2002).

In toddlerhood and early childhood, the brain actively develops areas responsible for: (1) filtering sensory input to identify useful information (thalamus; somatosensory cortices), (2) learning to detect (amygdala) and respond defensively (insula) to potential threats, (3) recognizing information or environmental stimuli that comprise meaningful contexts (hippocampal area), and (4) coordinating rapid goal-directed responses (ventral tegmentum; striatum). During this time there is a gradual shift from right hemisphere dominance (feeling and sensing) to primary reliance on the left hemisphere (language, abstract reasoning and long range planning) (De Bellis, Keshavan, & Shifflett, 2002; Kagan, 2003). A young child gradually learns to orient to both the external and internal environment (rather than responding reflexively to whatever stimulus presents itself), and to detect and react.

Trauma interferes with the integration of left and right hemisphere brain functioning, which explains traumatized children’s “irrational” ways of behaving under stress. In non-abused children, their semantic (i.e., verbal and left brain based) schemas of themselves and the world are generally in harmony with their emotional response to their surroundings (right brain based). In contrast, abused and neglected children often display vast discrepancies between how they make sense of themselves and how they respond to their surroundings. Under stress, their analytical capacities (left brain based) disintegrate, and their emotional

(right brain based) schemas of the world take over, causing them to react with uncontrolled helplessness and rage (Crittenden, 1998; Kagan, 2003; Teicher, Andersen & Polcari, 2002).

In early childhood, biologically compromised children are at risk for disorders in reality orientation (e.g., autism), learning (e.g., dyslexia), or cognitive and behavioral self-management (e.g., ADHD). A toddler or preschool-age child who (a) is exposed to traumatic stressors, or (b) did not develop basic capacities for self-regulation earlier in life, and who does not have a sustaining relationship with caregiver(s), is at risk for failing to develop brain capacities necessary to form interdependent relationships (e.g., separation anxiety or ODD) and for failing to modulate emotions in response to stress (e.g., major depression, phobias) (Kaufman, 2000).

In middle childhood and adolescence, the most rapidly developing brain areas are those responsible for three core features of “executive functioning” necessary for autonomous functioning and engagement in relationships. These features are: (1) conscious self-awareness and genuine involvement with other persons (anterior cingulate), (2) ability to assess the valence and meaning of complex emotional experiences (orbital prefrontal cortex), and (3) ability to determine a course of action based on learning from past experiences and creation of an inner frame of reference informed by accurate understanding of other persons’ different perspectives (dorsolateral prefrontal cortex). In adolescence, there is a burst of brain development in these areas and the limbic system (e.g., hippocampus) due to “myelination,” the growth of protective sheaths surrounding nerve cells. This process can consolidate new learning in the form of decision strategies and fundamental beliefs that become a system of “working memory that is highly

stable and readily accessed” (Benes, Turtle, & Kahn, 1994). Traumatic stressors or prior deficits in self-regulatory abilities that manifest during adolescence, in the absence of sustaining relationships (which in adolescence often involve peers as well as adults), may lead to disruptions in self-regulation (e.g., eating disorders), interpersonal mutuality (e.g., conduct disorders), reality orientation (e.g., thought disorder), or a combination of these critical competencies (e.g., borderline personality disorder; chronic addiction).

Biology of Resilience

Many studies show that stressors early or later in life that are predictable, escapable or controllable, or in which responsive caregiver contact is available, and safe opportunities for exploration are reinstated, tend to *enhance biological integrity*. In biological terms, these experiences increase hippocampal and prefrontal cortex neuronal functioning; *behaviorally*, they enhance curiosity, social status, working memory, anxiety management, and the ability to nurture (Champagne & Meaney, 2001; Gunnar & Donzella, 2002; Schore, 2001). Moreover, the restoration of secure caregiving after early life stressors has a protective effect, reducing long-term biological and behavioral impairment, even if: (a) only visual, not tactile, or symbolic contact with the caregiver is possible, (b) the sociophysical environment is severely impoverished, or (c) the caregiver is not the biological parent (Gunnar & Donzella, 2002).

Affect Regulation

Previous sections have described the deleterious impact that early childhood trauma may have on core regulatory systems. Impairment of neurobiological systems involved in emotion regulation leaves many traumatized children at risk for multiple manifestations of

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

dysregulated affect. Deficits in the capacity to regulate emotional experience may be broadly classified in three categories, including (a) deficits in the capacity to *identify* internal emotional experience, (b) difficulties with the safe *expression* of emotions, and (c) impaired capacity to *modulate* emotional experience.

Identification of internal emotional experience requires the ability to differentiate among states of arousal, interpret these states, and apply appropriate labels (e.g., “happy,” “frightened”). At birth, the infant has little capacity to discriminate among arousal states; predictable and differential response of caregivers to specific needs provides a framework through which the developing child begins to differentiate emotional experience and response. Similarly, children learn to interpret the nonverbal cues of others through consistent pairing of others’ affective expressions with behavior. When children are provided with inconsistent models of affect and behavior (e.g., smiling expression paired with rejecting behavior) or with inconsistent response to affective display (e.g., child distress met inconsistently with anger, rejection, nurturance, neutrality), no framework is provided through which to interpret experience. Deficits in the ability of maltreated children to discriminate among and label affective states in both self and other has been demonstrated as early as 30 months old (Beeghly & Cicchetti, 1996).

Following the identification of emotional state, a child must be able to *express* emotions safely, and then *modulate* or *regulate* internal experience. Complexly traumatized children show impairment in both of these skills. Distortions of emotional expression in traumatized children have been observed to range across a full spectrum, from overly constricted or rigid to excessively labile and explosive (e.g., Gaensbauer, Mrzaek & Harmon, 1981). Capacity to express emotions and

capacity to modulate internal experience are linked, and children with complex trauma histories show both behavioral and emotional expressions of impaired capacity to self-regulate and self-soothe. Children who are unable to consistently regulate internal experience may turn to alternative strategies, including dissociative coping (e.g., chronic numbing of emotional experience), avoidance of affectively laden situations, including positive experiences, and/or use of behavioral strategies (e.g., substance use). Those children who are unable to find consistent strategies to assist them in modulation of emotion may present as emotionally labile, demonstrating extreme responses to minor stressors, with rapid escalation and difficulty self-soothing.

Over time, traumatized children are vulnerable to the development and maintenance of disorders associated with chronic dysregulation of affective experience, including disorders of mood. The prevalence of Major Depression among individuals who have experienced early childhood trauma is an example of the lifelong impact complex trauma may exert over regulatory capacities.

The existence of a strong relationship between early childhood trauma and subsequent depression is now well established (Putnam, 2003). Recent twin studies, considered one of the highest forms of clinical scientific evidence because they can control for genetic and family factors, have conclusively documented that early childhood trauma, especially sexual abuse, dramatically increases risk for major depression, as well as many other negative outcomes. Twin studies indicate that, for women, a history of childhood sexual abuse increases the odds ratio for major depression 3- to 5-fold (Dinwiddie, Heath, et al., 2000; Nelson, Heath, et al., 2002). Numerous factors influence the strength of this relationship, including age of onset, duration, relationship to the perpetrator, number of

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

perpetrators, use of coercion or force, maternal support, and the type(s) of sexual abuse (Putnam, 2003). Children who experienced sexual intercourse abuses had an odds ratio of 8.1 for depression and 11.8 for a suicide attempt (Fergusson, Horwood, & Lynskey, 1996; Fergusson, Lynskey, & Horwood, 1996).

Childhood trauma appears not only to increase risk for Major Depression, but also to alter the course of illness in ways that contribute to a poorer prognosis. A history of childhood trauma seems to predispose toward earlier onset of affective problems, which in turn is associated with more depressive episodes and poorer outcome (Putnam, 2003). Depressed women with histories of child abuse have longer durations of illness and are less likely to respond positively to standard treatment (Zlotnick, Ryan, Miller, & Keitner, et al., 1995). Treatment of depression is complicated by lack of proper diagnosis, inability to adhere to a treatment regimen, or lack of insurance coverage or financial resources to pay for treatment. Many of these barriers are raised by the negative life trajectories commonly associated with histories of childhood trauma, such as lower education, mental illness, substance abuse, poor physical health, and unemployment. Thus, the population at highest risk for depression is also the population least likely to receive adequate treatment.

Dissociation

Dissociation is one of the key features of complex trauma in children. In essence, dissociation is the “failure to integrate or associate information and experience in a normally expectable fashion” (Putnam, 1997, p.7). Thus, cognition can be experienced without affect, affect can be experienced without cognition, somatic sensations occur in a void of awareness, or behavioral repetitions take place without conscious awareness (Chu, 1991). Dissociation runs along a continuum from normal kinds of experiences such as getting lost in thought while driving, to peritraumatic dissociation during traumatic exposures, to dissociative disorders. Although dissociation begins as a protective defense mechanism in the face of overwhelming trauma, under circumstances of chronic traumatic exposure it can develop into a problematic disorder that then becomes the focus of treatment. Moreover, there is growing research on the negative impact of peritraumatic dissociation on the development of PTSD (Weiss, Marmar, Metzler, & Ronfeldt, 1995).

Dissociation has been linked to several biological markers through the correlation of the Dissociative Experiences Scale (Bernstein & Putnam, 1986) to decreased left hippocampal



volume in women (Stein, Koverola, Hanna, Torchia, & McClarty, 1997) and to cerebrospinal fluid levels of neurotransmitters and their metabolites (Demitrack, Putnam, & Rubinaw, 1993). Moreover, dissociation is postulated to be connected with the stress response system (i.e., the Hypothalamic-Pituitary Adrenal Axis) (Putnam, 1997).

According to Putnam (1997), the three primary functions of dissociation are the automatization of behavior in the face of psychologically overwhelming circumstances, the compartmentalization of painful memories and feelings, and the detachment from one's self when confronting extreme trauma. When trauma is chronic, a child will rely more and more heavily upon dissociation to manage the experience, such that dissociation then leads to difficulties with behavioral management, affect regulation, and self-concept.

Behavioral Regulation

Chronic childhood trauma is associated with both under- and over-controlled behavior patterns. Over-control is a strategy that may counteract the feelings of helplessness and lack of power that are often a daily struggle for chronically traumatized children. Abused children demonstrate rigidly controlled behavior patterns, such as compulsive compliance with adult requests, as early as the second year of life (e.g., Crittenden & DiLalla, 1988). Many traumatized children are very resistant to changes in routine and display rigid behavioral patterns, including inflexible bathroom rituals and eating problems with rigid control of food intake.

Under-controlled or impulsive behaviors may be due in part to deficits in executive functions: the cognitive capacities responsible for planning, organizing, delaying response, and exerting control over behavior. Executive function deficits

have been well documented in traumatized children (see Cognition, below). One consequence of impaired executive functioning is an increase in impulsive responses, such as aggression. Early trauma is significantly associated with the development of impulse control disorders such as ODD (e.g., Ford et al., 2000).

An alternative way of understanding the behavioral patterns of chronically traumatized children is that they represent children's defensive adaptations to overwhelming stress. Children may re-enact behavioral aspects of their trauma (e.g., aggression, self-injurious behaviors, sexualized behaviors, controlling relationship dynamics) as automatic behavioral reactions to reminders or as attempts to gain mastery or control over their experiences. Children may also use such strategies to cope with their deficits in regulating internal experience. For instance, in the absence of more advanced coping strategies, traumatized youth may use substances in order to avoid experiencing intolerable levels of emotional arousal. Similarly, in the absence of knowledge of how to negotiate interpersonal relationships, sexually abused children may engage in sexual behaviors in order to achieve acceptance and intimacy. Ultimately, a history of childhood traumatic experiences raises the risk for adverse outcomes, including substance use and abuse, teen pregnancy and paternity, suicidality and other self-injurious behaviors, criminal activity, and re-victimization (Anda, 2002).

Cognition

During infancy and early childhood, children form an early working model of the world and develop the basic cognitive building blocks of later life. During this time period, children develop an early sense of self, a model of self-in-relation-to-other, an understanding of basic cause-and-effect, and a sense of agency.

Prospective studies have shown that children of abusive and neglectful parents have impaired cognitive functioning by late infancy, compared with control children (Egeland, Sroufe, & Erickson, 1983). The sensory and emotional deprivation associated with neglect appears to be particularly detrimental to development, with neglected infants and toddlers demonstrating delays in expressive and receptive language development, as well as deficits in overall IQ (Allen & Oliver, 1982; Culp, Watkins, Lawrence, Letts et al., 1991; Vondra, Barnett, & Cicchetti, 1990). Over time, these decrements in cognitive ability continue to be observed, such that abused and neglected children show lower IQ's and are disproportionately represented within the developmentally delayed spectrum of intellectual functioning (Sandgrund, Gaines, & Green, 1974).

During school age, academic functioning represents a significant domain of developmental competence. Academic performance is significantly influenced by children's ability to regulate internal experience and to interact competently with peers. By preschool, maltreated children demonstrate deficits in both of these arenas, exhibiting lower frustration tolerance, more anger and non-compliance, and more dependency on others for support than non-maltreated matched comparisons (Egeland et al., 1983; Vondra et al., 1990). In elementary school, maltreated children are less persistent on and more likely to avoid challenging tasks, and are overly reliant on teachers' guidance and feedback (Shonk & Cicchetti, 2001). By middle school and high school, maltreated children are more likely to be rated as working and learning below average, and they exhibit higher incidence of disciplinary referrals and suspensions (Eckenrode, Laird, & Doris, 1993).

By early childhood, maltreated children demonstrate less flexibility and creativity in

problem-solving tasks than same-age peers (Egeland et al., 1983). In later childhood, children and adolescents with a diagnosis of PTSD secondary to abuse or witnessing violence demonstrate deficits in attention, abstract reasoning, and executive function skills (Beers & de Bellis, 2002). Maltreated children have been found to exhibit increasingly impaired executive function performance from early childhood to middle school age; in contrast, non-abused, psychiatrically-impaired children show a gradual increase in executive function skills that lags behind but, over time, approximates the growth curve of normative matched controls (Mezzacappa, Kindlon, & Earls, 2001).

By early elementary school, maltreated children are more frequently referred for special education services (Shonk & Cicchetti, 2001). A history of maltreatment is associated with lower grades and poorer scores on standardized tests and other indices of academic achievement. Maltreated children are found to have significantly higher rates of grade retention and dropout; they have three times the dropout rate of the general school population. These findings have been demonstrated across a variety of trauma exposures (e.g., physical abuse, sexual abuse, neglect, exposure to domestic violence) and cannot be accounted for by the effects of other psychosocial stressors such as poverty (Cahill, Kaminer, & Johnson, 1999; Kurtz, Gaudin, Wodarski, & Howing, 1993; Leiter & Johnsen, 1994; Shonk & Cicchetti, 2001; Trickett, McBride-Chang, & Putnam, 1994).

Self-Concept

The early caregiving relationship has a profound effect on the development of a coherent sense of self. Over time, a child consolidates and internalizes a secure, stable, and integrated sense of identity (Bowlby, 1988). Responsive, sensitive caretaking and positive early life experiences allow children to develop a model of

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

self as generally worthy and competent. In contrast, repetitive experiences of harm and/or rejection by significant others, and the associated failure to develop age-appropriate competencies, are likely to lead to a sense of self as ineffective, helpless, deficient and unlovable. Alterations in children's self-representations may impact their capacity to cope with traumatic experience (Liem & Boudewyn, 1999). Children who perceive themselves as powerless or incompetent and who expect others to reject and despise them are more likely to blame themselves for negative experiences and have problems eliciting and responding to social support.

Traumatized children manifest alterations in their sense of self by early childhood. By 18 months, traumatized toddlers are more likely to respond to self-recognition with neutral or negative affect than non-traumatized youngsters (Schneider-Rosen & Cicchetti, 1991). In preschool, traumatized children are more resistant to talking about internal states, particularly those perceived as negative (Cicchetti & Beeghly, 1987). Traumatized children have problems estimating their own competence: early exaggerations of competence in preschool shift to significantly lowered estimates of self-competence by late elementary school (Vondra, Barnett, & Cicchetti, 1989). By adulthood, they suffer from a high degree of self-blame (Liem & Boudewyn, 1999).

Dissociative coping further complicates the development of a coherent sense of self. Habitual use of dissociation leads to "significant disturbances in the continuity of an individual's memory and integration of self" (Putnam, 1993, p.40). Over time, a reliance on dissociative coping may lead to serious disruptions in identity development and integration due to the loss of autobiographical memory, as well as to the lack of continuity in the traumatized individual's experience. Chronic dissociation is associated with the development of dissociative disorders

(e.g., Dissociative Disorder NOS and Dissociative Identity Disorder) in which the formation of dissociative identities becomes the source of maladaptive coping (van der Kolk, van der Hart, & Marmar, 1996).

Adaptation to Complex Trauma in Familial Context

The family plays a crucial role in determining how the child adapts to experiencing trauma. Factors that influence the child's response include the extent to which the family environment itself was responsible for the victimization, parental response to the traumatic event or disclosure, and the extent to which parents themselves are influenced by their own childhood histories of loss and/or trauma, as well as other parental psychopathology.

In the aftermath of trauma, parental support is a key mediating factor in determining how children adapt to victimization. Familial support and parental emotional functioning are strong factors that mitigate against the development of PTSD symptoms, as well as enhance a child's capacity to resolve the symptoms (Cohen, Mannarino, Berliner, and Deblinger, 2000). Research in the sexual abuse literature consistently supports Finkelhor and Kendall-Tackett's (1997) assertion that "the response of the child's social support system, and particularly the child's mother, is the most important factor in determining outcome, more important than objective elements of the victimization itself." There are three main issues in parents' responses to their children's trauma: 1) believing and validating their child's experience, 2) tolerating the child's affect, and 3) managing their own emotional response.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

The connection between a parent and child is broken when a parent denies the child's experiences. In such cases, the child is forced to act "as if" the trauma did not occur. In this context, a child learns he/she cannot trust the primary caretaker and cannot utilize language and communication to overcome adversity. Moreover, because the trauma is denied, the child remains unprotected from recurrence. Without safety, the child cannot begin to re-integrate the traumatic experiences and find new ways of coping. Instead, parental invalidation generates helplessness and hopelessness in a child.

Parents are often understandably distressed when their children have experienced traumatic events. In these instances, personal distress can limit parents' ability to provide adequate care to their children (Winston et al., 2002). However, Finkelhor & Kendall-Tackett (1997) note that it is not parental distress *per se* that is necessarily detrimental to the child, but more specifically, when the parent's distress overrides or diverts attention away from the needs of the child that children are negatively affected. Children may respond to their parent's distress by avoiding or suppressing the feelings or behaviors that elicited the parent's distress, by avoiding their parent altogether, or by becoming "parentified" and attempting to reduce the distress of their parent (Deblinger & Heflin, 1996). As a result, the child may have difficulty identifying communicating and communicating emotions (Wiehe, 1997), both of which are crucial in dealing with stressful or traumatic situations.

Traumatized children often rekindle painful feelings in biological parents or in substitute parents trying to provide a child with a new home. Parents who have had impaired relationships with attachment figures in their own lives are especially vulnerable to problems in raising their own children. Parents' ability to access information about their own childhood

and to tell their own story coherently may be the strongest indicators of parental capacity and effective parenting (Main & Goldwyn, 1994).

Parents with their own unresolved traumatic experiences may avoid experiencing their own emotions, which may make it difficult for them to "read" and respond appropriately to the child's emotional state. In addition, parents with their own unresolved trauma histories may have difficulty providing safe environments for their children because of their difficulty identifying dangerous circumstances. Moreover, children's attachment-seeking behavior can trigger their parents' own painful memories. Parents and guardians may see a child's behavioral responses to trauma as a personal threat or provocation, rather than as a reenactment of what happened to the child and a behavioral representation of what the child cannot express verbally. The hurt child's simultaneous need for *and* fear of closeness can trigger a parent's *own* memories of loss, rejection, or abuse.

Ongoing psychopathology and substance use by parents also complicate their capacity to assist in their children's recovery from trauma. Chronic mental illness or ongoing substance abuse prevents parents from being consistently available or responsive to their children, thus leaving the child at risk for future victimization. Violence or abuse in the home gives rise to a special set of characteristic adaptations. When the trauma is the result of predictable caretaker violence, children may become compulsively compliant, constantly monitoring parental cues and trying to modify their behavior in an attempt to prevent parental violence. Unpredictable parental aggression may lead to wide fluctuations in children's behavior and affect, as they are unable to figure out when or under what circumstances the parent may strike out (Crittenden, 1998).

Intrafamilial victimization generally leaves children at higher risk for victimization outside of the home. Children who are unable to get their needs met at home may seek support outside the home, and are therefore at higher risk for exploitation. Furthermore, chronic exposure to threat can interfere with children's natural internal warning systems, and may numb them to danger cues. Ultimately, a child who has been exposed to multiple sources or types of trauma, whether within or outside of the family, is more likely to be negatively affected (Garbarino, Kostelny & Grady, 1993; Margolin, 2000).

Adaptation to Complex Trauma in Ethnocultural Context

While human beings share a common biological heritage, each person belongs to not one, but many ethnocultural groups and has a unique family and cultural heritage and genetic makeup—all of which interact to shape development and the experience of trauma. One must exercise caution applying categorical delineations of ethnocultural variables (e.g., refugee, urban residence, ethnic group, primary language, socioeconomic status, nationality) because doing so runs the risk of obscuring significant differences within these larger groups (Loo et al., 2001; Marsella, Friedman, Gerrity, & Scurfield, 1996). In studying adaptation to complex trauma in ethnocultural context, one must start with the broad categories and then delve deeper into the subcategories that reflect group, community, family, and individual differences.

Although the specific forms may vary, the role of culture is not limited to trauma-affected groups who experience the disruption of their

connections to their primary culture, community, and homes (e.g., refugees or immigrants). Youth and families who are not forced to leave their homes still may have critical ethnocultural ties strained or broken by disaster, war, political repression, poverty, racism, and community violence (Garbarino & Kostelny, 1996; Rabalais, Ruggiero, & Scotti, 2002).

Assessment of trauma history and PTSD outcomes should always occur in a cultural context that includes the background, community, and modes of communication that both the assessor as well as the family bring to their interaction (Manson, 1996). Exposure to different types of trauma is variable across diverse ethnocultural backgrounds (i.e., exposure to war/genocide, family violence, community violence, child maltreatment). In addition, people of different cultural, national, linguistic, spiritual, and ethnic backgrounds define key trauma-related constructs in many different ways and with different expressions (e.g., flashbacks may be "visions," hyperarousal may be "attaque de nerves," dissociation may be spirit possession; Loo et al., 2001; Manson, 1996). The threshold for defining a PTSD reaction as "distressing" or as a problem warranting intervention differs not only across national and cultural groups, but also within subgroups (e.g., geographic regions of a country with different sub-cultures; different religious communities within the same geographic area). As a result, psychometric assessment with standardized measures may confront children and families with questions that are considered unacceptable (e.g., including peyote under use of illicit drugs), irrelevant (e.g., distinguishing blood family from close friends, in a group that considers all community members as family), incomplete (e.g., limiting health care to Western medical or therapeutic services, to the exclusion of traditional forms of healing and healers), or simply incomprehensible (Manson, 1996).

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

With children, cultural factors may influence the substance or expression of developmental differences in ability to comprehend and communicate concepts such as social intentionality and causality, the distinction between self and others, and the ability to symbolize and to access working or long term memory (T. Miller, 1998; Salmon & Bryant, 2002). For example, in some cultures children are socialized to view intentionality and causality as attributes of collective groups rather than of individuals in isolation. If such children are sexually molested, they may not disclose the abuse because it might threaten their acceptance as a valued member of their families and communities. This acceptance may be perceived as more crucial to recovery than having the ability to say "no" or knowing how to counteract self-blaming thoughts or self-soothe if feeling overwhelmed. Culturally sensitive approaches to trauma assessment have been developed for adults (e.g., Loo et al., 2001) and children (Ford et al., 2000). However, their appropriateness and psychometric reliability, validity, and utility in different ethnocultural groups, contexts, and communities have not been systematically evaluated.

Different cultures have different concepts of family, in terms of who is a member, the roles and responsibilities of each member, and how involved family members are with different children. This becomes important when considering how to treat the child, especially in

determining whether individual or family therapy is the best approach. The chosen trauma treatment may be individualized to the family's needs, but yet may not fit with the family's cultural understanding of a child's role in the family system. Furthermore, there are often different levels of acculturation within the same family. For example, children who are born in the United States but whose parents moved here as adults often have developed a mixed sense of ethnic identity that is bicultural, frequently leading to family conflict around cultural difference and varying levels of ethnic identity.



Interventions for prevention or treatment of children or adolescents' posttraumatic impairment typically have been developed within the context of the Western medical model (Parson, 1997). However, evidence-based models such as cognitive-behavior therapy (Cohen et al.,

2000), Eye Movement Desensitization and Reprocessing (EMDR) (Chemtob, Tolin, & van der Kolk, 2000; Greenwald, 1998), or parent-child dyadic psychotherapy (Lieberman, van Horn, Grandison, & Pekarsky, 1997) are eminently adaptable to address not only developmental, but also ethnocultural, differences. For instance, it is possible to incorporate features designed to strengthen culture-specific resilience factors derived from empirical studies of children in different cultures who have been exposed to different types of complex trauma (e.g., mental

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

flexibility among Palestinian children, coping resources of South African children, social support among African American children).

Naturalistic healing resources are also potentially vital to children's recovery from complex trauma (Manson, 1996). There are many indigenous cultural mechanisms for addressing the disruptions of affect regulation, body allostasis, and sense of meaning or connection that result from complex trauma. The Navajo, for example, have developed Enemy Way or Beauty Way ceremonies as approaches to spiritual purification and social reintegration for warriors (Manson, 1996). The integration of these methods and rituals in prevention or treatment services for children who are survivors of complex trauma is warranted, but will require careful ethnographic study and collaboration between professionals in the traumatic stress field and varied cultural communities. Finally, prevention and treatment interventions also must consider the impact of racism and political/ethnic/class oppression as traumatic stressors (Loo et al., 2001).

Coping and Protective Factors

While exposure to complex trauma has a potentially devastating impact on the developing child, there is also the possibility that children in these situations can nevertheless function effectively and competently across a variety of domains (Kendall-Tackett, Williams, & Finkelhor, 1993; Masten & Coatsworth, 1998). Resilience is no longer regarded as a static attribute or a single, global construct but rather is viewed as multi-determined and evolving domains of competency, consisting of interacting forces

within an individual, the family, and their social environment (Masten & Coatsworth, 1998; Waller, 2001). A child may function well in certain domains (e.g., academic) while exhibiting distress in others (e.g., behavior) (Luthar, Cicchetti & Becker, 2000). Areas of competence can also shift as children are faced with new stressors and developmental challenges. Understanding the continuum of responses to trauma and the coping and protective factors underlying resilience is vital to secondary and tertiary prevention efforts with children exposed to complex trauma (Egeland, Carlson & Stroufe, 1993).

Competence and resilience have been linked with several protective factors consisting of individual, family, and environmental variables (Masten & Coatsworth, 1998). Resilience develops from very ordinary adaptational processes and is not limited to remarkable individuals (Masten, 2001). Several factors have been found to be the most critical for promoting resilience, including: (a) positive attachment and connections to emotionally supportive and competent adults within a child's family or community, (b) development of cognitive and self-regulation abilities, (c) positive beliefs about oneself, and (d) motivation to act effectively in one's environment (Luthar, et al., 2000; Masten, 2001; Werner & Smith, 1992; Wyman, Sandler, Wolchik, & Nelson, 2000). Additional individual factors associated with resilience include an easygoing disposition, positive temperament, and sociable demeanor; internal locus of control and external attributions for blame; effective coping strategies; degree of mastery and autonomy; special talents; creativity; and spirituality (Werner & Smith, 1992). Additional familial and environmental factors that have been found to foster resilience include parenting with warmth, structure, and high expectations of the child; socioeconomic resources; ties to extended family; involvement with prosocial

community organizations; and effective schools (Masten & Coatsworth, 1998).

The greatest threats to resilience appear to follow the breakdown of protective systems: damage to brain development and associated cognitive and self-regulatory capacities; compromised caregiver-child relationships; and loss of motivation to interact with one's environment, learn and develop new skills. In situations of severe adversity, poor parenting and cognitive skills increase the risk of maladaptive child behavior patterns, while normative intellectual skills and parenting protect the child and foster growth of competence (Masten, 2001). Ultimately, supportive connections and cognitive resources help buffer children against the worst effects of trauma and serve as "inoculations against adversity" (Schimmer, 1999).

Other research has illuminated the importance of coping strategies on long-term mental health outcomes in response to complex trauma exposure in childhood (Vaillant, 1986; Vaillant, Bond, & Vaillant, 1986). Coping strategies represent the expression of psychological defense mechanisms that develop in childhood as protective responses that accentuate, limit, or block perceptions of inner and outer reality as a means of managing trauma and deprivation. The more severe the exposure to complex trauma in childhood, the stronger the use of certain coping strategies—such as sublimation, humor, altruism and suppression—has been associated with successful management of life problems and promotion of positive mental health in adulthood. In contrast, reliance on primitive defense mechanisms including dissociation, projection, passive aggression and hypochondriasis is linked to greater functioning deficits and more severe psychopathology over time.

Approaches to Comprehensive Assessment of Complex Trauma in Children

Typically, regardless of the initial trauma event that prompts referral for treatment services, the accepted standard of care involves conducting a comprehensive assessment, which uses observations, clinical interviews with child/adolescent and primary caretakers, collateral information (as appropriate— schools, child protection, previous therapist, forensic interviewer, pediatrician, etc.). Clinical interviews should follow a consistent format using a specific comprehensive form completed by the clinician. The assessment should also include the use of standardized assessment instruments that include self-report measures as well as measures completed by caretakers and/or teachers based on types of trauma, developmental/chronological factors, and availability of informants. Such a comprehensive assessment conducted over several sessions will establish treatment goals based on the phase-oriented model of trauma treatment.

Since trauma evaluations often involve the criminal and/or probate court systems, it is imperative that the evaluations be conducted in a forensically sound, as well as clinically rigorous manner. Specifically, questions must be asked in a non-leading manner and be accompanied by thorough documentation of all relevant disclosures. Even when referrals begin as a clinical assessment, any disclosures that occur are often the backbone of legal efforts to keep a child safe.

Areas to Assess in Clinical Interviews

A comprehensive evaluation assesses both complex traumatic *exposures* and complex traumatic *outcomes* or adaptations, and is accompanied by thorough psychological evaluation of symptoms and history. The evaluation should begin with the reason for referral, the presenting concerns, and the history of those presenting problems. Important historical information includes: developmental history, family history, trauma history for child and family, attachment relationship(s) for child/adolescent and primary caregiver(s), child protective services involvement and placement history, illnesses, losses, separation/abandonment by parent, deaths, parental/family mental illness, substance abuse, legal history, coping skills, strengths of child/adolescent and family, and any other stressors (e.g. community violence, economic issues, racial discrimination). Clinicians need to evaluate for all types of traumatic experiences since there is considerable evidence supporting multiple traumatic exposures. In addition to specific information regarding the nature of the traumatic experience(s), it is also important to gather information regarding circumstances of disclosure, responses of family members and agency professionals, safety concerns/issues, and the child/adolescent's ability to express feelings about the traumatic experiences.

In addition to assessing traumatic exposures, the clinicians must evaluate adaptations to complex trauma in the seven domains described earlier: biology, attachment, affect regulation, dissociation, behavioral management, cognition, and self-perception. These domains should be assessed in terms of their current presentation, as well as their developmental trajectories.

Standardized Measures

Assessment measures are administered as part of the initial evaluation; at 6-month, or ideally, 3-month intervals to track treatment progress and inform clinical decision-making in an individualized and empirically based manner; as well as at termination so as to determine treatment outcome and guarantee the appropriateness of termination. Follow-up is also recommended, when possible, to determine endurance of positive treatment outcomes. Standard psychological and neuropsychological testing can be useful in further understanding a child's adaptation to complex trauma, as well as in defining the specifics of learning difficulties, thought disorder, and other possible organic contributors. It is important to assess multiple areas of functioning and to gather information from multiple informants (i.e. parent, teacher, and child) across different settings (i.e. school and home). In a typical trauma evaluation, some combination of the following measures would be included:

Child/Adolescent Measures

Trauma Symptom Checklist for Children (TSCC, Briere), UCLA Trauma Reminders Inventory, Children's PTSD-Reaction Index (Pynoos), Adolescent-Dissociative Experiences Scale (A-DES, Putnam), Youth Self-Report (YSR, Achenbach), Children's Depression Inventory (CDI, Kovacs)

Parent/Caretaker Measures

Child Behavior Checklist (CBCL, Achenbach), Child Dissociative Checklist (CDC, Putnam), Child Sexual Behavior Inventory (CSBI, Friedrich), Traumatic Events Screening Inventory (TESI, Ford)

Teacher Measures

Teacher Report Form (TRF, Achenbach): Specific information regarding these measures and their relative merits as well as more detailed related to assessment approaches can be obtained from a number of sources (Friedrich, 2002; Ohan, Meyers, & Collett, 2002; Pearce & Pezzot-Pearce, 1997; Briere & Spinazzola, in press).

Approaches to Treatment of Complex Trauma in Children

Phase-Based Approaches

Intervention Needs

Interventions for traumatized children and adolescents must be developed and tested which directly address the specific complex trauma domains. Treatments for traumatized youth thus far have been conceptualized as having four central goals: (1) *safety* in one's environment, including home, school, and community, (2) *skills development* in emotion regulation and interpersonal functioning, (3) *meaning-making* about past traumatic events they have experienced so that youth can consider more positive, adaptive views about themselves in the present, and experience hope about their future, and (4) *enhancing resiliency and integration into social network*.

Almost all traumatized youth face the task of living in a continually traumatizing environment or finding a place in a new environment. Thus, the initial tasks of treatment are focused on creating a system of care and safety in which a

child and the family can begin to heal. Often, this means clinicians working with child protective services and the court system to develop a safer living environment. It is also critical to engage the family and the school, as well as other primary support figures, in order to create a network that will develop safety within the living environment.

It is then possible for psychosocial treatments to provide recovery from the damages of abuse and rehabilitation of skills lost or never formed. Development of these basic skills, e.g. identifying feelings and forming a relationship with another person, occurs in the therapeutic context partnered with significant caretaker involvement, so that the newly learned skills are reinforced at home. The final challenge is the transmission and maintenance of these skills in the day-to-day world. This final effort can take root in treatment but will need partnering with the family and with community agencies.

Why Use Phase-Based Intervention?

There is consensus that treatment development should take a phase-based, or sequential approach. Research with traumatized adults indicates that treatments in which all aspects of work occur simultaneously tend to create "information overload" such that learning never fully occurs. This is likely to be especially true of children whose ability to attend to and process information is less well developed than adults. The sequential order of the treatment is such that the lessons learned in one phase serve as a building block for those to come next. The process is not linear, however, so that it is often necessary to revisit earlier phases of treatment in order to remain on the overall trajectory.

Before any treatment can truly begin, the safety of the child and family must be addressed. It would be impossible for any child, or adult, to

take in new information when he or she is fighting for survival. The focus of treatment at this early juncture largely involves building a network for the child and family. Thus, clinicians work closely with child protective services, the school system, and other providers for the family to develop safety and a treatment plan that addresses the needs of the child, as well as the family. Within the treatment relationship, the focus is on building trust and a positive working relationship.

The emotion regulation skills of the second stage help clients review their traumatic experiences. Once children possess improved methods for coping and an increased capacity for emotion regulation, they are better able to communicate and process traumatic memories. This process leads to a decrease in psychological distress concerning their history and to reduced reactivity to the inevitable traumatic reminders (schools, streets, sounds) in their home environment. The development of emotion regulation along with social skills also allows youth to see themselves as different from the people they were at the time of the traumatic events. The contrast between who they were during these events and who they are becoming, with the help of the skills work, provides them with a more confident view of themselves and the notion that change is possible.

The goal of the last phase of treatment is to instill principles of resiliency in youth so that they can continue to develop in positive, healthy, and functional ways and avoid future victimization and/or aggressive behaviors. Phase 4 interventions involve the creation or reinforcement of assets that build resiliency (DeRosa et al., 2003). These activities can include involving the youth in creative projects or youth programs, identifying expectations and responsibilities, working with families and communities to maximize safety and encourage

youth to achieve and develop their unique talents. The traumatic experience can then move from being the central aspect of their lives to being a part of their history.

Complex Trauma Treatment Programs for Children and Adolescents

While most treatment of traumatized children and their families takes place within community mental health settings, hospitals, schools, and home-based family stabilization teams, there are a number of trauma-specific treatment programs in development for children and adolescents. Several of these are modeled upon earlier work conducted with adults (Cloitre et al., 2002; Ford, in press; Turner, DeRosa, Roth & Davidson, 1996), although these interventions are clearly modified in order to be developmentally appropriate. There are several treatment models designed for children of different ages and their families (Cloitre et al., 2002; Cohen & Mannarino, 1998; DeRosa, et al., 2003; Hembree-Kigin & McNeil, 1995; Kagan, in press; Lieberman, et al., 1997; Lyons Ruth & Jacobvitz, 1999; Rivard et al., 2003).

The treatment of choice for infants and toddlers uses a parent-child dyadic model (Hembree-Kigin & McNeil, 1995; Lieberman et al., 1997; Lyons Ruth & Jacobvitz, 1999). Because attachment is critical to overall healthy development, as well as to recovery from trauma, parental attunement is the primary goal of treatment. Without it, there can be no healthy attachment in preschool age children. Thus, the child has the best chances for healing and recovery when intervention is early and focuses on the parent-child relationship.

For latency age children who have been sexually abused, Cohen & Mannarino (1998) have designed a treatment program in which children participate in a short-term trauma-specific intervention, while parents simultaneously

attend separate therapy sessions in order to learn about the children's treatment and to learn ways to help their children cope. This intervention has been associated with a reduction in depressive symptomatology and an increase in social competence. Similarly, Kagan (in press) has developed Real Life Heroes, a program for traumatized children that utilizes creative arts, life story work, and the metaphor of heroes to help children and their parents to increase skills for overcoming trauma and to build or rebuild attachments.

There are several group models in development for adolescent girls with histories of sexual or physical abuse (Cloitre, Koenen, Cohen & Han, 2002) and witnessing domestic violence (DeRosa et al., 2003). Cloitre and colleagues are developing a 16-session treatment for adolescent girls who have been physically or sexually abused. This treatment is organized into three of the phases described earlier: skills training in emotion management and interpersonal effectiveness, trauma narrative story telling, and resiliency-building. Similarly, the broad treatment goals of DeRosa and colleagues' model include: "Managing the Moment", strategies to help girls manage and regulate their affect and impulses more effectively "here and now" when experiencing acute distress; "Building Coping Strategies", strategies to enhance ability to cope with the impact of the trauma including identifications of triggers, anger management and problem solving strategies; and "Enhancing Resiliency", strategies designed to help participants identify current adaptations to the trauma that are proving successful. Preliminary data thus far suggest this phase-based approach is much more successful than either supportive treatment or skills only treatment in improving PTSD symptoms, emotion regulation, depression, dissociation, anger and social competence (Cloitre, 2002).

Each of the treatments just reviewed has been manualized in order to carefully document the details and mechanisms of the interventions, and to ensure fidelity across treatment providers. With the creation of manuals documenting effective treatments for children and adolescents experiencing complex trauma outcomes, we can begin to affect standards of care and influence best practices guidelines. The clear benefit of manualized treatments is that they can be disseminated and used to train clinicians across various settings. However, treatment manuals also have limitations. Treatments for traumatized youth are not "one-size-fits-all." As manuals are brought to community clinics, they must be adapted in order to be culturally relevant and to be flexible enough to meet the needs of individual children and their families. Manuals must also be tailored to address developmental differences in children and adolescents. Most importantly, clinical decision-making about complex trauma intervention with children should always begin with comprehensive assessment of the impacted child's needs, strengths and trauma outcomes in order to provide more individualized, empirically based treatment.

Going into the Community

The mental health field has been moving toward greater accessibility for families, which has led to more community-based programs (e.g. schools, child protective services, shelters, family courts). Focusing on one of these types of community intervention, school-based interventions can provide critical access for students in need of mental health services, and can address multiple financial, psychological and logistical barriers to treatment. Trauma-informed programs are currently being implemented and tested in schools and residential settings and are also confronting the "real world" challenge of working with the large and underserved population of children and

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

adolescents who live and remain in chronically stressful and unstable environments, such as homes or communities where violence commonly occurs (DeRosa, et al., 2003; Cook, Henderson, and Jentoft, 2003).

The traumatized children and adolescents seen in schools and the community are often those easily identified as “at risk” due to chronic deficits in their ability to regulate attention, affect and behavior. These deficits often lead to specialized and/or alternative school and home placements in which the staff, teachers, and counselors frequently become primary caretaker(s) and attachment figures. Therefore, when working with traumatized children in the community; providers must consider both the child and the context as the targets of intervention. Cook, Henderson, and Jentoft, (2003) propose a “milieu” model of working with traumatized children in the community. This conceptual model (ARC) emphasizes the child and the adults in their environment and focuses on three key areas: (1) building secure “a”ttachments between child and caregiver(s); (2) enhancing self –”r”egulatory capacities; and (3) increasing “c”ompetencies across multiple domains.

In order to strengthen the attachment between child and caretaker(s), it is essential that four basic principles be implemented. The first is to create a structured and predictable environment through the establishment of rituals and routines. This includes behavior management and limit setting. The second is enhancement of the adult’s ability to “tune in” to the child’s affect in order to respond to the affect rather than react to the behavioral manifestation. The third principle is that the caretaker is helped to model effective management of intense affect by supporting the child in both labeling and coping with emotional distress. It should be noted that in order to respond to rather than react to a child requires that the adult model

adaptive coping in regard to his or her own emotional response to difficult circumstances. The fourth principle revolves around praise, reinforcement and the opportunities to focus on a child doing something positive so as to help the child to identify with competencies rather than deficits. These principles are likely to promote increased security in attachment relationships, which will then become the basis for the development of all other competencies including regulation of attention, affect, and behavior. It should be noted that these principles could be applied in a variety of contexts including clinic based, school based, home based and community based settings.

Enhancement of self-regulatory capacities and increases in competency across domains are common goals among trauma-specific school-based approaches (DeRosa et al., 2003; Cook et al., 2003). The goal is to increase cognitive, emotional, physical, and spiritual mastery (James, 1989). Examples of techniques used to promote cognitive mastery include direct teaching, story telling, and bibliotherapy. Emotional mastery is achieved through art, play, and body-oriented strategies. Children who are traumatized or neglected often exhibit inhibited play or the inability to play while others may reenact their experiences. Thus, play is essential to facilitate healing and to learn skills that are later necessary in different developmental phases (James, 1994).

Physical mastery comes through involvement in physical activities. Activities such as yoga, music, movement, sports (in school/program settings, and drama can be modified to be included in individual and group work. In addition, such activities can and should be included in treatment planning as *adjunctive auxiliary treatment methods*. These activities support children in a number of ways including: (1) Finding a new vehicle of expression that decreases arousal and increases soothing; (2)

Gaining trust in their environment; (3) Decreasing isolation; and, (4) Developing accessible tools (visual, tactile, auditory, kinesthetic) for dealing with distress (Macy, R., Macy, D., Gross, S., Brighton, P., & Rozelle, D., 1999-2003). Body oriented treatments and activities can teach children to change their physiological response to threatening stimuli, which will ultimately lead to improvement in their functioning. These techniques provide effective therapy for children who experience extreme physical vulnerability and who have distorted body concepts (James, 1989). Finally, adjunctive therapies provide a natural forum for mentoring, affiliation, integration, and socialization all of which are essential to enhancing resiliency.

Trauma-specific milieu treatment appears to have been successful in increasing ability to regulate affect. This has been demonstrated by fewer suspensions and aggressive outbursts, increasing ability to regulate attention as indicated by increased time spent on academic tasks, increasing affiliation and group cohesion as reflected by fewer peer conflicts, and increasing compliance with rules and expectations, which may also suggest improvement in adult-child attachment relationships (Cook et al., 2003).

The principles of the school-based model described are designed to be applicable in other types of community settings, including residential programs, shelter systems, and child protection agencies. In order to effect significant systemic change for traumatized children, it is imperative to work closely with these community systems, so that a phase-oriented model that focuses on safety first, skill building, meaning making, and enhancing resiliency can be implemented on a broad scale.

Psychopharmacological Interventions

Psychopharmacological interventions for traumatized children and adolescents are primarily considered to be adjunctive to psychosocial treatment modalities. They aid in the management of symptoms that might interfere with the attention and learning demands of psychosocial treatments, or that can threaten to disrupt a placement. However, medication should only be used in conjunction with trauma-specific treatment and not in place of it. Six open label studies are available in the medical literature and at least one double-blind study with a positive outcome has been published on the treatment of PTSD in children. Drawbacks to these studies include modest samples sizes. Recent studies on the use of the Selective-Serotonin-Reuptake-Inhibitor agents (SSRI'S) have shown promise. In general, early intervention with medication should be reserved for the more extreme cases, existing comorbidities, or as an adjunct to other forms of treatment. Further research in this area is needed to assess the efficacy and safety of medications for use and the conditions under which they may be helpful adjuncts or even preferred to psychosocial interventions (See Silva, Cloitre, Davis et al., 2003).

Child Complex Trauma Treatment Summary

Preliminary data from youth-oriented phase-based treatments for complex trauma suggest that they provide symptom relief, as well as improvement in social competence and emotion management, and that they are consistently superior to nonspecific supportive therapies. These programs, however, are in the earliest phase of development. Several more years of work are necessary to test the treatments' core aspects and adapt them for culturally and geographically diverse populations. In addition, it is critical that the field and the NCTSN continue to develop and explore new multi-

modal, empirically based interventions that address the range of complex trauma adaptations, while simultaneously providing clinicians with access to the requisite training and resources to implement, modify, and evaluate the effectiveness of available treatments across diverse child complex trauma populations. Finally, there is consensus that interventions should build strengths as well as reduce symptoms. In this way, treatment for children and adolescents also serves as a prevention program for poor outcomes in adulthood.

- a. increase external safety
- b. develop internal safety and competence
- c. alter developmental trajectory in positive, health-promoting direction
- d. foster healthy primary attachment relationship, as well as cultivating other social supports

5. Develop, implement, disseminate and support prevention programs and services that reduce children's exposure to violence in the home, school and community.

Recommendations and Future Directions

Recommendations for Clinicians Working with Child Complex Trauma Populations

1. Increase public and professional awareness of chronic complex trauma in children and adolescents.
2. Develop comprehensive continuum of care based on phase-oriented model of treatment for complex trauma.
3. Increase collaboration among community agencies and organizations serving traumatized children and their caregivers.
4. Recognize and address the following goals of multi-modal treatment intervention with complexly traumatized children:

Recommendations for Researchers Studying Child Complex Trauma Populations

1. Implement multi-site epidemiological characterization studies of complex child trauma exposure and outcomes.
2. Conduct evidence-based development and testing of phase-oriented treatments for complex trauma in children and adolescents.
3. Review and evaluate promising programs and innovative intervention models that span service sectors (e.g., Head Start; juvenile justice; mental health) and attempt to reach complexly traumatized children through multiple contexts (e.g., parent-child, peer-based, faith-based communities) and across multiple domains (e.g., clinical services; auxiliary services, academic and vocational development).
4. Establish and cultivate ongoing partnerships between academic settings and community clinics to develop and test community-based, culturally relevant, age-appropriate interventions for traumatized children and adolescents.

5. Increase focus on understanding characteristics of resilient youth, and the impact of treatments and strengths-based initiatives that focus on building competence, positive self-regard and resiliency in traumatized children and adolescents.

Recommendations for Policy Makers Acting on Behalf of Child Complex Trauma Populations

1. Advocate for recognition of complex child trauma as a public health problem effecting millions of children in the United States each year.
2. Engage in policy efforts aimed at closing the gap between needs of children and families impacted by complex trauma and available resources.
3. Increase awareness that effective interventions for children exposed to complex trauma can be implemented; however, these interventions need to be integrated across the systems in which impacted children are located.

4. Work to influence the creation and design of state, federal and foundation service, training and research grants dedicated to increasing understanding, intervention and access to resources for children and families impacted by complex child trauma.

5. Lobby for the inclusion of exemplary intervention and prevention programs for complex child trauma in local, state and federal budgets, with a prioritization for integrated programs across federal, state and local agencies including the Departments of Defense, Justice, Education, and Health and Human Services; the Center for Disease Control; and the Substance Abuse and Mental Health Services Administration.

6. Advocate for the incorporation of an empirically based parity diagnosis of the impact of complex child trauma in the DSM-V in order to improve clinician understanding of complex trauma outcomes in children and adolescents, anchor treatment guidelines, and increase third party compensation mental health services required by this population.



Complex Trauma Survey: National Child Traumatic Stress Network

The NCTSN conducted a survey on complex trauma exposure, outcomes and treatment approaches for impacted children and their families receiving intervention and/or comprehensive assessment services in 2002. Aggregate data was provided on a sample of 1,699 children across 25 network sites (Spinazzola et. al., 2003). This sample constitutes approximately 15% of the total population of children directly served by the network during a typical quarter.

Findings revealed that the vast majority of children served by the network (78%) have been exposed to multiple and/or prolonged trauma, with a modal number of 3 trauma exposure types. Findings further revealed that initial exposure typically occurs early, with an average age of onset of 5 years old. Moreover, 98% of clinicians surveyed reported average trauma onset prior to age 11, and 93% reported average onset by age 8.

Interpersonal victimization uniformly emerged as the most prevalent form of trauma exposure experienced by children in the network, with the locus of impact typically in the home (see Figure 1). Specifically, each of the following types of trauma exposure was reported for approximately one-half of the children surveyed: *psychological maltreatment* (CEA; i.e., verbal abuse, emotional abuse or emotional neglect); *traumatic loss*; dependence on an *impaired caregiver* (i.e., parental mental illness or substance abuse); and *domestic violence*. These experiences were closely followed by *sexual maltreatment/assault* (CSA), and *neglect* (i.e., physical, medical, or educational neglect), both observed in at least one-in-three children. Smaller but notable percentages of children had histories of exposure to *physical maltreatment/assault* (CPA) or *terrorism* within the United States. Forms of trauma exposure not involving interpersonal victimization were significantly less common: fewer than one-in-ten children included in the survey had been exposed to serious accidents, medical illness or disaster.

The survey further revealed that a large percentage of trauma exposed children exhibit several forms of posttraumatic sequelae not captured by standard PTSD, depressive or anxiety disorder diagnoses (see Figure 2). Notably, 50% or more of the children surveyed were reported to exhibit significant disturbances in the following domains: *affect regulation*; *attention and concentration*; *negative self-image*; *impulse control*; and *aggression or risk taking*. In addition, approximately one-third of the sample exhibited significant problems with *somatization*, *attachment*, *conduct disorder or ODD*, *sexual interest*, *activity or avoidance*; and *dissociation*.

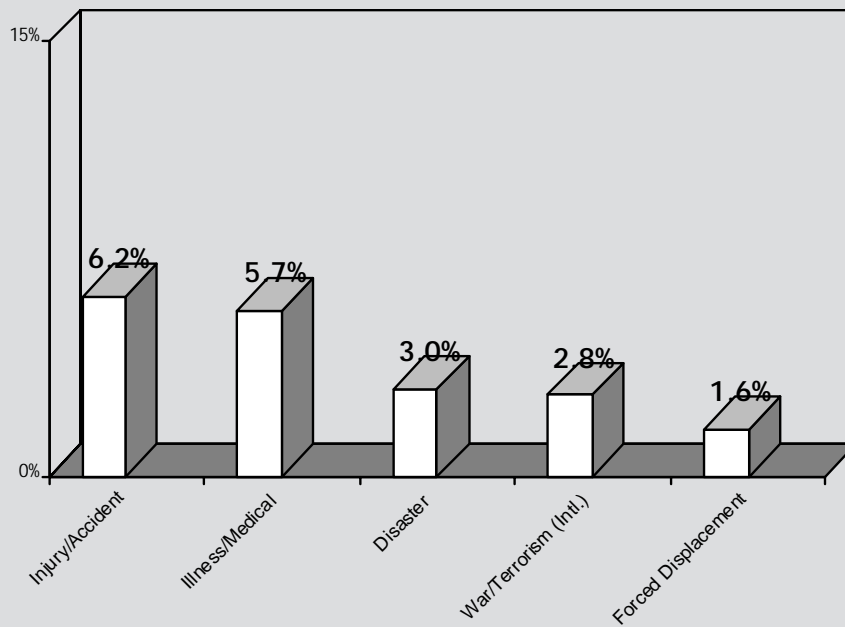
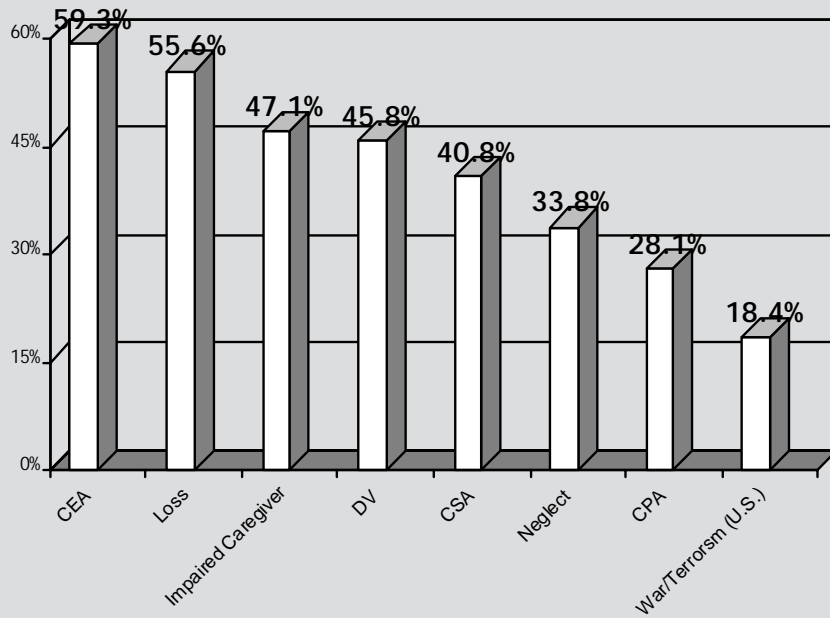
Complex Trauma Survey: National Child Traumatic Stress Network Continued

Despite the wide array of interventions reported to be available for child exposed to complex trauma, no clear clinical consensus emerged regarding the relative effectiveness of available modalities. Notably, 5 the top 7 intervention modalities identified by clinicians to be most effective with complex trauma in children—*play therapy*, *expressive therapies*, *multisystemic therapy*, *group therapy*, and *self-management/coaching*—were also ranked among the 7 least effective interventions with this population. Only *weekly individual therapy* and *family therapy* were unequivocally perceived to be effective modalities with this population, with *pharmacotherapy* and *home-based therapies* consistently rated as ineffective. Nevertheless, the majority of clinicians surveyed spontaneously identified the active involvement of caregivers in children’s treatment as a crucial element of the treatment’s effectiveness. A number of clinicians also noted the utility of combined approaches to intervention, as well as the need to tailor intervention services to children’s specific needs based on contextual factors, which include developmental stage, sociocultural context, and the availability of environmental resources. Finally, several clinicians pointed to the importance of coordinating services across service sectors (e.g., schools, mental health, social services) to ensure effective intervention for children exposed to complex trauma.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

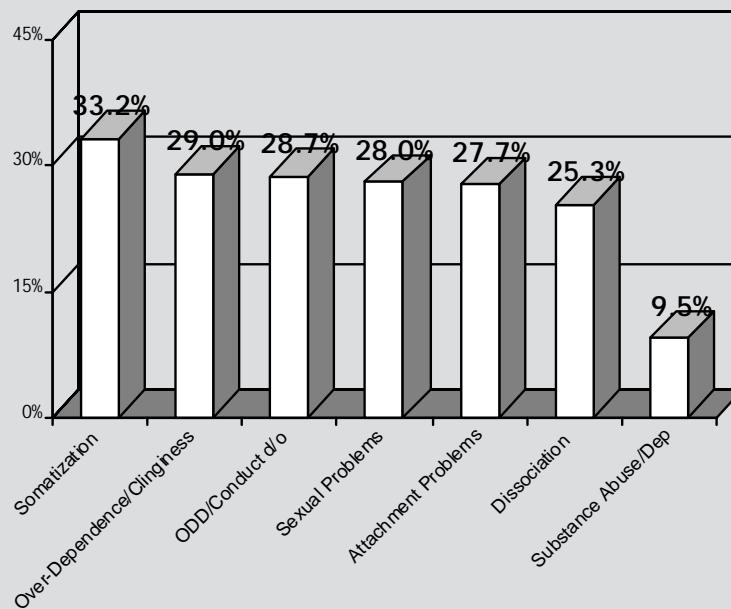
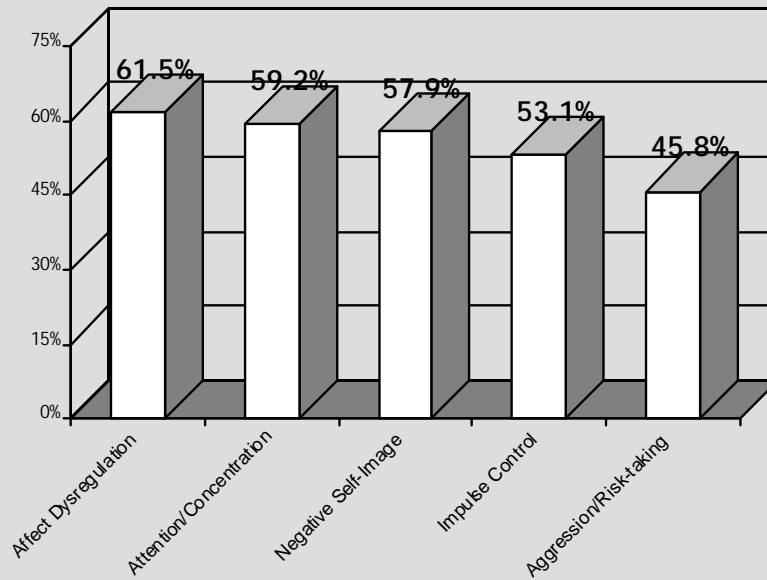
Figure 1: Trauma Exposure Prevalence in the National Child Traumatic Stress Network (N = 1,699)

Child Trauma History: Most Frequent Exposure Types



COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

Figure 2: Complex Trauma Adaptation in the National Child Traumatic Stress Network (N = 1,699)



References

- Ainsworth, M. S., Blehar, M. C., Waters, E., (1978). *Patterns of attachment: A psychological study of the strange situation*. Oxford, England: Lawrence Erlbaum.
- Allen, R. E., & Oliver, J. M. (1982). The effects of child maltreatment on language development. *Child Abuse & Neglect, 6*, 299-305.
- Anda, R. (2002, November). The wide ranging health effects of adverse childhood experiences. Paper presented at the 18th Annual Meeting of the International Society for Traumatic Stress Studies, Baltimore, MD.
- Beeghly, M., & Cicchetti, D. (1996). Child maltreatment, attachment, and the self system: Emergence of an internal state lexicon in toddlers at high social risk. In M. Hertzog, & E. Farber (Eds.). *Annual progress in child psychiatry and child development* (pp. 127-166). Philadelphia, PA: Brunner/Mazel.
- Beers, S. R., & De Bellis, M. D. (2002). Neuropsychological function in children with maltreatment-related posttraumatic stress disorder. *Journal of Psychiatry, 159*, 483-486.
- Benes, F. M., Turtle, M., & Khan, Y. (1994). Myelination of a key relay zone in the hippocampal formation occurs in the human brain during childhood, adolescence, and adulthood. *Archives of General Psychiatry, 51*, 477-484.
- Bernstein, E. M., & Putnam, F. W. (1986). Development, reliability, and validity of a dissociation scale. *Journal of Nervous & Mental Disease, 174*, 727-735.
- Bowlby, J. (1988). *A secure base: Parent-child attachment and healthy human development*. New York, NY: Basic Books.
- Briere, J., & Spinazzola, J. (in press). Phenomenology and psychological assessment of complex posttraumatic states. *Journal of Traumatic Stress*.
- Cahill, L. T., Kaminer, R. K., Johnson, P. G. (1999). Developmental, cognitive, and behavioral sequelae of child abuse. *Child & Adolescent Psychiatric Clinics of North America, 8*, 827-843.
- Cassidy, J., & Mohr, J. J. (2001). Unsolvability, fear, trauma, and psychopathology: Theory, research, and clinical considerations related to disorganized attachment across the life span. *Clinical Psychology: Science & Practice, 8*, 275-298.
- Champagne, F., & Meaney, M. J. (2001). Like mother, like daughter: Evidence for non-genomic transmission of parental behavior and stress responsivity. *Progress in Brain Research, 133*, 287-302.
- Chemtob, C. M., Tolin, D. F., van der Kolk, B. A. (2000). Eye movement desensitization and reprocessing. In E. B. Foa & T. M. Keane (Eds.), *Effective treatments for PTSD: Practice guidelines from the International Society for Traumatic Stress Studies* (pp. 139-154). New York, NY: Guilford Press.
- Chu, J. (1991). The Repetition compulsion revisited: Reliving dissociated trauma. *Psychotherapy, 28*, 327-332.
- Cicchetti, D., & Beeghly, M. (1987). Symbolic development in maltreated youngsters: An organizational perspective. *New Directions for Child Development, 36*, 47-68.
- Cicchetti, D., & Lynch, M. (1995). Failures in the expectable environment and their impact on individual development: The case of child maltreatment. In: D. Cicchetti & D. J. Cohen (Eds.), *Developmental psychopathology, Vol. 2: Risk, disorder, and adaptation* (pp. 32-71). New York: John Wiley & Sons.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

- Cicchetti, D., & Toth, S. (1995). A developmental psychopathology perspective on child abuse and neglect. *Journal of the American Academy of Child and Adolescent Psychiatry, 34*, 541-564.
- Cloitre, M. (2002, November). *Working with the multiply traumatized adolescent*. Paper presented at the Pre-Meeting Institute at the International Society of Traumatic Stress Studies, Baltimore, MD.
- Cloitre, M., Koenen, K., Cohen, L.R., & Han, H. (2002). Skills training in affective and interpersonal regulation followed by exposure: A phase-based treatment for PTSD related to childhood abuse. *Journal of Consulting and Clinical Psychology, 70*, 1067-1074.
- Cohen, J.A., & Mannarino, A.P. (1998). Interventions for sexually abused children: Initial treatment findings. *Child Maltreatment, 3*, 53-62.
- Cohen, J. A., Mannarino, A. P., Berliner, L., & Deblinger, E. (2000). Trauma-focused cognitive behavioral therapy for children and adolescents: An empirical update. *Journal of Interpersonal Violence, 15*, 1202-1223.
- Cook, A., Henderson, M., & Jentoft, K. (2003, May). *Out of the Office and into the community*. Presented at The Boston Trauma Conference, Boston, MA.
- Crittenden, P. (1998). Dangerous behavior and dangerous contexts: A 35-year perspective on research on the developmental effects of child physical abuse. In P. Trickett & C. Schellenbach (Eds.), *Violence Against Children in the Family and the Community* (pp. 11-38). Washington, DC: American Psychological Association.
- Crittenden, P.M., & DiLalla, D.L. (1988). Compulsive compliance: The development of an inhibitory coping strategy in infancy. *Journal of Abnormal Child Psychology, 16*, 585-599.
- Culp, R. E., Watkins, R. V., Lawrence, H., Letts, D., et al. (1991). Maltreated children's language and speech development: Abused, neglected, and abused and neglected. *First Language, 11*, 377-389.
- De Bellis, M. D., Keshavan, M. S., & Shifflett, H. (2002). Brain structures in pediatric maltreatment-related posttraumatic stress disorder: A sociodemographically matched study. *Biological Psychiatry, 52*, 1066-1078.
- Deblinger, E., & Heflin, A. (1996). *Cognitive behavioral interventions for treating sexually abused children*. Thousand Oaks, CA: Sage.
- Demitrack, M. A., Putnam, F. W., & Rubinow, D. R. (1993). Relation of dissociative phenomena to levels of cerebrospinal fluid monoamine metabolites and beta-endorphin in patients with eating disorders: A pilot study. *Psychiatry Research, 49*, 1-10.
- DeRosa, R., Pelcovitz, D., Kaplan, S., Rathus, J., Ford, J., Layne, C., & Saltzman, W. (2003). *Group treatment for adolescents with complex PTSD manual*. North Shore University Hospital, Adolescent Trauma Treatment Development Center, National Child Traumatic Stress Network.
- Dinwiddie, S., Heath, C., Dunne, M., Bucholz, K., Madden, P., Slutske, W., Bierut, L., Statham, D. & Martin, N. (2000). Early sexual abuse and lifetime psychopathology: A co-twin-control study. *Psychological Medicine, 30*, 41-52.
- Dube, S.R., Anda, R.F., Felitti, V.J., Chapman, D.P., Williamson, D.F., & Giles, W.H. (2001). Childhood abuse, household dysfunction, and the risk of attempted suicide throughout the life span: Findings from the adverse childhood experiences study. *JAMA: Journal of the American Medical Association, 286*, 3089-3096.
- Dube, S. R., Anda, R. F., Felitti, V. J., Croft, J. B., Edwards, V. J., & Giles, W. H. (2001). Growing up with parental alcohol abuse: Exposure to childhood abuse, neglect, and household dysfunction. *Child Abuse & Neglect, 25*, 1627-1640.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

- Eckenrode, J., Laird, M., & Doris, J. (1993). School performance and disciplinary problems among abused and neglected children. *Developmental Psychology, 29*, 53-62.
- Egeland, B. R., Carlson, E., & Sroufe, L. A. (1993). Resilience as process. *Development & Psychopathology, 5*(4), *Special Issue: Milestones in the development of resilience*, 517-528.
- Egeland, B., Sroufe, A., & Erickson, M. (1983). The developmental consequence of different patterns of maltreatment. *Child Abuse & Neglect, 7*, 459-469.
- Felitti, V.J., Anda, R.F., Nordenberg, D., Williamson, D.F., Spitz, A.M., Edwards, V., et al. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The adverse childhood experiences (ACE) study. *American Journal of Preventive Medicine, 14*, 245-258.
- Fergusson, D. M., Lynskey, M. T., & Horwood, L. J. (1996). Childhood sexual abuse and psychiatric disorder in young adulthood: I. Prevalence of sexual abuse and factors associated with sexual abuse. *Journal of the American Academy of Child & Adolescent Psychiatry, 35*, 1355-1364.
- Fergusson, D. M., Horwood, L. J., & Lynskey, M. T. (1996). Childhood sexual abuse and psychiatric disorder in young adulthood: II. Psychiatric outcomes of childhood sexual abuse. *Journal of the American Academy of Child & Adolescent Psychiatry, 35*, 1365-1374.
- Finkelhor, D., & Kendall-Tackett, K. (1997). A developmental perspective on the childhood impact of crime, abuse and violent victimization. In D. Cicchetti & S. Toth (Eds.), *Rochester Symposium on Developmental Psychopathology and Developmental Perspectives on Trauma* (pp. 1-32). Rochester, NY: University of Rochester Press.
- Ford, J. (in press). *Treatment of the complex sequelae of psychological treatment*. Special Issue of the *Journal of Traumatic Stress*.
- Ford, J.D., Racusin, R., Ellis, C., Daviss, W.B., Reiser, J., Fleischer, A., & Thomas, J. (2000). Child maltreatment, other trauma exposure, and posttraumatic symptomatology among children with Oppositional Defiant and Attention Deficit Hyperactivity Disorders. *Child Maltreatment, 5*, 205-217.
- Friedrich, W. N. (2002). Psychological assessment of sexually abused children and their families. Thousand Oaks, CA: Sage Publications.
- Fromm, S. (2001). Total estimated cost of child abuse and neglect in the United States. *Prevent Child Abuse America*.
- Gaensbauer, Mrzaek, D. & Harmon, R. (1981). Emotional expression in abused and/or neglected infants. In N. Frude (Ed.), *Psychological Approaches to Child Abuse* (pp. 120-135). Totowa, NJ: Rowan and Littlefield.
- Garbarino, J., & Kostelny, K. (1996). The effects of political violence on Palestinian children's behavior problems: A risk accumulation model. *Child Development, 67*, 33-45.
- Garbarino, J., Kostelny, K., & Grady, J. (1993). Children in dangerous environments: Child maltreatment in the context of community violence. In D. Cicchetti & S. Toth (Eds.), *Child Abuse, Child Development, and Social Policy* (pp. 167-189). Norwood, NJ: Ablex Publishing Corporation.
- Gordon, H. W. (2002). Early environmental stress and biological vulnerability to drug abuse. *Psychoneuroendocrinology, 27*(1-2), *Special Issue: Stress and drug abuse*, 115-126.
- Greenwald, R. (1998). Eye movement desensitization and reprocessing (EMDR): New hope for children suffering from trauma and loss. *Clinical Child Psychology and Psychiatry, 3*, 279-287.
- Gunnar, M. R., & Donzella, B. (2002). Social regulation of the cortisol levels in early human development. *Psychoneuroendocrinology, 27*(1-2), *Special Issue: Stress and drug abuse*, 199-220.
- Hembree-Kigin, T.L., & McNeil, C.B. (1995) *Parent-child interaction therapy*. Kluwer Academic/Plenum Press.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

- Herman J. L., Perry J. C., & van der Kolk B. A. (1989). Childhood trauma in Borderline Personality Disorder. *American Journal of Psychiatry*, *146*, 490-495.
- Herman, J. (1992). Complex PTSD: A syndrome in survivors of prolonged and repeated trauma. *Journal of Traumatic Stress*, *5*, 377-391.
- James, B. (1989). *Treating traumatized children: New insights and creative interventions*. Lexington, MA: Lexington Books/D. C. Heath and Com.
- James, B. (1994). *Handbook for treatment of attachment-trauma problems in children*. New York: Maxwell Macmillan International
- Kagan J. (2003). *Surprise, uncertainty and mental structures*. Cambridge, MA: Harvard University Press.
- Kagan, R. (in press). *Rebuilding attachments with traumatized children: Healing from losses, violence, abuse, and neglect*. Binghamton, NY: Haworth Press.
- Kaufman, J., Plotsky, P. M., & Nemeroff, C. B. (2000). Effects of early adverse experiences on brain structure and function: Clinical implications. *Biological Psychiatry*, *48*, 778-790.
- Kendall-Tackett, K. A., Williams, L. M., & Finkelhor, D. (1993). Impact of sexual abuse on children: A review and synthesis of recent empirical studies. *Psychological Bulletin*, *113*, 164-180.
- Kurtz, P. D., Gaudin, J. M., Wodarski, J. S., & Hoving, P. T. (1993). Maltreatment and the school-aged child: School performance consequences. *Child Abuse & Neglect*, *17*, 581-589.
- Leiter, J., & Johnsen, M. C. (1994). Child maltreatment and school performance. *American Journal of Education*, *102*, 154-189.
- Lieberman, A. F., Van Horn, P., Grandison, C. M., & Pekarsky, J. H. (1997). Mental health assessment of infants, toddlers, and preschoolers in a service program and a treatment outcome research program. *Infant Mental Health Journal*, *18*, 158-170.
- Liem, J. H., & Boudewyn, A. C. (1999). Contextualizing the effects of childhood sexual abuse on adult self- and social functioning: An attachment theory perspective. *Child Abuse & Neglect*, *23*, 1141-1157.
- Loo, C., Fairbank, J., Scurfield, R., Ruch, L., King, D., Adams, L., & Chemtob, C. (2001). Measuring exposure to racism: Development and validation of a Race-Related Stressor Scale (RRSS) for Asian American Vietnam veterans. *Psychological Assessment*, *13*, 503-520.
- Luthar, S.S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, *71*, 543-562.
- Lyons-Ruth, K., & Jacobovitz, D. (1999). Attachment disorganization: Unresolved loss, relational violence, and lapses in behavioral and attentional strategies. In: J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical application*. (pp.520-554). New York, NY.
- Macy, R., Macy, D., Gross, S., & Brighton, P. (1999-2003). Basic and advanced training manual for the 12-session classroom based psychosocial intervention program (CBI): Stress inoculation targeting threat & terror for K-8th grade youth. *The Center for Trauma Psychology*, Boston, MA.
- Main, M., & Goldwyn, R. (1994). *Adult Attachment Rating and Classification Systems, Version 6.0*. Unpublished manuscript, University of California at Berkeley.
- Manson, S. (1996). The wounded spirit: A cultural formulation of posttraumatic stress disorder. *Culture, Medicine and Psychiatry*, *20*, 489-498.
- Margolin, G. (2000). The effects of family and community violence on children. *Annual Review of Psychology*, *1-40*.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

- Marsella, A.J., Friedman, M.J., Gerrity, E.T., & Scurfield, R.M. (Eds.) (1996). *Ethnocultural aspects of posttraumatic stress disorder: Issues, research, and clinical applications*. Washington, DC: American Psychological Association.
- Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist*, *56*, 227-238.
- Masten, A., & Coatsworth, J., (1998). The development of competence in favorable and unfavorable environments: Lessons from research of successful children. *American Psychologist*, *53*, 205-220.
- Maunder, R. G., & Hunter, J. J. (2001). Attachment and psychosomatic medicine: Developmental contributions to stress and disease. *Psychosomatic Medicine*, *63*, 556-567.
- Mezzacappa, E., Kindlon, D., & Earls, F. (2001). Child abuse and performance task assessments of executive functions in boys. *Journal of Child Psychology & Psychiatry & Allied Disciplines*, *42*, 1041-1048.
- Miller, T.W. (Ed.) (1998). *Children of trauma: Stressful life events and their effects on children and adolescents*. Madison, CT: International Universities Press.
- National Child Abuse and Neglect Data System (2001). The Children's Bureau of the U.S. Department of Human Services.
- Nelson, E., Heath, A., Madden, P., Cooper, M., Dinwiddie, S., Bucholz, K., et al. (2002). Association between self-reported childhood sexual abuse and adverse psychosocial outcomes: Results from a twin study. *Archives of General Psychiatry*, *59*, 139-146.
- Ohan, J.L., Myers, K., & Collett, B.R., (2002). Ten-year review of rating scales. IV: Scales assessing trauma and its effects. *Journal of the American Academy of Child & Adolescent Psychiatry*, *41*, 1401-1422.
- Parson, E.R. (1997). Posttraumatic child therapy (P-TCT): Assessment and treatment factors in clinical work with inner-city children exposed to catastrophic community violence. *Journal of Interpersonal Violence*, *12*, 172-194.
- Pearce, J. W., & Pezzot-Pearce, T. D. (1997). *Psychotherapy of abused and neglected children*. New York, NY: Guilford Press.
- Pelcovitz, D., van der Kolk, B., Roth, S., Mandel, F., Kaplan, S. & Resick, P. (1997). Development of a criteria set and a structured interview for disorders of extreme stress (SIDES). *Journal of Traumatic Stress*, *10*, 3-16.
- Pelletier, M. (2001). Total annual cost of child abuse and neglect in the United States. *Prevent Child Abuse America*.
- Perry, B. D., & Pollard, R. (1998). Homeostasis, stress, trauma, and adaptation: A neurodevelopmental view of childhood trauma. *Child & Adolescent Psychiatric Clinics of North America*, *7*, 33-51.
- Putnam, F. (1993). Dissociative disorders in children: Behavioral profiles and problems. *Child Abuse and Neglect*, *17*, 39-45.
- Putnam, F. W. (1997). *Dissociation in children and adolescents: A developmental perspective*. New York, NY: Guilford Press.
- Putnam, F. (2003). Ten-year research update review: Child sexual abuse. *Journal of the American Academy of Child and Adolescent Psychiatry*, *43*, 269-278.
- Rabalais, A., Ruggiero, K., & Scotti, J. (2002). Multicultural issues in the response of children to disasters. In A. La Greca, W. Silverman, E. Vernberg, & M. Roberts (Eds.), *Helping children cope with disasters and terrorism* (pp. 73-99). Washington: American Psychological Association.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

- Rivard, J. C., Bloom, S. L., Abramovitz, R., Pasquale, L. E., Duncan, M., McCorkle, D. et al. (2003). Assessing the implementation and effects of a trauma-focused intervention for youths in residential treatment. *Psychiatric Quarterly*, *74*, 137-154.
- Salmon, K., & Bryant, R.A. (2002). Posttraumatic stress disorder in children: The influence of developmental factors. *Clinical Psychology Review*, *22*, 163-188.
- Sandgrund, A., Gaines, R. W. & Green, A. H. (1974). Child abuse and mental retardation: A problem of cause and effect. *American Journal of Mental Deficiency*, *79*, 327-330.
- Schneider-Rosen, K., & Cicchetti, D. (1991). Early self-knowledge and emotional development: Visual self-recognition and affective reactions to mirror self-images in maltreated and non-maltreated toddlers. *Developmental Psychology*, *27*, 471-478.
- Schore, A. (2001). The effects of early relational trauma on right brain development, affect regulation, and infant mental health. *Infant Mental Health Journal*, *22*, 201-269.
- Schore, A. N. (2002). Advances in neuropsychoanalysis, attachment theory, and trauma research: Implications for self psychology. *Psychoanalytic Inquiry*, *22*, Special Issue: *Self-regulation: Issues of attention and attachment*, 433-484.
- Sedlak, A., & Broadhurst, D. (1996). Executive summary of the third national incidence study of child abuse and neglect (NIS-3). *National Clearinghouse on Child Abuse and Neglect Information*. Washington, DC: U.S. Department of Health and Human Services.
- Shonk, S. M., & Cicchetti, D. (2001). Maltreatment, competency deficits, and risk for academic and behavioral maladjustment. *Developmental Psychology*, *37*, 3-17.
- Siegel, D.J. (1999). *The developing mind: Toward a neurobiology of interpersonal experience*. New York, NY: Guilford Press.
- Silva, R.R., Cloitre M., Davis L., Levitt J., Gomez S., Ngai I, & Brown, E. (in press). Early Intervention with Traumatized Children. *Psychiatric Quarterly*, *74*.
- Simpson, T. L., & Miller, W. R. (2002). Concomitance between childhood sexual and physical abuse and substance use problems: A review. *Clinical Psychology Review*, *22*, 27-77.
- Spinazzola, J., Ford, J., van der Kolk, B., Blaustein, M., Brymer, M., Gardner, L., M., Silva, S., et al. (2003, November). *Complex trauma in the National Child Traumatic Stress Network*. Paper presented at the 19th Annual Meeting of the International Society for Traumatic Stress Studies, Chicago, IL. <http://www.nctsnet.org>.
- Stein, M. B., Koverola, C., Hanna, C., Torchia, M. G., & McClarty (1997). Hippocampal volume in women victimized by childhood sexual abuse. *Psychological Medicine*, *27*, 951-959.
- Teicher, M. H., Andersen, S. L., & Polcari, A. (2002). Developmental neurobiology of childhood stress and trauma. *Psychiatric Clinics of North America*, *25*, Special Issue: *Recent advances in the study of biological alterations in post-traumatic stress disorder*, 397-426.
- Trickett, P., McBride-Chang, C., & Putnam, F. (1994). The classroom performance and behavior of sexually abused females. *Development & Psychopathology*, *6*, 183-194.
- Turner, K., DeRosa, R., Batson, R., & Davidson, J.R.T. (1996). A multi-modal treatment for incest survivors: Preliminary outcome data. *Clinical Psychology and Psychotherapy*, *3*, 208-219.
- Vaillant, G. E. (1994). Ego mechanisms of defense and personality psychopathology. *Journal of Abnormal Psychology*, *103*, 44-50.
- Vaillant, G. E., Bond, M., & Vaillant, C.O. (1986). An empirically validated hierarchy of defense mechanisms. *Archives of General Psychiatry*, *73*, 786-794.

COMPLEX TRAUMA IN CHILDREN AND ADOLESCENTS

- van der Kolk B.A. (2003). The neurobiology of childhood trauma and abuse. *Child and Adolescent Clinics of North America*, 12, 293-317.
- van der Kolk, B.A., Pelcovitz, D., Roth, S., Mandel, F., McFarlane, A.C., Herman, J. (1996). Dissociation, somatization and affect dysregulation: The complexity of adaptation to trauma. *American Journal of Psychiatry*, 153 (suppl), 83-93.
- van der Kolk, B., Roth, S., Pelcovitz, D., Mandel, F., & Spinazzola, J. (in press). Disorders of Extreme Stress: The empirical foundation of complex adaptation to trauma. *Journal of Traumatic Stress*.
- van der Kolk, B. A., van der Hart, O. & Marmar, C. (1996). Dissociation and Information processing and in PTSD. In B. A. van der Kolk, A. C. McFarlane & L. Weisaeth (Eds.), *Traumatic Stress: The effects of overwhelming experience on mind, body and society* (pp. 303-327). New York: Guilford Press.
- Vondra, J., Barnett, D., & Cicchetti, D. (1989). Perceived and actual competence among maltreated and comparison school children. *Development & Psychopathology*, 1, 237-255.
- Vondra, J. I., Barnett, D., & Cicchetti, D. (1990). Self-concept, motivation, and competence among preschoolers from maltreating and comparison families. *Child Abuse & Neglect*, 14, 525-540.
- Waller, M. A. (2001). Resilience in ecosystemic context: Evolution of the concept. *American Journal of Orthopsychiatry*, 71, 290-297.
- Weiss, D. S., Marmar, C. R., Metzler, T. J., & Ronfeldt, H. M. (1995). Predicting symptomatic distress in emergency services personnel. *Journal of Consulting & Clinical Psychology*, 63, 361-368.
- Werner A .A., & Smith A. E. (1992). *High risk children from birth to adulthood*. Ithaca, NY: Cornell University Press.
- Wiehe, V. (1997). Approaching child abuse treatment from the perspective of empathy. *Child Abuse and Neglect*, 21, 1191-1204.
- Winston, F., Kassam-Adams, N., Vivarelli-O'Neil, C., Ford, J., Newman, E., Baxt, C., Stafford, P., & Cannan, A. (2002). Acute stress disorder in children and their parents after pediatric traffic injury. *Pediatrics*, 109, e90.
- Wyman, P. A., Sandler, I., Wolchik, S., & Nelson, K. (2000). Resilience as cumulative competence promotion and stress protection: Theory and intervention. In D. Cicchetti & J. Rappaport (Eds.), *The promotion of wellness in children and adolescents* (pp. 133-184). Washington, DC: Child Welfare League of America.
- Yehuda, R., Spertus, I. L., & Golier, J. A. (2001). Relationship between childhood traumatic experiences and PTSD in adults. In S. Eth (Ed.), *PTSD in children and adolescents* (pp. 117-158). Washington, DC: American Psychiatric Association.
- Zlotnick, C., Ryan, C., Miller, I., & Keitner, G. (1995). Childhood abuse and recovery from depression. *Child Abuse & Neglect*, 19, 1513-1516.

Citation for this Document:

Cook, A., Blaustein, M., Spinazzola, J., & van der Kolk, B. (Eds.) (2003). *Complex trauma in children and adolescents*. National Child Traumatic Stress Network. <http://www.NCTSNet.org>

www.NCTSNet.org

Page purposely left blank for back cover sheet

Complex Trauma:

In Juvenile Justice System-Involved Youth



Elizabeth is a 17-year-old Hispanic female whose father was murdered by a drug dealer when she was three years old. After his death, she, her mother, stepfather, and two older sisters lived together in an economically disadvantaged neighborhood. Her stepfather, who left when she turned 12, physically and verbally abused Elizabeth and her other family members. Elizabeth's mother was also verbally and physically abusive toward her.

Elizabeth also remembers being bullied in elementary school. In addition to the direct maltreatment she experienced, she has known several female family members and friends – including her sister and her best friend from preschool – who were sexually assaulted.

Elizabeth first began affiliating with gangs when she was 12 years old and considered them her “real family.” She started smoking marijuana heavily after joining the gang and used multiple other substances to get high. At age 13, she assaulted another teen and received 18 months of house arrest. She reports that she “blacked out” during this incident and doesn’t remember much of it. She later discovered that she had broken the youth’s nose and arm. Despite her lack of recall about that assault, however, she reports that she is haunted by the image of seeing someone shot in the head and watching him die. At the age of 16, she was convicted of drug- and weapons-related offenses and was sentenced to a youth detention center for a year. At the time, she reported that beating people up was part of her gang’s expectations for belonging.

As Elizabeth’s story illustrates, youth who come to the attention of law enforcement and become involved in the juvenile justice system are often experiencing the after-effects of years of exposure to complex interpersonal trauma. These youth have faced repeated threats to their lives or the lives of people closest to them. Losing key people in their lives, and experiencing betrayals of trust and abandonment from caregivers, compound the violations of the basic social contract that every youth should have an equal opportunity to have a successful life as a valued member of society.

These survival threats and painful emotional (and often also physical) injuries are a part of daily life and second nature for too many youth who become involved with law enforcement and juvenile justice. They also are forms of complex trauma that can have lifelong adverse effects.

More than two-thirds of youth involved with law enforcement or juvenile justice have complex histories of interpersonal trauma, including exposure to neglect, emotional, physical, and sexual abuse, family and community violence, traumatic losses, and disrupted relationships with primary caregivers (Ford, et al., 2013). Many also come from families in which caregivers and siblings are coping with other adversities such as substance abuse, mental health problems, unemployment, or discrimination based on race, ethnicity, sexual identity, or disability, legal problems, or incarceration). Youth from ethnic and racial minorities and those from low-income backgrounds are disproportionately involved in the juvenile justice system and subject to these additional adversities.

WHAT IS COMPLEX TRAUMA?

The term complex trauma describes both children's exposure to multiple traumatic events, often of an invasive, interpersonal nature, and the wide-ranging, long-term impact of this exposure. These events are severe and pervasive, such as abuse or profound neglect. They usually begin early in life and can disrupt many aspects of the child's development, including the formation of a self. Since these adversities frequently occur in the context of the child's relationship with a caregiver, they can interfere with the child's ability to form a secure attachment bond. Many aspects of a child's healthy physical and mental development rely on this primary source of safety and stability.

PATHWAYS FROM COMPLEX TRAUMA TO INVOLVEMENT IN JUVENILE JUSTICE AND RECIDIVISM

The pathways from complex trauma exposure to involvement in juvenile justice and recidivism are correspondingly complex and variable. **One common denominator is the adoption of an unstated code of behavior.** This "survival code" differs from the established rules of the majority society, and is a direct consequence of traumatic stress on emotional, physiological, and behavioral factors which place youth at increased risk of committing offenses. The experience of complex trauma violates the social contract that lies at the heart of societal laws and structures: the unspoken contract that says that good deeds and behavior are rewarded, that perpetrating harm should and will be punished, and that maintaining order is mutually beneficial. For youth who have experienced repeated violence, violation, exploitation, rejection, and abandonment in their homes, schools, and communities, safety and justice seem impossible to obtain. As a result, the rubric of survival ("What do I have to do to survive?") is likely to trump legality ("Is this behavior appropriate within the laws of my community and society?").

A second common denominator for youth with complex trauma histories who are involved with law enforcement or juvenile justice is difficulty in effectively managing emotions, physical reactions, impulses, attention, consequential thinking (i.e., problem-solving and decision-making based on an awareness of and accurate

evaluation of consequences), and involvement in interpersonal relationships (i.e., ranging from extreme isolation to enmeshment in dangerous or exploitive relationships). These are the building blocks for self-regulation, the ability to draw on one's own inner strengths and genuinely supportive relationships in order to channel motivation, manage distress, and think effectively. The development in childhood of these self-regulation capacities is severely undermined by complex trauma.

As a result, these youth often have problems in school, family relationships, and with substance abuse, sexualized behaviors, risky or reckless behavior, delinquency, and running away. On the surface, these behaviors may appear to be motivated by disregard for their own or others' safety and well-being and the law, but actually they are attempts to cope with or prevent further traumatization. Seen from the perspective of these youths' internal realities, their excessive suspiciousness, hostility, defiance, and disconnection from relationships with others may be necessary adaptations in order to prevent further vulnerability, betrayal, and victimization.

COMPLEX TRAUMA AND GIRLS IN THE JUSTICE SYSTEM

Girls now account for approximately 30 percent of the estimated 2.11 million juvenile arrests made each year. On any given day, more than 7,800 girls reside in detention or juvenile corrections facilities in the US (Kerig & Ford, 2014). Girls' arrest rates for violent offenses—including physical assault, sexual assault, and homicide—have increased 78 percent while declining 6 percent for boys. Girls in the justice system also report higher levels of exposure to traumatic experiences, interpersonal victimization (particularly forms of abuse that occur in the context of close personal relationships such as family violence and sexual assault), and mental health problems, including PTSD, than their male peers. Among traumatized girls, researchers have found heightened stress-reactivity, developmental lags, and adverse effects of traumatic maltreatment. These effects increase the risk for “intra- and inter-relational chaos” and lead to volatile and conflictual relationships, as well as involvement with antisocial romantic partners. These relationship choices, in turn, increase the risk not only of justice-involvement but of subsequent intimate partner violence and re-victimization (Chamberlain & Leve, 2004). Experiences of trauma, maltreatment, and victimization play a role in placing girls on the pathway toward delinquency, re-traumatization, and chronic exposure to complex trauma. Other researchers observe that many girls in the justice system have endured their most traumatic experiences in the context of close personal relationships, and that involvement in those relationships also increases the risk of their perpetrating violence themselves. Fostering positive relationships may play a significant role in helping girls both to heal from trauma and avoid furthering a course leading to more involvement with the juvenile justice system.

HOW YOUTH IN THE JUVENILE JUSTICE SYSTEM ARE AFFECTED BY COMPLEX TRAUMA

Survival-oriented coping, although necessary for self-protection when complex trauma is occurring (or could re-occur, even during periods of apparent safety), may compromise the functioning of three key systems in the brain and body:

- The **reward/motivation system** that is essential for attention, learning, initiating and completing tasks, and social and moral judgment;
- The **distress tolerance system** that is crucial to coping with frustration, boredom, unhappiness, worry, sadness, fear, guilt, shame, and depression; and
- The **executive system** that is necessary for proactive problem-solving, sustained and focused attention, setting goals and making and carrying out plans to achieve them, and recognizing and utilizing emotions as a guide to personal decisions and relationships.



Thus, youth with complex trauma histories tend to have extremely high “survival IQs,” but due to operating in survival mode they often experience serious difficulties in several areas:

- stopping to think before reacting
- setting and achieving goals that involve positive outcomes
- handling intense feelings of frustration/anger without resorting to aggression
- handling intense feelings of disappointment/hopelessness without becoming isolative, reckless, self-harming, or suicidal
- using alcohol and drugs to cope with frustration, boredom, and hopelessness
- developing and maintaining relationships based on mutual trust and well-being
- following social and legal rules and expectations
- recognizing their own self-worth and positive accomplishments

Often youth who have had to survive complex trauma and have become involved in the juvenile justice system appear defiant, unmotivated, and “incorrigible” as a result of attempting to deny and conceal distress, disillusionment, and self-blame through a façade of indifference or aggression. In order to gain a sense of personal control, relief from distress, social inclusion, and self-esteem, they may turn to self-medication, avoidance and isolation, or choose peer relationships based on detachment from or rejection of mainstream values, norms, and cultural practices.

RECOMMENDATIONS

Although complex trauma leads youth to be suspicious or even defiant toward adults who offer help, these youth are very resilient and can be reached by adults who are willing to support them patiently – not by endorsing actions that are illegal, dangerous, or harmful, but by aligning with these youths’ core goals, values, and personal strengths, and offering guidance that empowers rather than judges them.

For Judges and Juvenile Justice Program Administrators

The Substance Abuse and Mental Health Services Administration (SAMHSA) provides practical guidance for leaders such as judges and administrators who are seeking to implement a trauma-informed approach in their systems.

- Ensure that all staff as well as all youth and families have the knowledge, tools and resources needed in order to **realize** the impact of trauma in youths’ daily lives.
- **Recognize** the role that trauma-related reactions and survival coping play in youths’ behavioral, emotional, and legal problems.
- **Respond** in a manner that enhances the safety of the youth as well as the community and the youth’s ability to achieve her/his full potential through developing a healthy lifestyle, skills, and relationships. And,
- Prevent **re-traumatization** or the triggering of trauma-related memories.

Adding to SAMHSA's "4 Rs," as this guidance is known, the National Child Traumatic Stress Network (NCTSN) has identified eight essential elements of trauma-informed practice to support youth in the juvenile justice system who have been complexly traumatized. These are:

- 1 Ensure the physical and psychological safety of all youth, family members, and staff through the development of trauma-informed policies and procedures.
- 2 Identify youth who have experienced complex trauma through carefully timed screening.
- 3 Offer clinical assessment and trauma-focused intervention for complexly traumatized youth who have been identified as impaired in the screening process.
- 4 Provide trauma-informed programming and staff education on complex trauma for staff across all components of the juvenile justice system.
- 5 Recognize and respond to the adverse effects of secondary traumatic stress in the workplace in order to support workforce safety, effectiveness, and resilience.
- 6 Engage youth and their families as partners in all juvenile justice programming and therapeutic services.
- 7 Through cross-system collaboration, ensure the provision of continuous integrated services to justice-involved youth who have experienced complex trauma.
- 8 Review practices and policies to ensure that they address the diverse and unique needs of all groups of youth and do not result in disparities related to race, ethnicity, gender, gender-identity, sexual orientation, age, intellectual and developmental level, or socioeconomic background.

Other steps the juvenile justice system can take to help youth recover from complex trauma while pursuing the mission of ensuring public safety have been outlined in the [Report of the Attorney General's National Task Force on Children Exposed to Violence](#) and include:

- Limit laws and policies that have unintended negative consequences for youth with complex trauma (e.g., seclusion, restraints, shackling, pepper spray, and other potentially traumatizing sanctions, crisis interventions, and behavioral management strategies).
- Foster the social and emotional development of youth as a co-equal goal to preserving public safety. This is because public safety depends upon having youth who are able to develop into productive and responsible citizens.
- Provide services that increase the safety of youth who are being traumatized by abuse, sexual exploitation/trafficking, and stigma due to their racial/ethnic background, gender or sexual identity, or disabilities.

For Parents, Family Members, and Adults Who Supervise Youth

- Take time to build trust with youth with complex trauma. Each has a personal story to share with only a few people who have earned his or her trust. Knowing the youth's story is the crucial first step to helping that youth build a good life.
- It takes a community: everyone in the youth's family and other supportive relationships must join together in order to heal their lives and make the community safe and healing.
- Strive to make every interaction with youth an honest and respectful dialogue by setting a model for how everyone—not just the youth—can and must “walk the walk” by taking responsibility for their emotions and actions and striving to achieve social justice.
- Be open to alternative ways of understanding the youths' motivations that highlight their core values, goals, and competencies instead of stigmatizing them as “incorrigible,” “unmotivated,” or “delinquent.”
- When conflict or disagreements occur, remember that it is developmentally appropriate for adolescents to be on an emotional rollercoaster and to assert their independence by debating everything others say. When adults are able to model being emotionally regulated and respectful this shows the adolescent that it's possible to work out disagreements without anyone being disrespected or being forced to be the “loser.”
- Remember there is no “one size fits all” formula that can be applied to all complexly traumatized youth—each youth is an individual who needs to be known and understood as the person that she/he is capable of being, rather than being treated as “just another bad kid” or “just another victim.”



SOURCES

- Chamberlain, P., & Leve, L. D. (2004). Female juvenile offenders: Defining an early-onset pathway for delinquency. *Journal of Child & Family Studies, 13*, 439-452.
- Cook, A., Spinazzola, J., Ford, J., Lanktree, C., Blaustein, M., Cloitre, M., & van der Kolk, B. (2005). Complex trauma in children and adolescents. *Psychiatric Annals, 35*, 390-398.
- Ford, J. D., & Blaustein, M. (2012). Systemic self-regulation: A framework for trauma-informed services in residential juvenile justice programs. *Journal of Family Violence, 28*, 655-677.
- Ford, J. D., Chapman, J., Mack, M., & Pearson, G. (2006). Pathway from traumatic child victimization to delinquency: Implications for juvenile and permanency court proceedings and decisions. *Juvenile and Family Court Journal, 57(1)*, 13-26.
- Ford, J. D., Chapman, J. C., Connor, D. F., & Cruise, K. C. (2012). Complex trauma and aggression in secure juvenile justice settings. *Criminal Justice & Behavior, 39(5)*, 695-724.
- Ford, J. D., Grasso, D. J., Hawke, J., & Chapman, J. F. (2013). Poly-victimization among juvenile justice-involved youths. *Child Abuse and Neglect, 37*, 788-800. doi: 10.1016/j.chiabu.2013.01.005
- Kerig, P. K., & Ford, J. D. (2015). *Trauma among girls in the juvenile justice system*. http://www.nctsn.org/sites/default/files/assets/pdfs/trauma_among_girls_in_the_ji_system_2014.pdf

Recommended Citation: Complex Trauma Treatment Network of the National Child Traumatic Stress Network. (2016). *Complex trauma: In juvenile justice-system involved youth*. Los Angeles, CA, & Durham, NC: National Center for Child Traumatic Stress.

A Special Thanks to: Julian Ford, PhD, Rocio Chang, PsyD at the University of Connecticut & Rachel Liebman, PhD, Joseph Spinazzola, PhD at The Trauma Center at Justice Resource Institute.

CHILD TRAUMA: CONNECTING THE DOTS



As the number of childhood traumatic events increases, the risk for the following health problems in adulthood increases: depression; alcoholism; drug abuse; suicide attempts; heart and liver diseases; pregnancy problems; high stress; uncontrollable anger; and family, financial, and job problems.^{6,7}

RESILIENCE is a child's ability to bounce back following difficult times. There are conditions or attributes of an individual, family, or community that can buffer the impact of trauma, helping to lower risk and promote resilience. These are called **protective factors**.⁸ Some protective factors include:

Individual

- Healthy and strong peer relationships
- High self-esteem
- Emotional self-regulation
- Positive coping skills

Family

- Reliable support from caregivers and extended family
- Clear values and expectations for behavior

Community

- Presence of mentors
- School engagement with families
- Positive norms
- Opportunities for community involvement

WWW.REMEMBERINGTRAUMA.ORG

¹National Center for Mental Health Promotion and Youth Violence Prevention, 2012; ²Barth et al., 2008; ³Duke Early Childhood Study: Egger, 2016; ⁴Teplin et al, 2002; ⁵Abram et al., 2004; ⁶Felitti et al., 1998; ⁷Anda et al., 2004; ⁸ O'Connell, Boat, & Warner, 2009.

Perspective

Neurological and Behavioral Consequences of Childhood Lead Exposure

David C. Bellinger

Among environmental chemicals, lead's reputation as a "bad actor" is confirmed in study after study. Over the past 30 years, we have learned that its toxicities are expressed in many forms, and, unfortunately, at levels of exposure that are still prevalent in the general population. The United States Centers for Disease Control and Prevention's current screening guidelines for preventing lead poisoning in young children suggest that screening should be targeted at identifying those with a blood lead level of 10 µg/dl or more [1]. However, this level has no special biological significance and certainly should not be interpreted as "safe." Indeed, a "safe" level has yet to be found. Two new studies published in this issue of *PLoS Medicine*, both from the long-running Cincinnati Lead Study (CLS), extend our knowledge of lead's effects and their societal implications [2,3].

Increased Lead Exposure and Changes in Brain Structure

A wealth of experimental data show, unequivocally, that lead causes neurological dysfunction in animals [4]. But in the context of environmental regulation and litigation, it remains contentious whether the observed associations between lead exposure and neurological dysfunction in humans, particularly children, reflect a causal or a secondary (epiphenomenal) role for lead. Some continue to argue that the associations observed merely reflect residual confounding, that is, the adverse effects of other known risk factors with which lead exposure often co-occurs. Such confounding seems highly unlikely to account completely for the associations, given the wide range of circumstances and settings in which they have been found. Evidence that so-called "subclinical" exposure

The Perspective section is for experts to discuss the clinical practice or public health implications of a published article that is freely available online.

Linked Research Articles

This Perspective discusses the following new studies published in *PLoS Medicine*:

Cecil KM, Brubaker CJ, Adler CM, Dietrich KN, Altaye M, et al. (2008) Decreased brain volume in adults with childhood lead exposure. *PLoS Med* 5(5): e112. doi:10.1371/journal.pmed.0050112

Using magnetic resonance imaging to assess brain volumes, Kim Cecil and colleagues find that inner-city children with higher blood lead levels showed regions of decreased gray matter as adults.

Wright JP, Dietrich KN, Ris MD, Hornung RW, Wessel SD, et al. (2008) Association of prenatal and childhood blood lead concentrations with criminal arrests in early adulthood. *PLoS Med* 5(5): e101. doi:10.1371/journal.pmed.0050101

Kim Dietrich and colleagues find an association between developmental exposure to lead and adult criminal behavior.

to lead not only alters behavior but brain structure as well would make the argument of confounding even less tenable. To date, clear neuropathological changes, including edema, herniation, and atrophy, have been reported in clinically lead-intoxicated children, and white matter degeneration and volume reductions in regions of cortical gray matter have been found in adult workers exposed to lead [5].

The new study by Kim Cecil and colleagues is the first population-based study of childhood lead exposure to include morphometric brain imaging [2]. The study's participants, now 19–24 years old, were recruited from areas of inner-city Cincinnati. Detailed blood lead histories were assembled prospectively, beginning before birth. Dose-dependent decreases were found in the volumes of gray matter in the ventrolateral prefrontal cortex, the anterior cingulate cortex, the postcentral gyri, the inferior parietal

lobule, and the cerebellum. Reduced volumes in the prefrontal cortical areas were particularly striking in males.

Being observational in design, this study cannot settle the issue of causality. One could still postulate that the relationships observed reflect residual confounding, but this seems unlikely in view of the socioeconomic homogeneity of the participants and the dose-dependence of the relationships. Cecil and colleagues attempted to discern the functional significance of the volume changes using data previously collected on the neuropsychological status of the participants. They were unable to identify clear structure–function correlates except in the case of motor skills. This is not entirely unexpected, however, given that complex neuropsychological functions almost certainly depend more on the integrity of distributed circuits than on the sizes of discrete brain regions. Correlations between volumes and neuropsychological test scores have been found in adults with occupational lead exposure [6]. Perhaps the absence of such relationships in the CLS reflects differences in the effects that lead has on a developing brain versus an adult brain.

Funding: This article was supported in part by National Institutes of Health grants P30 HD18655 and T32 MH073122. The funding agency provided no input on the contents of this article.

Competing Interests: The author has declared that no competing interests exist.

Citation: Bellinger DC (2008) Neurological and behavioral consequences of childhood lead exposure. *PLoS Med* 5(5): e115. doi:10.1371/journal.pmed.0050115

Copyright: © 2008 David C. Bellinger. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abbreviations: CLS, Cincinnati Lead Study

David C. Bellinger is Professor of Neurology, Harvard Medical School, and Professor in the Department of Environmental Health, Harvard School of Public Health, Boston, Massachusetts, United States of America. E-mail: David.Bellinger@childrens.harvard.edu

Nevertheless, the associations observed by Cecil and colleagues provide a clear warning sign that early lead exposure disrupts brain development in ways that are likely to be permanent, and that are robust enough to affect an index as gross as volume. It is important to note that in a previous study, using functional MRI on members of the CLS cohort, these investigators also reported lead effects on activation patterns during a verb generation task [7].

Increased Lead Exposure and Criminal Activity

The second new study [3], by Kim Dietrich and colleagues, adds to the literature indicating that lead produces psychosocial as well as cognitive morbidity. The existing studies implicating lead as a risk factor for antisocial behavior are provocative but limited by a variety of methodological factors, including use of an ecological design, indirect measures of lead exposure history, or parent- or self-reported outcome data, rendering them subject to a variety of alternative interpretations [8–15].

Exploiting the rich historical dataset available for the 19 to 24-year-olds in the CLS, Dietrich and colleagues evaluated the association between early blood lead history and arrests, since the age of 18 years, for violent offenses, drug offenses, theft or fraud, obstruction of justice, serious motor vehicle offenses, and disorderly conduct. The covariate-adjusted rate ratios for number of arrests associated with each 5 µg/dl increment were modest, but statistically significant, for prenatal childhood blood lead and blood lead at six years of age. The adjusted rate ratios for arrests for violent crimes were significant, and again modest, for average childhood blood lead and blood lead at age six. In other studies, increased lead exposure has also been linked to attention deficit hyperactivity disorder [16], teen pregnancy [17], and, in animals, to certain forms of substance abuse [18]. The underlying common pathway for all of these associations might be lead's adverse effects on executive functioning [19–21], resulting in poor impulse control.

The use of a county-wide database as the source of information on arrests and the prospective collection of data

on both blood lead levels and potential confounders prior to the occurrence of the outcomes of interest reduced the likelihood of information biases and effectively eliminated a role for selection bias as an explanation for these findings. The frequency of arrests in this group is startling, even among the participants with lower levels of childhood lead exposure. More than half (55%) had been arrested at least once after the age of 18 years, with means of 5.2 arrests for males and 1.1 arrests for females. Thus, although early lead exposure might increase a child's risk of being arrested after the age of 18 years, it is clearly only one of many factors. Even if the contribution of lead to arrest risk is small, however, it has a special status in that, in contrast to most other known risk factors for criminality, we know full well how to prevent it.

Public Health Implications

The studies by Cecil and colleagues and Dietrich and colleagues expand the range of outcomes linked to increased lead exposure in the “subclinical” range and help to place the problem in a larger public health context. Lead's detrimental effect on IQ, the outcome most often studied, is clearly only the “tip of the iceberg.”

The good news is that the blood lead levels at which reduced brain volumes and increased risk of arrest were observed are much less common among US children today than they were in the early 1980s, when the participants in the CLS were young children. The mean childhood blood lead level of CLS participants was 13 µg/dl, and ranged from 4 to 37 µg/dl. Currently, the median blood lead level among one to five-year-old US children is 1.5 µg/dl, and 5% have a level greater than 5.8 µg/dl [22]. In Ohio, where the CLS study is based, the percentage of children less than six years of age who had a blood lead level of more than 10 µg/dl was 16.55% in 1997, but only 2.30% in 2006 [23]. This is an impressive public health victory, but in light of clear evidence that a broad array of adverse effects occur at blood lead levels that are well below 10 µg/dl, it is a national disgrace that so many children continue to be exposed at levels known to be neurotoxic.

References

1. US Centers for Disease Control and Prevention (2005) Preventing lead poisoning in young

- children. Available: http://www.cdc.gov/nceh/lead/publications/pub_Reas.htm. Accessed 21 April 2008.
2. Cecil KM, Brubaker CJ, Adler CM, Dietrich KN, Altaye M, et al. (2008) Decreased brain volume in adults with childhood lead exposure. *PLoS Med* 5: e112. doi:10.1371/journal.pmed.0050112
3. Wright JP, Dietrich KN, Ris MD, Hornung RW, Wessel SD, et al. (2008) Association of prenatal and childhood blood lead concentrations with criminal arrests in early adulthood. *PLoS Med* 5: e101. doi:10.1371/journal.pmed.0050101
4. White LD, Cory-Slechta DA, Gilbert ME, Tiffany-Castiglioni E, Zawia NH, et al. (2007) New and evolving concepts in the neurotoxicology of lead. *Toxicol Appl Pharmacol* 225: 1-27.
5. Stewart WF, Schwartz BS, Davatzikos C, Shen D, Liu D, et al. (2006) Past adult lead exposure is linked to neurodegeneration measured by brain MRI. *Neurology* 66: 1476-1484.
6. Schwartz BS, Chen S, Caffo B, Stewart WF, Bolla KI, et al. (2007) Relations of brain volumes with cognitive function in males 45 years and older with past lead exposure. *Neuroimage* 37: 633-641.
7. Yuan W, Holland SK, Cecil KM, Dietrich KN, Wessel SD, et al. (2006) The impact of early childhood lead exposure on brain organization: A functional magnetic resonance imaging study of language function. *Pediatrics* 118: 971-977.
8. Denno D (1990) *Biology and violence*. New York: Cambridge University Press.
9. Nevin R (2000) How lead exposure relates to temporal changes in IQ, violent crime, and unwed pregnancy. *Environ Res* 83: 1-22.
10. Nevin R (2007) Understanding international crime trends: The legacy of preschool lead exposure. *Environ Res* 104: 315-336.
11. Stretesky PB, Lynch MJ (2001) The relationship between lead exposure and homicide. *Arch Pediatr Adolesc Med* 155: 579-582.
12. Reyes JW (2007) Environmental policy as social policy? The impact of childhood lead exposure on crime. Working Paper no. 13097. National Bureau of Economic Research. Available: <http://www.nber.org/papers/w13097>. Accessed 23 April 2008.
13. Needleman HL, Riess JA, Tobin MJ, Biesecker GE, Greenhouse JB (1996) Bone lead levels and delinquent behavior. *J Am Med Assoc* 275: 363-369.
14. Needleman HL, McFarland C, Ness RB, Fienberg SE, Tobin MJ (2002) Bone lead levels in adjudicated delinquents. A case control study. *Neurotoxicol Teratol* 24: 711-717.
15. Dietrich KN, Ris MD, Succop PA, Berger OG, Bornschein RL (2001) Early exposure to lead and juvenile delinquency. *Neurotoxicol Teratol* 23: 511-518.
16. Braun JM, Kahn RS, Froehlich T, Auinger P, Lanphear BP (2006) Exposures to environmental toxicants and Attention Deficit Hyperactivity Disorder in U.S. children. *Environ Health Perspect* 114: 1904-1909.
17. Lane SD, Webster NJ, Levandowski BA, Rubinstein RA, Keefe RH, et al. (2008) Environmental injustice: Childhood lead poisoning, teen pregnancy, and tobacco. *J Adolesc Health* 42: 43-49.
18. Rocha A, Valles R, Cardon AL, Bratton GR, Nation JR (2005) Enhanced acquisition of cocaine self-administration in rats developmentally exposed to lead. *Neuropsychopharmacology* 30: 2058-2064.
19. Canfield RL, Gendle MH, Cory-Slechta DA (2004) Impaired neuropsychological functioning in lead-exposed children. *Dev Neuropsychol* 26: 513-540.
20. Surkan PJ, Zhang A, Trachtenberg F, Daniel DB, McKinlay S, et al. (2007) Neuropsychological function in children with blood lead levels <10 µg/dL. *Neurotoxicology* 28: 1170-1177.
21. Froehlich TE, Lanphear BP, Dietrich KN, Cory-Slechta DA, Wang N, et al. (2007) Interactive

effects of a DRD4 polymorphism, lead, and sex on executive functions in children. *Bio Psychiatry* 62: 243-249.

22. US Department of Health and Human Services, US Centers for Disease Control and

Prevention (2005) Third national report on human exposure to environmental chemicals. Available: <http://www.cdc.gov/ExposureReport/pdf/thirdreport.pdf>. Accessed 23 April 2008.

23. US Centers for Disease Control and Prevention (2006) CDC surveillance data, 1997-2006. Available: <http://www.cdc.gov/nceh/lead/surv/stats.htm>. Accessed 23 April 2008.



Search the archives

All *PLoS Medicine* articles are archived at plosmedicine.org and pubmedcentral.gov. Their full texts and figures can be searched by various criteria including keyword, author, subject, volume, and issue number.

www.plosmedicine.org

Association of Prenatal and Childhood Blood Lead Concentrations with Criminal Arrests in Early Adulthood

John Paul Wright¹, Kim N. Dietrich^{2*}, M. Douglas Ris³, Richard W. Hornung³, Stephanie D. Wessel², Bruce P. Lanphear³, Mona Ho³, Mary N. Rae²

1 Cincinnati Children's Environmental Health Center, Division of Criminal Justice, University of Cincinnati, Cincinnati, Ohio, United States of America, **2** Cincinnati Children's Environmental Health Center, Division of Epidemiology and Biostatistics, Department of Environmental Health, University of Cincinnati College of Medicine, Cincinnati, Ohio, United States of America, **3** Cincinnati Children's Environmental Health Center, Cincinnati Children's Hospital Medical Center, Department of Pediatrics, University of Cincinnati College of Medicine, Cincinnati, Ohio, United States of America

Funding: This work was supported by grants from the National Institute of Environmental Health Sciences (PO1-ES011261 and RO1-ES015559-01) and the United States Environmental Protection Agency (R82938901). The funding agencies played no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: Two of the study's authors, BPL and RH, are on the editorial board of *PLoS Medicine*. BPL and KND sporadically serve as expert witnesses without personal financial gain.

Academic Editor: John Balmes, University of California San Francisco, United States of America

Citation: Wright JP, Dietrich KN, Ris MD, Hornung RW, Wessel SD, et al. (2008) Association of prenatal and childhood blood lead concentrations with criminal arrests in early adulthood. *PLoS Med* 5(5): e101. doi:10.1371/journal.pmed.0050101

Received: August 14, 2007

Accepted: March 18, 2008

Published: May 27, 2008

Copyright: © 2008 Wright et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abbreviations: ADHD, attention deficit hyperactivity disorder; CI, confidence interval; RR, rate ratio; SES, socioeconomic status

* To whom correspondence should be addressed. E-mail: kim.dietrich@uc.edu



ABSTRACT

Background

Childhood lead exposure is a purported risk factor for antisocial behavior, but prior studies either relied on indirect measures of exposure or did not follow participants into adulthood to examine the relationship between lead exposure and criminal activity in young adults. The objective of this study was to determine if prenatal and childhood blood lead concentrations are associated with arrests for criminal offenses.

Methods and Findings

Pregnant women were recruited from four prenatal clinics in Cincinnati, Ohio if they resided in areas of the city with a high concentration of older, lead-contaminated housing. We studied 250 individuals, 19 to 24 y of age, out of 376 children who were recruited at birth between 1979 and 1984. Prenatal maternal blood lead concentrations were measured during the first or early second trimester of pregnancy. Childhood blood lead concentrations were measured on a quarterly and biannual basis through 6.5 y. Study participants were examined at an inner-city pediatric clinic and the Cincinnati Children's Hospital Medical Center in Cincinnati, Ohio. Total arrests and arrests for offenses involving violence were collected from official Hamilton County, Ohio criminal justice records. Main outcomes were the covariate-adjusted rate ratios (RR) for total arrests and arrests for violent crimes associated with each 5 µg/dl (0.24 µmol/l) increase in blood lead concentration. Adjusted total arrest rates were greater for each 5 µg/dl (0.24 µmol/l) increase in blood lead concentration: RR = 1.40 (95% confidence interval [CI] 1.07–1.85) for prenatal blood lead, 1.07 (95% CI 0.88–1.29) for average childhood blood lead, and 1.27 (95% CI 1.03–1.57) for 6-year blood lead. Adjusted arrest rates for violent crimes were also greater for each 5 µg/dl increase in blood lead: RR = 1.34 (95% CI 0.88–2.03) for prenatal blood lead, 1.30 (95% CI 1.03–1.64) for average childhood blood lead, and 1.48 (95% CI 1.15–1.89) for 6-year blood lead.

Conclusions

Prenatal and postnatal blood lead concentrations are associated with higher rates of total arrests and/or arrests for offenses involving violence. This is the first prospective study to demonstrate an association between developmental exposure to lead and adult criminal behavior.

The Editors' Summary of this article follows the references.

Introduction

Early onset of aggressive or violent behavior is a precursor to a life course marred by limited social and educational achievement, incarceration, underemployment, and premature mortality [1,2]. These maladaptive behavioral patterns, which often emerge early in life, remain highly stable [3]. These facts highlight the importance of identifying risk factors that may place youth on an early developmental trajectory toward a career of crime and violence.

A meta-analysis of 34 independent studies identified and prioritized risk factors for serious, violent criminal behavior [4]. The most consistent risk factors were male gender, prenatal exposure to tobacco smoke, having antisocial parents, and low family socioeconomic status. In contrast, few studies have evaluated the consequences of childhood lead exposure as a risk factor for criminal behavior.

Some epidemiological studies have found a relationship between childhood lead exposure and antisocial behavior. In a study of Philadelphia youth, a history of lead poisoning was among the most significant predictors of adolescent delinquency and adult criminality in males [5]. Bone lead levels were associated with delinquent behavior in a retrospective cohort study of 11-year-old Pittsburgh children [6]. In Cincinnati, prenatal and childhood blood lead concentrations were associated with an increased risk for antisocial behavior and delinquency in adolescence [7]. Finally, elevated bone lead levels were observed in juvenile court-adjudicated delinquents residing in Allegheny County, Pennsylvania compared to matched controls [8]. These studies suggest that exposure to environmental lead during childhood is associated with the development of conduct problems and delinquent behavior. In consideration of these findings, it is noteworthy that a number of recent ecological investigations correlating leaded gasoline sales or atmospheric lead levels with crime rates also support an association between lead exposure and criminal behavior [9–12]. Questions remain, however, because these studies were cross-sectional (hence causality cannot be firmly established), relied on indirect measures of lead exposure, or did not follow participants into adulthood.

Here, we report the results of a long-term prospective study on the effects of one potential childhood risk factor of adult arrests, elevated prenatal and childhood blood lead concentrations.

Methods

Participants

The Cincinnati Lead Study (CLS) is a birth cohort recruited from late 1979 to early 1984. The CLS enrolled women in their first or early second trimester of pregnancy who attended four prenatal clinics within impoverished Cincinnati neighborhoods with a high concentration of older, lead-contaminated housing [13]. Women were excluded or ineligible if they were known to be addicted to drugs, were known to have diabetes or a neurological or psychiatric condition, or refused prenatal participation. Newborns were excluded if their gestational age was less than 35 wk, birth weight less than 1,500 g, Apgar score at 5 min less than 6, or if genetic or other serious medical issues were present at birth. This process netted 376 newborns who were recruited at birth

(i.e., informed oral and written consent was obtained from the mother in the hospital and a blood lead sample was obtained from the newborn). Of these newborns 305 were developmentally examined at the CLS follow-up clinic when they were 3 and 6 mo of age [14]. They were followed up quarterly through age 5 y and semiannually from age 5 to 6.5 y [15].

A total of 250 CLS participants who were between 19 and 24 y of age and had been followed at least through the first 6 y of life participated in the current study. Thus, individuals in the current analysis had serial blood lead concentrations spanning the entire preschool and early school-age period of development. Written informed consent was obtained by the investigator or a senior member of the research staff at each stage of this longitudinal study after it was determined that the participant or the participant's legal guardian understood the nature of the research. This protocol has been reviewed and approved by the institutional review boards of the University of Cincinnati College of Medicine and the Cincinnati Children's Hospital Medical Center.

The 250 participants in this analysis were not substantially different from those with missing data with regard to baseline perinatal characteristics such as birth weight (3,134 versus 3,138 g), sex (50% versus 54% male), 6-y average Hollingshead [16] socioeconomic status (SES) total score (18.0 versus 18.3), years of maternal education (11.2 versus 11.1 y), scores on the Home Observation for Measurement of the Environment (the preschool version of a quantitative observational measure of early nurturing and environmental stimulation [17]) (32.3 versus 33.4), and average childhood blood lead (13.4 versus 14.2 $\mu\text{g}/\text{dl}$).

Exposure and Outcome Assessments

We examined three measures of blood lead. Prenatal maternal blood lead concentration [$\mu\text{g}/\text{dl}$] was measured during the first or early second trimester of pregnancy. Approximately 50% of the prenatal samples were obtained during the first trimester of pregnancy. The difference between maternal blood lead concentration assessed in the first and second trimesters was not statistically significant ($p = 0.76$) [14]. Postnatal blood lead indices included average childhood blood lead (average of 23 blood lead concentrations obtained quarterly from age 3 to 60 mo and semiannually from 66 to 78 mo), and 6.5-y blood lead. If a 6.5-y blood lead value was not available for a child, we used the blood lead test from 6 y. We selected 6.5 y blood lead over other serial blood lead measures because preliminary analyses indicated that blood lead measured at 6 y was more highly associated with the number of arrests than blood lead measured at other ages. Complete blood lead data were available for 89%–92% of the cohort at any particular quarterly assessment from 3 mo to 5 y of age. Missing postnatal blood lead concentrations were imputed from a weighted average of a within-participant regression of blood lead on age. This imputation was done to avoid excluding those participants who may have one or only a few missing blood lead tests. Prenatal blood lead concentrations were available for 87% (217/250) of the participants.

The primary outcome variable in this study was the individual's number of criminal arrests since turning 18 y of age. We did not collect data on convictions. Arrest is a more proximate measure of criminal behavior than are

conviction data. Arrest typically occurs at the scene of the criminal event or immediately thereafter. Arrest decisions, moreover, usually reflect the seriousness of the offense, the offender's prior record, and the desire of the victim to have the individual arrested. Conversely, conviction data are distal indicators of criminal behavior. Actual criminal convictions derived from a trial represent less than 10% of all criminal arrests. Over 90% of all criminal cases are subject to plea bargaining, in which a plea of "guilty" is usually rewarded with a reduced charge and/or sentence. From the time of arrest it can take upward of 2 y or more before a defendant is tried in a court, or it can take over 1 y from the time of arrest to the time at which a plea deal is accepted by the court. Furthermore, a range of extra-legal variables can enter into the plea and trial process, including the defendant's economic status, support system, and access to quality defense counsel. We should also add that Hamilton County, Ohio (the study's catchment area) makes extensive use of "diversion" programs. These programs select individuals with specified problems or offenses, such as drunken driving or drug abuse and "divert" them from jail or prison into community-based rehabilitation programs. Upon successful completion of the program and a probationary term, many of these programs "erase" the individual's legal conviction, but not the arrest. Finally, at least for this study, arrest data are substantially more complete than are conviction data. Arrest data in Hamilton County, Ohio are compiled into a single county-wide database and are updated at regular intervals. Court data, however, are not updated regularly. This problem is endemic to court systems nationwide, because courts operate at different levels (city, county, state, Federal) and are under the guidance of individual judges.

Data on Criminal Arrests

Data on criminal arrests for participants and their mothers were obtained from a computer search of Hamilton County, Ohio criminal justice records. These records provided information on the nature, number, and disposition of arrests. Two reviewers who were blind to participants' blood lead concentrations independently coded each arrest into one of the following categories: violent offenses (e.g., murder, rape, domestic violence, assault, robbery, or possession of a weapon); offenses against property (e.g., burglary or arson); drug offenses (e.g., trafficking, abuse, or possession); fraud; obstruction of justice; serious motor vehicle offenses (e.g., driving without a license, driving under the influence of alcohol, or driving under suspension); disorderly conduct; and other offenses, which included offenses that did not fit in any previously mentioned category. Minor motor vehicle offenses, such as speeding, safety restraint violations, lights burned out, failing to stop, and pedestrian offenses were excluded from the analyses. We counted the number of arrests and coded the nature of the offense that led to each arrest. If an individual was charged with more than one offense during a single arrest, then the most serious offense was used for classification. Thus, arrest counts were lower than the total number of offenses. Legally determined guilt was not a factor in our coding. Only those offenses that were filed before 31 October 2005 were included in the analyses.

Inter-reviewer differences with respect to arrest and category of offense were resolved by a third reviewer who conducted the initial training for criminal record coding.

Interobserver agreement as assessed by Cohen's kappa was 0.93 for maternal offenses and 0.97 for participant offenses.

Statistical Analyses

We used negative binomial regression models to analyze these data because the counts of arrests were overdispersed when originally examined using Poisson regression models [18]. This model provided a very good fit to these data in terms of the estimated scale parameter. These models were used to estimate the association between blood lead concentrations and arrest rates adjusted for other important risk factors. We calculated separate models for each blood lead measure. Our dependent variable was the number of criminal arrests for each participant measured as discrete counts, which were positively skewed. To account for the number of years at risk of arrest, we used the log of current age as an offset in all models. To control for potential confounding, we examined variables reflecting the effects of other neurotoxicants such as maternal cigarette and marijuana smoking and consumption of narcotics during pregnancy, as well as variables related to adult criminal involvement in prior studies. Our list of candidate covariates included: sex; a validated measure of the quality of early care-giving and environmental stimulation called the Home Observation for Measurement of the Environment (HOME) inventory score [17]; birth weight (g); maternal smoking during pregnancy (half-packs consumed per day); maternal alcohol, marijuana, or narcotic use (Y/N); maternal education level (highest grade); maternal IQ [19]; total prior maternal arrests; SES (average Hollingshead [16] score); number of children in the home; and whether the mother was on public assistance during the participant's childhood (Y/N). Data on fathers or male caregivers in the home were not available, since 84% of the households were headed by the mother or a male caregiver was not consistently present. Continuous covariates were examined using linear, polynomial, and log-transformed functions to assess whether simple linear terms were adequate for adjustment of covariate or confounder influences.

Candidate covariates or confounders remained in the final multivariable models if they were either statistically significant ($p \leq 0.05$) or if their inclusion in the model caused a change of $\geq 10\%$ in the rate ratio estimates for lead, regardless of their level of statistical significance. We tested the interaction of lead by sex, since some studies have indicated that developing male central nervous systems may be more vulnerable than females' to environmental insults leading to later behavioral problems [20]. Before deciding upon a final multivariable model, regression diagnostics for collinearity and influence using the methods described in Belsley, et al. were employed [21]. As a measure of the absolute change in arrest rates between participants with higher levels of blood lead compared to those with lower blood lead levels, we defined attributable risk as the average difference in annual arrest rates between participants at the 95th percentile of blood lead and those at the 5th percentile. All significance tests were two-tailed. Results for blood lead variables are presented as adjusted rate ratios (RR) for total arrests and arrests for violent crimes. All statistical analyses were conducted with SAS (Statistical Analysis System), version 9.1 [22].

Table 1. Characteristics of the Participants and of their Mothers in the Cincinnati Lead Study (*n* =250)

Category	Characteristic	Total (<i>n</i> =250) No. (%) or Mean (SD)	Participant Never Arrested (<i>n</i> =114) No. (%) or Mean (SD)	Participant Ever Arrested (<i>n</i> =136) No. (%) or Mean (SD)	
Participant characteristics	Male	125 (50.0%)	34 (29.8%)	91 (66.9%)	
	African-American	225 (90.0%)	99 (86.8%)	126 (92.7%)	
	Age at study date, y	22.5 (1.5)	21.9 (4.8)	22.5 (4.5)	
	Marijuana use	29 (11.6%)	13 (11.4%)	16 (11.8%)	
Blood lead, µg/dl ^a	Prenatal blood lead ^b	8.3 (3.8)	7.9 (3.2)	8.7 (4.1)	
	Average childhood blood lead	13.4 (6.1)	13.3 (6.7)	13.5 (5.5)	
	6-year blood lead	8.3 (4.8)	7.6 (4.3)	8.8 (5.0)	
Maternal characteristics	Age at delivery, y	22.5 (4.2)	22.0 (4.0)	22.9 (4.4)	
	Maternal IQ (points)	75.3 (9.3)	76.9 (10.4)	73.9 (8.1)	
	High school graduate	132 (52.8%)	68 (59.6%)	64 (47.1%)	
	HOME inventory at age 3 y (points)	32.3 (6.6)	33.6 (6.3)	31.6 (6.7)	
Socioeconomic status (Hollingshead score)		18.0 (4.8)	18.5 (5.1)	17.8 (4.5)	
	Marital status	Married	39 (15.6%)	21 (18.4%)	18 (13.2%)
		Single	155 (62.0%)	70 (61.4%)	85 (62.5%)
Other		56 (22.4%)	23 (20.2%)	33 (24.3%)	
Smoked during pregnancy		129 (51.6%)	62 (54.4%)	67 (49.3%)	
Number of children in home		3.0 (1.4)	2.9 (1.4)	3.1 (1.3)	
Public assistance		190 (76%)	82 (71.9%)	108 (79.4%)	

Data presented as *n* (%) or mean (SD). Average childhood blood lead concentration was defined as the mean of blood lead tests taken from 3 months through the 6-year blood lead test.

^aTo convert blood lead to µmol/l multiply by 0.04826.

^b*n* = 217 for prenatal blood lead.

doi:10.1371/journal.pmed.0050101.t001

Results

The sample was largely African-American (90%), 50% of the participants were male, and 73% of families scored in the lowest two levels of the Hollingshead Four-Factor Index of Social Position [16]. A single female caregiver headed 84% of households.

Mean blood lead concentrations (µg/dl) were 8.3 (0.40 µmol/l) (range 1–26) for maternal prenatal, 13.4 (0.65 µmol/l) (range 4–37) for average childhood, and 8.3 (0.40 µmol/l) (range 2–33) for 6-y. The mean postnatal blood lead concentration of CLS participants increased to a peak of 17.7 (standard deviation [SD] 9.7) µg/dl (0.85 µmol/l) at 21 mo. After age 21 mo, average blood lead concentrations declined to a mean of 8.4 (SD 4.9) µg/dl (0.40 µmol/l) at 6.5 y. At 6.5 y of age, 67 children (26.9%) had a blood lead concentration above 10 µg/dl (0.48 µmol/l) (Table 1). Pearson correlations between blood lead indices examined in this study were 0.32 and 0.28

between prenatal and average childhood and 6-y respectively, and 0.80 between average childhood and 6 y.

We identified a total of 800 arrests within the sample. Of these arrests, 108 (14%) were for violent offenses, 90 (11%) involved theft or fraud, 216 (28%) involved drugs, 35 (5%) were for obstruction of justice, 211 (27%) were related to serious motor vehicle offenses, 35 (5%) were for disorderly conduct, and 82 (11%) other. Approximately 55% of participants (62.8% of males, 36.3% of females) had at least one arrest. The mean number of arrests among males was 5.2, which was significantly higher than the mean number of 1.1 for females (*p* < 0.001). The overall mean arrest rate was 0.68 per year after age 18, but the mean arrest rate for males was 4.5 times higher than the female arrest rate (1.1 versus 0.25 per year).

Preliminary analysis of the association between blood lead measures and covariates revealed generally weak correlation coefficients ranging from 0.24 to 0.35, indicating a relatively

Table 2. Relationship of Prenatal, Early Childhood Average, and Six-Year Blood Lead Concentrations with Total Arrest Rates in Young Adults

Blood Lead Variable	Median (5th–95th Percentile), µg/dl ^a	Attributable Risk (95% CI), per Year	Rate Ratio for 5 µg/dl Increase in Blood Lead (95% CI)
Prenatal	7.8 (2.9–16.0)	0.48 (0.29–0.79)	1.40 (1.07–1.85)
Early Childhood Average	12.3 (6.0–26.3)	0.13 (0.03–0.33)	1.07 (0.88–1.29)
Six-Year	6.8 (3.4–18.3)	0.39 (0.21–0.68)	1.27 (1.03–1.57)

Estimates adjusted for maternal IQ, sex, SES using the Hollingshead Score, and maternal education level.

^aTo convert blood lead to µmol/l multiply by 0.04826.

doi:10.1371/journal.pmed.0050101.t002

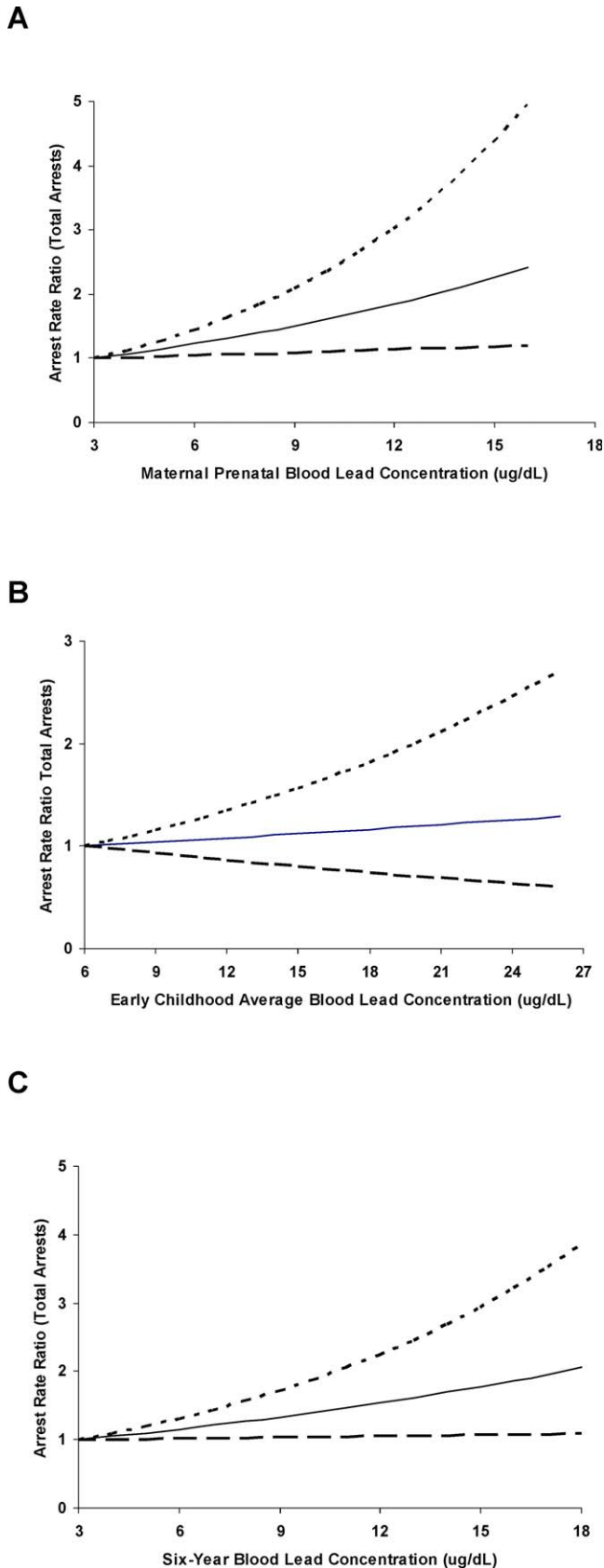


Figure 1. Adjusted Relationship between Blood Lead Concentration and Arrest Rate Ratio For Total Arrests
Shown are data for maternal prenatal blood lead concentration (A), early childhood average blood lead concentration (B), and 6-year blood lead

concentration (C). Rate ratios are plotted as a function of increasing blood lead from the 5th to the 95th percentiles of blood lead relative to participants at the 5th percentile. Dashed lines are 95% confidence intervals. To convert to $\mu\text{mol/l}$: $(\mu\text{g/dl}) \times 0.04826$.
doi:10.1371/journal.pmed.0050101.g001

small potential for confounding. In multivariable regression analyses of the total number of arrests, we found that the associations between prenatal and 6-y blood lead concentrations were statistically significant. In each model, the blood lead association was adjusted for the cofactors of maternal IQ, sex, SES score, and maternal education. The RRs for total arrests increased for each 5 $\mu\text{g/dl}$ (0.24 $\mu\text{mol/l}$) increment in blood lead concentration; the RRs were 1.40 (95% confidence interval [CI] 1.07–1.85) for prenatal blood lead, 1.07 (95% CI 0.88–1.29) for average childhood blood lead, and 1.27 (95% CI 1.03–1.57) for 6-y blood lead. The attributable risk was 0.48 arrests/year (95% CI 0.29–0.79) for prenatal blood lead, 0.13 (95% CI 0.03–0.33) for average childhood blood lead, and 0.39 (95% CI 0.21–0.68) for 6-y blood lead (Table 2). The rate of total arrests was modeled as a log-linear function of increasing blood lead concentrations for each of the three blood lead assessments: maternal prenatal (Figure 1A), early childhood (Figure 1B), and 6 y (Figure 1C).

In multivariable analyses of violent criminal arrests, we found statistically significant associations with both average childhood and 6-y blood lead variables. The RRs for arrests involving violent crimes increased for each 5 $\mu\text{g/dl}$ (0.24 $\mu\text{mol/l}$) increment in blood lead; the RRs were 1.34 (95% CI 0.88–2.03) for prenatal blood lead, 1.30 (95% CI 1.03–1.64) for average childhood blood lead, and 1.48 (95% CI 1.15–1.89) for 6-y blood lead. The attributable risk was 0.055 arrests/year (95% CI 0.026–0.118) for prenatal blood lead, 0.077 (95% CI 0.039–0.156) for average childhood blood lead, and 0.087 (95% CI 0.049–0.152) for 6-y blood lead (Table 3). As with the analyses for total arrests, the rate of arrests for violent offenses was modeled as a log-linear function of each of the blood lead indices: maternal prenatal (Figure 2A), early childhood (Figure 2B), and 6 y (Figure 2C).

The results for analyses restricted to arrests for nonviolent crimes were similar to those found for all arrests. Specifically, the RRs for nonviolent arrests for each 5 $\mu\text{g/dl}$ (0.24 $\mu\text{mol/l}$) in blood lead were 1.40 (95% CI 1.06–1.84) for prenatal blood lead, 1.05 (95% CI 0.86–1.28) for average childhood blood lead, and 1.22 (95% CI 0.97–1.53) for 6-y blood lead.

There was no statistical evidence that the shape of the exposure-response relationship differed by sex with any of the blood lead indices for total arrests or arrests for violent offenses. The interaction term for sex was statistically nonsignificant (p -values for interaction term ranged from 0.42 to 0.79). However, the attributable risk for males was considerably higher than for females. For example, the attributable risk for 6-y blood lead rate was 0.85 arrests/year (95% CI 0.48–1.47) for males and 0.18 (95% CI 0.09–0.33) for females.

Discussion

In a prospective birth cohort, we found that prenatal and childhood blood lead concentrations were predictors of adult arrests. Prenatal and 6-y blood lead concentrations were significantly associated with higher RRs for total arrests.

Table 3. Relationship of Prenatal, Early Childhood Average, and Six-Year Blood Lead Concentrations with Violent Crime Arrest Rates in Young Adults

Blood Lead Variable	Median (5th–95th Percentile), $\mu\text{g}/\text{dl}^{\text{a}}$	Attributable Risk (95% CI), per Year	Rate Ratio for 5 $\mu\text{g}/\text{dl}$ Increase in Blood Lead (95% CI)
Prenatal	7.8 (2.9–16.0)	0.055 (0.026–0.118)	1.34 (0.88–2.03)
Early Childhood Average	12.3 (6.0–26.3)	0.077 (0.039–0.156)	1.30 (1.03–1.64)
Six-Year	6.8 (3.4–18.3)	0.087 (0.049–0.152)	1.48 (1.15–1.89)

Estimates adjusted for maternal IQ, sex, SES using the Hollingshead Score, and maternal education level.

^aTo convert blood lead to $\mu\text{mol}/\text{l}$ multiply by 0.04826.

doi:10.1371/journal.pmed.0050101.t003

Average childhood as well as later (6-y) blood lead concentrations were significantly associated with higher RRs for arrests involving a violent offense. Data from several recent prospective studies suggest that blood lead concentrations in the later preschool years may be more predictive of cognitive and behavioral problems [23]. However, the potential importance of prenatal blood lead concentrations should not be underestimated, as they were predictive of total arrests in our data. The number of arrests in the CLS cohort was significantly higher in males. However, no significant interactions between sex and blood lead with arrest rates were found.

Environmental lead levels as well as crime have dropped over the last 30 y in the US [9]. However, the overall reduction was not uniform; inner-city children, who are predominately African-American, remain particularly vulnerable [24]. Crime and violent crime are concentrated in urban centers in the US where many poor African-Americans reside. One factor in the disproportional representation of African-Americans in crime statistics could well be the historically higher exposures to lead in these communities. Furthermore, recent data from epidemiological studies implicate blood lead concentrations well below the current level of concern adopted by the United States Centers for Disease Control in the development of neurobehavioral deficits [25]. We were unable to explore racial differences in our data since almost all participants were African-American. However, Needleman found that the lead-associated risk for juvenile court-adjudicated delinquency was present in both African-American and white youth, indicating that these findings are not restricted to any one racial or ethnic group [8].

The neurodevelopmental consequences associated with lead exposure in previous studies, such as lower IQ, less tolerance for frustration, deficits in attention, hyperactivity, and weak executive control functions, are potent predictors of delinquent and criminal behaviors [26–29]. Attention deficit hyperactivity disorder (ADHD) is a common finding among juvenile delinquents, and those with ADHD are more likely to have severe cognitive impairments [30]. ADHD is also a known risk factor for criminal behavior in adulthood [31]. A recent analysis of data from the third National Health and Nutrition Examination Survey (NHANES-III) found that higher blood lead concentrations were significantly associated with ADHD. Children with blood lead concentrations greater than 2 $\mu\text{g}/\text{dl}$ were at a 4.1-fold increased risk of ADHD [32]. Similarly, in experiments with rodents, felines, and nonhuman primates, early lead exposure was associated with

increased impulsivity, aggression, antagonistic interactions, reduced social play and abnormal mother–infant interaction [33–36]. Childhood lead exposure therefore seems to place individuals at risk for multiple underlying neurobehavioral deficits associated with a higher probability of later criminal behavior.

A number of mechanisms may be at work. Lead interferes with synapse formation, disrupts dopamine systems, and lowers serotonin levels. Lead exposure has been shown to reduce MAO A (monoamine oxidase A) activity, and low MAO A activity has been associated with violent and criminal behaviors [37]. One consequence of these alterations could be neural dysfunction in areas of the brain involved in arousal, emotion, judgment, and behavioral inhibition such as the prefrontal cortex [38].

This study has several limitations. First, most criminal behavior never comes to the attention of authorities; thus, our measure of arrest underestimates actual criminal activity. Had we been able to account for all criminal acts, it is possible that the results of our study may have been different. For example, it could be argued that lead-associated lower intelligence makes it more likely that an offender will be caught (i.e., arrested). However, a recent large-scale prospective study of school-aged children with early blood lead levels similar to those in the CLS suggests that lead impacts social behaviors somewhat independently of IQ [39]. Furthermore, we did not adjust arrest rates for child IQ in our analyses because controlling for a variable that might potentially be on the causal pathway is clearly inappropriate in studies of this kind. Variables along the causal pathway between exposure and outcome cannot be bona fide confounders [40]. Second, we examined only Hamilton County, Ohio records. Although most participants in our cohort continued to reside in Hamilton County, we may have missed some arrests that occurred in other counties. Third, official records of arrest were available only when the participants reached 18 y of age. Thus, the average follow-up was under 5 y. The possibility of bias introduced by nonrandom attrition in the CLS cohort cannot be ruled out, although we found no important differences on key exposure and demographic variables. Fourth, it is always possible in observational studies to have uncontrolled confounding. This can be problematic when it comes to measuring SES, since global assessments of social standing such as the one used in this [16] and many other studies fail to capture all potentially relevant factors [41]. As pointed out by Weiss and Bellinger [42] in their discussion of the social ecology of exposure to environmental

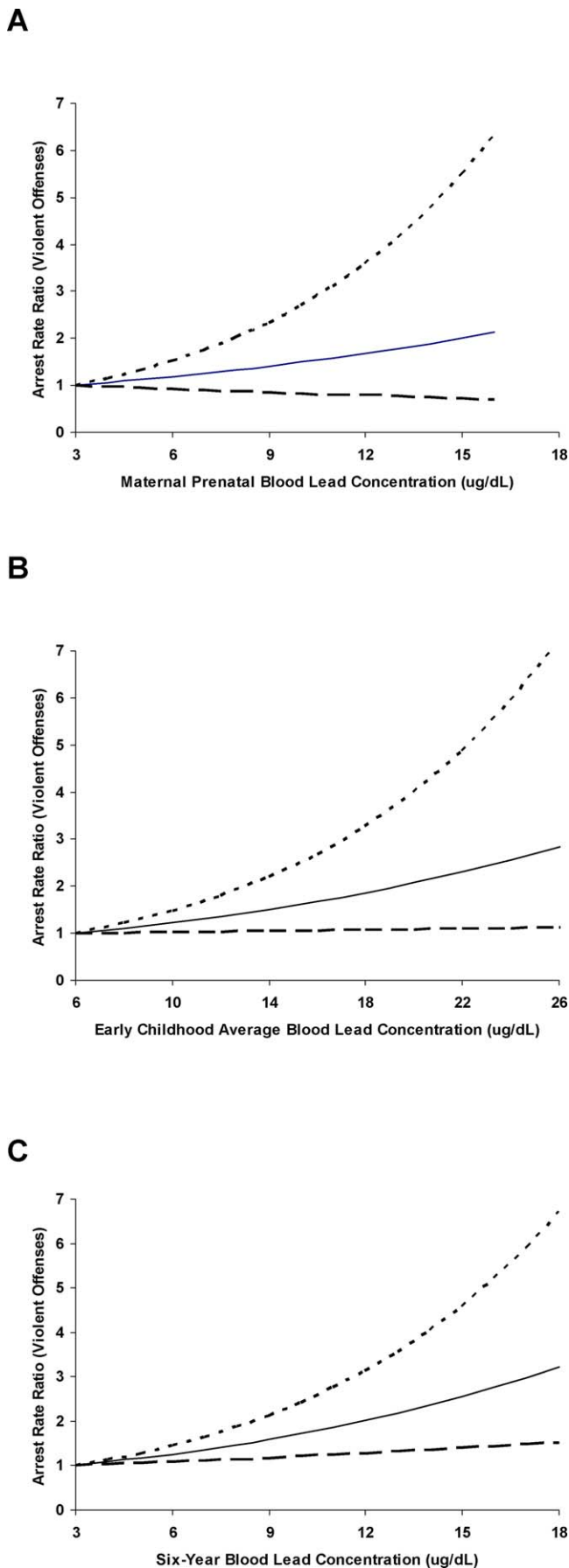


Figure 2. Adjusted Relationship between Blood Lead Concentration and Arrest Rate Ratio For Violent Offenses

Shown are data for maternal prenatal blood lead concentration (A), early childhood average blood lead concentration (B), and 6-year blood lead concentration (C). Rate ratios are plotted as a function of increasing blood lead from the 5th to the 95th percentiles of blood lead relative to participants at the 5th percentile. Dashed lines are 95% confidence intervals. To convert to $\mu\text{mol/l}$: ($\mu\text{g/dl}$) \times 0.04826. doi:10.1371/journal.pmed.0050101.g002

pollutants, neurotoxicant exposures are not randomly distributed, but are “chained” to many other risks to normal development that are sometimes quite difficult to partition. Finally, as with all studies of this kind, our measure of dose to the critical organ (brain) was indirect. Blood, as well as other tissues in which lead is often measured such as teeth or bone, are surrogates for dose to the central nervous system.

On the other hand, this study has a number of qualities that contribute to the validity of our findings. To our knowledge this is the first prospective study to directly examine the relationship between early exposure to lead and official documentation of arrests in adulthood. Lead dose as assessed by frequent serial blood lead determinations, assessment of a large number of potentially important covariate factors, and careful documentation of criminal arrests were unique aspects of this investigation. Furthermore, the sample was relatively homogenous with respect to sociodemographic variables such as SES and ethnicity; thus decreasing the extent to which strong confounding factors might generate spurious associations. Therefore, we conclude that these data implicate early exposure to lead as a risk factor for behaviors leading to criminal arrest.

Acknowledgments

We are grateful to members of the Cincinnati Lead Study cohort and their families for their participation.

Author contributions. JPW, KND, MDR, and BPL designed the experiments/the study. SDW and KND collected data or did experiments for the study. RWH, MH and JPW analyzed the data. KND and SDW enrolled patients. JPW and KND wrote the first draft of the paper. JPW, KND, MDR, RWH, SDW, BPL, and MNR contributed to writing the paper.

References

- Farrington DP (1986) Stepping stones to adult criminal careers. In: Olweus D, Block J, Radke-Yarrow M, editors. *Development of Antisocial and Prosocial Behavior*. New York: Academic Press. pp. 359–384.
- Farrington DP (1991) Childhood aggression and adult violence: Early precursors and later-life outcomes. Pepler DJ, Rubin KH, editors. *The Development and Treatment of Childhood Aggression*. Hillsdale (New Jersey): Lawrence Erlbaum. pp. 5–29.
- Nagin DS, Farrington DP (1992) The stability of criminal potential from childhood to adulthood. *Criminology* 30: 235–260.
- Lipsy MW, Derzon JH (1998) Predictors of violent or serious delinquency in adolescence and early adulthood: a synthesis of longitudinal research. In: Loeber R, Farrington DP, editors. *Serious and Violent Juvenile Offenders: Risk Factors and Successful Interventions*. Thousand Oaks (California): Sage Publications. pp. 86–105.
- Denno D (1990) *Biology and Violence*. New York: Cambridge University Press.
- Needleman HL, Riess JA, Tobin MJ, Biesecker GE, Greenhouse JB (1996) Bone lead levels and delinquent behavior. *JAMA* 275: 363–369.
- Dietrich KN, Ris MD, Succop PA, Berger OG, Bormschein RL (2001) Early exposure to lead and juvenile delinquency. *Neurotoxicol Teratol* 23: 511–518.
- Needleman HL, McFarland C, Ness RB, Fienberg SE, Tobin MJ (2002) Bone lead levels in adjudicated delinquents: a case control study. *Neurotoxicol Teratol* 24: 711–717.
- Nevin R (2000) How lead exposure relates to temporal changes in IQ, violent crime, and unwed pregnancy. *Environ Res* 83: 1–22.
- Nevin R (2007) Understanding international crime trends: The legacy of preschool lead exposure. *Environ Res* 104: 315–336.

11. Stretesky PB, Lynch MJ (2001) The relationship between lead exposure and homicide. *Pediatr Adol Med* 155: 579–582.
12. Masters RD, Hone B, Doshi A (1997) Environmental pollution, neurotoxicity, and criminal behavior. In: Rose J, editor. *Aspects of environmental toxicology*. London: Taylor and Francis Group. pp. 13–48.
13. Clark CS, Bornschein RL, Succop P, Que Hee SS, Hammond PB, Peace B (1985) Condition and type of housing as an indicator of potential environmental lead exposure and pediatric blood lead levels. *Environ Res* 38: 46–53.
14. Dietrich KN, Krafft KM, Borschein RL, Hammond PB, Berger O, et al. (1987) Low level fetal lead exposure effect on neurobehavioral development in early infancy. *Pediatrics* 80: 721–730.
15. Dietrich KN, Berger OG, Succop PA, Hammond PB, Bornschein RL (1993) The developmental consequences of low to moderate prenatal and postnatal lead exposure: intellectual attainment in the Cincinnati Lead Study Cohort following school entry. *Neurotoxicol Teratol* 15: 37–44.
16. Cirino PT, Chin CE, Sevcik RA, Wolf M, Lovett M, et al. (2002) Measuring socioeconomic status: reliability and preliminary validity for different approaches. *Assessment* 9: 145–155.
17. Bradley RH, Caldwell BM (1979) Home observation for measurement of the environment: a revision of the preschool scale. *Am J Mental Defic* 84: 235–244.
18. Cameron AC, Trivedi PK (1998) *Regression analysis of count data*. Cambridge (United Kingdom): University of Cambridge Press.
19. Silverstein AB (1985) Two-and four-subtest short forms of the WAIS-R: a closer look at validity and reliability. *J Clin Psychol* 41: 95–97.
20. Moffitt TE, Caspi A, Rutter M, Silva PA (2003) Sex differences in antisocial behavior: conduct disorder, delinquency, and violence in the Dunedin Longitudinal Study. Cambridge (United Kingdom): University of Cambridge Press.
21. Bellsley DA, Kuh E, Welsch RE (1980) *Regression diagnostics*. New York: Wiley.
22. SAS (2004) *Statistical analysis system, version 9.1*. Cary, North Carolina: SAS Institute.
23. Chen A, Dietrich KN, Ware JH, Radcliffe J, Rogan WJ (2005) IQ and blood lead from 2 to 7 years of age: are the effects in older children the residual of high blood lead concentrations in 2-year-olds? *Environ Health Perspect* 113: 597–601.
24. Pirkle JL, Kaufmann RB, Bordy DJ, Hickman T, Gunter EW, et al. (1998) Exposure of the U.S. population to lead, 1991–1994. *Environ Health Perspect* 106: 745–750.
25. Lanphear BP, Hornung R, Khoury J, Yolton K, Baghurst P, et al. (2005) Low-level environmental lead exposure and children's intellectual function: an international pooled analysis. *Environ Health Perspect* 113: 894–899.
26. Silva PA, Hughes P, Williams S, Faed JM (1988) Blood lead, intelligence, reading attainment, and behaviour in eleven year old children in Dunedin, New Zealand. *New Zealand J Child Psychol Psychiatry Allied Discip* 29: 43–52.
27. Thomson GOB, Raab GM, Hepburn WS, Hunter R, Fulton M, Laxen DHP (1989) Blood-lead levels and children behavior—results from the Edinburgh lead study. *J Child Psychol Psychiatry* 30: 515–528.
28. Fergusson DM, Fergusson JE, Horwood LJ, Kinzett NG (1988) A longitudinal study of dentine lead levels, intelligence, school performance and behaviour. Part III. Dentine lead levels and attention/activity. *J Child Psychol Psychiatry Allied Discip* 29: 811–824.
29. Canfield RL, Kreher DA, Cornwell C, Herderson CR (2003) Low-level lead exposure, executive functioning, and learning in early childhood. *Child Neuropsychol* 9: 35–43.
30. Moffitt TE, Silva PA (1988) Self-reported delinquency, neuropsychological deficit, and history of attention deficit disorder. *J Abnorm Child Psychol* 16: 553–569.
31. Vitelli R (1996) Prevalence of childhood conduct disorder and attention-deficit hyperactivity disorders in adult maximum-security inmates. *Int J Offender Therapy Compar Criminol* 40: 263–271.
32. Braun JM, Kahn RS, Froehlich T, Auinger P, Lanphear BP (2006) Exposures to environmental toxicants and attention deficit hyperactivity disorder in US children. *Environ Health Perspect* 114: 1904–1909.
33. Cory-Slechta DA (2003) Lead-induced impairments in complex cognitive function: Offerings from experimental studies. *Child Neuropsychol* 9: 54–75.
34. Delville Y (1999) Exposure to lead during development alters aggressive behavior in golden hamsters. *Neurotoxicol Teratol* 21: 445–449.
35. Li W, Han S, Gregg TR, Kemp FW, Davidow AL, et al. (2003) Lead exposure potentiates predatory attack behavior in the cat. *Environ Res* 92: 197–206.
36. Laughlin NK, Bushnell PJ, Bowman RE (1991) Lead exposure and diet: Differential effects on social development in the rhesus monkey. *Neurotoxicol Teratol* 13: 429–440.
37. Caspi A, McClay J, Moffitt TE, Mill J, Martin J, et al. (2002) Role of genotype in the cycle of violence in maltreated children. *Science* 297: 851–854.
38. Lidsky T, Schneider JS (2003) Lead neurotoxicity in children: Basic mechanisms and clinical correlates. *Brain* 126: 5–19.
39. Chen A, Cai B, Dietrich KN, Radcliffe J, Rogan WJ (2007) Lead exposure, IQ, and behavior in urban 5- to 7-year-olds: Does lead affect behavior only by lowering IQ? *Pediatrics* 119: 650–658.
40. Jacobson JL, Jacobson SW (1996) Prospective longitudinal assessment of developmental neurotoxicity. *Environ Health Perspect* 104: 275–283.
41. Braverman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, et al. (2005) Socioeconomic status in health research. One size does not fit all. *JAMA* 294: 2879–2888.
42. Weiss B, Bellinger DC (2006) Social ecology of children's vulnerability to environmental pollutants. *Environ Health Perspect* 114: 1479–1485.

Editors' Summary

Background. Violent crime is an increasing problem in many countries, but why are some people more aggressive than others? Being male has been identified as a risk factor for violent criminal behavior in several studies, as have exposure to tobacco smoke before birth, having antisocial parents, and belonging to a poor family. Another potential risk factor for antisocial behavior as an adult is exposure to lead during childhood, although few studies have looked directly at whether childhood lead exposure is linked with criminal behavior in adulthood. Lead is a toxic metal that damages the nervous system when ingested or inhaled. It is present throughout the environment because of its widespread use in the past in paint, solder for water pipes, and gasoline. In 1978, 13.5 million US children had a blood lead level above 10 $\mu\text{g}/\text{dl}$, the current US Centers for Disease Control and Prevention blood lead level of concern (the average US blood lead level is 2 $\mu\text{g}/\text{dl}$). Lead paint and solder were banned in 1978 and 1986, respectively, by the US federal government; leaded gasoline was finally phased out in 1996. By 2002, only 310,000 US children had a blood lead level above 10 $\mu\text{g}/\text{dl}$. However, children exposed to lower levels of lead than this—through ingesting flakes or dust residues of old lead paint, for example—can have poor intellectual development and behavioral problems including aggression.

Why Was This Study Done? Although some studies have suggested that childhood lead exposure is associated with later criminal behavior, these studies have often relied on indirect measurements of childhood lead exposure such as bone lead levels in young adults or a history of lead poisoning. Other studies that have measured childhood lead exposure directly have not followed their participants into adulthood. In this new study, the researchers investigate the association between actual measurements of prenatal and childhood blood lead concentrations and criminal arrests in early adulthood to get a clearer idea about whether early lead exposure is associated with subsequent violent behavior.

What Did the Researchers Do and Find? Between 1979 and 1984, the researchers recruited pregnant women living in poor areas of Cincinnati, which had a high concentration of older, lead-contaminated housing, into the Cincinnati Lead Study. They measured the women's blood lead concentrations during pregnancy as an indication of their offspring's prenatal lead exposure and the children's blood lead levels regularly until they were six and half years old. They then obtained information from the local criminal justice records on how many times each of the 250 offspring had been arrested between becoming 18 years old and the end

of October 2005. The researchers found that increased blood lead levels before birth and during early childhood were associated with higher rates of arrest for any reason and for violent crimes. For example, for every 5 $\mu\text{g}/\text{dl}$ increase in blood lead levels at six years of age, the risk of being arrested for a violent crime as a young adult increased by almost 50% (the "relative risk" was 1.48).

What Do These Findings Mean? These findings provide strong evidence that early lead exposure is a risk factor for criminal behavior, including violent crime, in adulthood. One possibility, which the authors were unable to assess in this study, is that lead exposure impairs intelligence, which in turn makes it more likely that a criminal offender will be caught (i.e., arrested). The authors discuss a number of limitations in their study—for example, they probably did not capture all criminal behavior (since most criminal behavior does not lead to arrest). Although both environmental lead levels and crime rates have dropped over the last 30 years in the US, the overall reduction was not uniform—inner-city children remain particularly vulnerable to lead exposure. The findings therefore suggest that a further reduction in childhood lead exposure might be an important and achievable way to reduce violent crime.

Additional Information. Please access these Web sites via the online version of this summary at <http://dx.doi.org/10.1371/journal.pmed.0050101>.

- A PLoS *Medicine* Perspective article by David Bellinger further discusses this study and a related paper on childhood lead exposure and brain volume reduction in adulthood
- Study researcher Kim Dietrich can be heard talking about "The Lethal Legacy of Lead", a brief MP3 about lead exposure and violent crime
- Toxtown, an interactive site from the US National Library of Medicine, provides information on environmental health concerns including exposure to lead (in English and Spanish)
- The US Environmental Protection Agency provides information on lead in paint, dust, and soil and on protecting children from lead poisoning (in English and Spanish)
- MedlinePlus provides a list of links to information on lead poisoning (in English and Spanish)
- The US Centers for Disease Control and Prevention provides information about its Childhood Lead Poisoning Prevention Program
- The UK Health Protection Agency also provides information about lead and its health hazards

